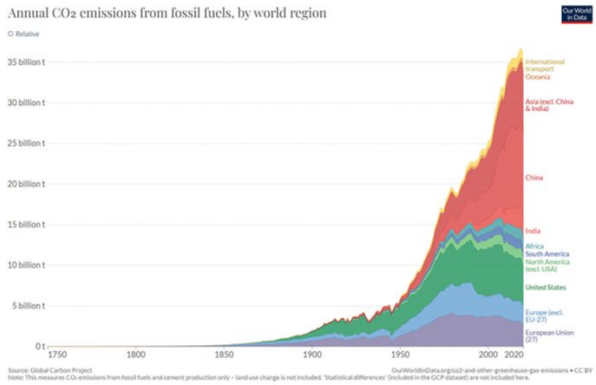
GaN ICs Drive Sustainability and Deliver CarbonNeutral Status

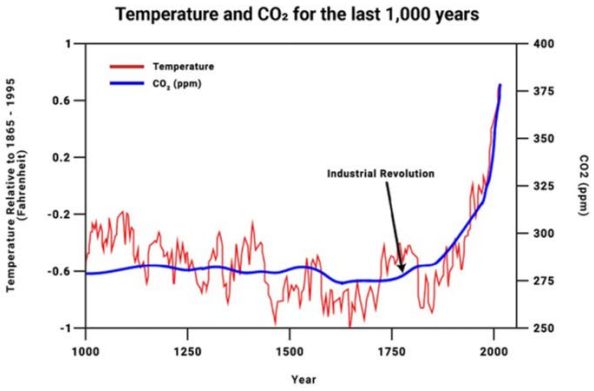
By Anthony Schiro, VP Quality & Sustainability, and Llew Vaughan-Edmunds, Senior Director of Marketing, both at Navitas Semiconductor

The Threat

In 2021, over 80% of our energy sources were based on fossil-fuel power plants and over 80% of our energy requirements were coal-, gas-, or oil-powered across consumer, commercial, and industrial markets — including transportation, IT and communications, heating, cooling, and cooking. In the past 150 years, humans have increased emissions of carbon dioxide (CO_2) into the atmosphere from nearly zero to 35 billion tons per year.[1] This gas absorbs infrared energy radiated from Earth and re-emits half of it back, contributing to the greenhouse effect.

As CO_2 emissions have exponentially grown, so has Earth's temperature. As these increases correlate closely, it is now widely accepted that the temperature rise is a clear effect from the increase in CO_2 and other greenhouse gas emissions.





Figures 1 and 2: Over 35 billion tons of CO_2 were emitted globally in 2020, aligning with a relative temperature rise of over 0.6˚F.[2]

Without any changes to improve climate policies over the 36.3-gigaton baseline (2021), total CO_2 emissions would rise to over 46.5 Gtons/year by 2050,[3] impacting global temperature by up to an additional 4.8˚C. Changes in temperature at these levels would lead to catastrophic damage across the planet, affecting weather patterns and causing unprecedented heatwaves, severe drought, and major floods that would dramatically impact all living habitats, ecosystems, and vegetation.

The Challenge

Today's energy sources primarily derive from fossil fuels and nuclear energy, with only 2% to 3% of the world's energy coming from wind and solar. However, reserves-to-production ratios estimate approximately only 50 years remaining for oil and gas and 250 years for coal.[4]

In 2020, energy demand was significantly dependent on fossil fuels, not least in transportation, where gasoline, diesel, and aeronautical fuel are required, and in buildings, where gas is predominantly used to heat water and air.

With a finite supply of fossil fuels, and their damaging impact on our planet, we now see political pressure, initiatives, regulations, and policies to drive the transition to a greener, sustainable future. The "net zero" philosophy is the first significant step toward this realization.

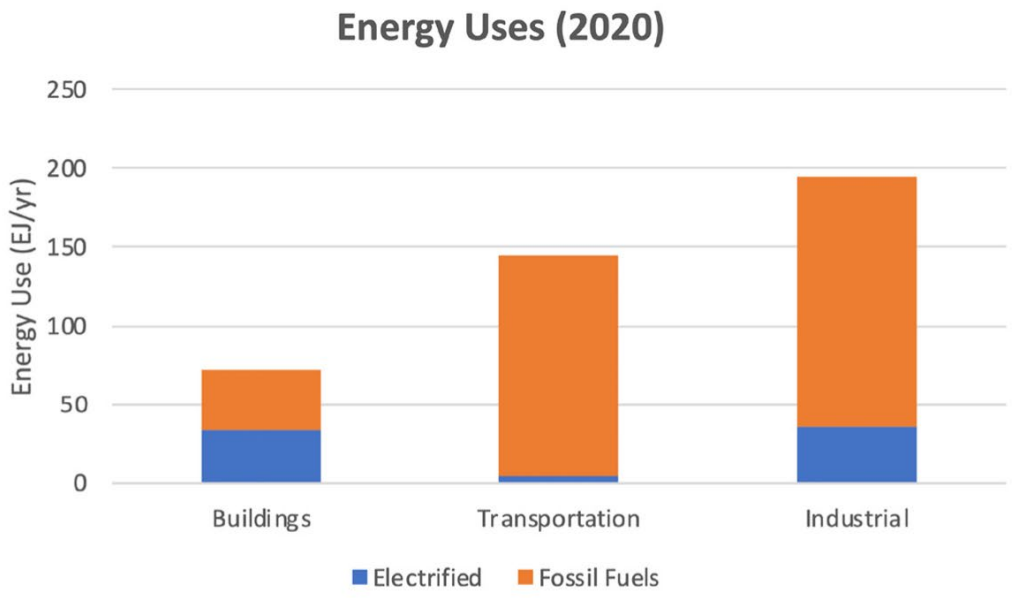


Figure 3: End-use energy by source. Electricity comprises only 45% of energy used in buildings, while electric vehicles have just ~3% market share in transportation.[5]

The Goal: Net Zero

Over 70 countries, including the U.S., China, and those in the European Union, have set net-zero targets.[6] Companies like Microsoft and PepsiCo have now committed to carbon "net zero," which is achieved by balancing the amount of carbon emitted into the atmosphere with the carbon removed from it.

Over 319 businesses have committed to the Climate Pledge, reaching the goals of the Paris Agreement 10 years early, by 2040.[7] Apple is more aggressive, committing to be 100% carbon-neutral for its supply chain and products by 2030. By using 100% renewable energy sources for its entire supply chain and influencing its suppliers to reduce or convert to renewable energies, Apple's carbon emissions have reduced by over 14 megatons annually, equivalent to the emissions from 3 million cars. Additionally, Apple invested over 6 million square feet into energy-efficiency upgrades to new and existing buildings, reducing electricity costs by 20% and saving the company $27 million.

The Mission: Electrify Our World

We need to shift the "fossil electrical" energy ratio from 80/20 to 20/80.

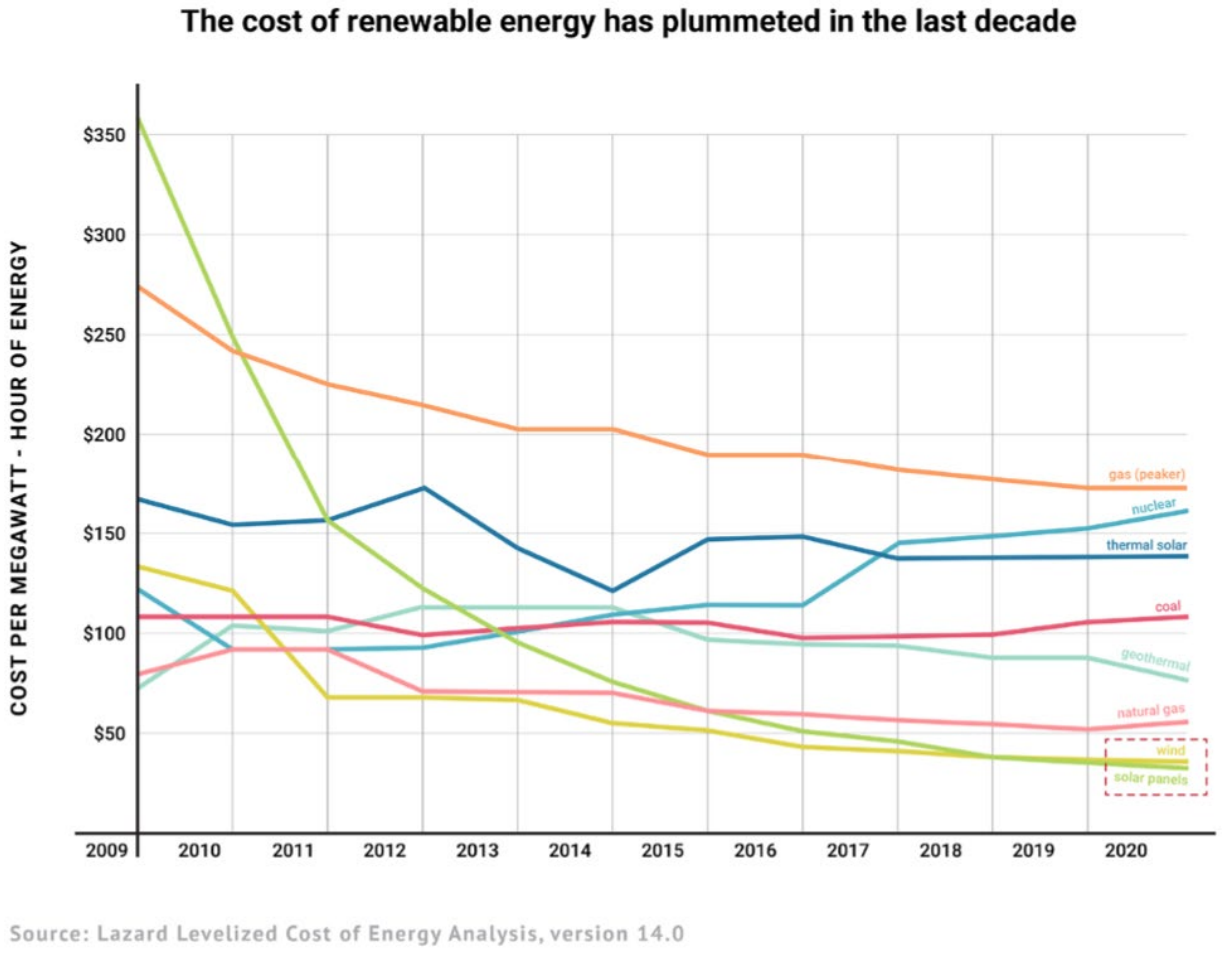


Figure 4: The price of solar and wind energy has significantly reduced over the last 10 years.[8]

The cost to generate electrical energy from solar and wind sources has significantly reduced over the last 10 years. Various sources indicate that wind and solar are now less expensive, or soon will be, in major regions of our planet versus fossil-fuel generation. Even operating costs are significantly cheaper. If the U.S. retired all its coal power plants and replaced them with solar farms, it would cut expenses by $5.6 billion per year and save 332 million tons of CO_2, reducing emissions from coal in the U.S. by one-third. In Germany, no existing coal plant has lower operating costs than new solar PV or onshore wind capacity.

This transition to renewable energies to generate electricity will be the key to achieve net-zero emissions. However, we must also consider energy demand and how to reduce the CO_2 footprint of applications that use that energy. Transportation is a great example of the green transition, with the combustion engine now being phased out and replaced with hybrid and electric vehicles. Following Tesla's lead, several companies such as General Motors and Volkswagen have announced a full conversion to sell only electric vehicles by 2030.[9] At the same time, in California, natural gas lines are no longer allowed to be installed in new homes, accelerating the adoption of electric cookers, space heaters, and heat pumps, which are highly efficient HVAC systems that run entirely on electricity.

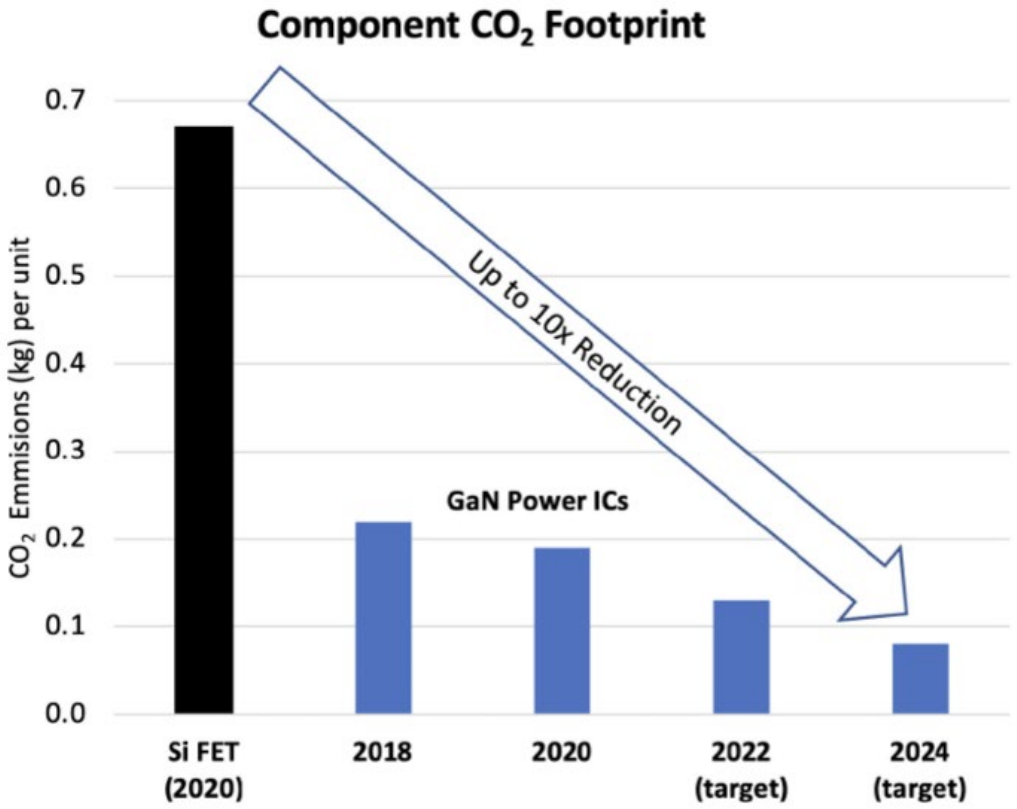


Figure 5: GaNFast power ICs offer 5× reduction in CO2 versus legacy silicon FETs. New generations on 200-mm wafer processing are expected to offer 10× reduction in CO_2.

The Enabler: GaN

Gallium nitride is a next-generation semiconductor, and replacing legacy silicon chips with GaN ICs in power-conversion systems offers a significant opportunity to achieve net-zero goals. Navitas Semiconductor's GaNFast power ICs are devices that enable up to 40% energy savings and reduce or eliminate external components and heatsinks, resulting in 50% reduction in size and weight compared with old, silicon-based solutions.

What's more, the manufacturing of GaNFast power ICs requires less energy, water, and other resources compared with silicon equivalents. Additionally, the GaN device is significantly smaller, due to superior characteristics that derive from GaN being a wide-bandgap semiconductor material. Combining these factors enables a 10× lower CO_2 footprint than silicon equivalents at the component level.

At the system level, the high-performance benefits of GaNFast ICs and the integration of power, control, protection, and sensing into a single device enables higher efficiency, translating not only into the consumption of less energy but also lower operating temperatures, minimizing or eliminating the need for heatsinks and larger cases. The higher-frequency capability of GaN enables end-application "dematerialization," i.e., the requirement for fewer, smaller passive components (such as magnetics, filters, capacitors) and fewer, smaller, or eliminated mechanical components (such as PCBs, housings, and heatsinks). These factors, in turn, reduce oil/refinement demand and lower shipping costs, further minimizing CO_2 footprint. Compounding all these factors in a life-cycle analysis, every GaNFast power IC shipped saves a net 4 kg of CO_2 versus legacy silicon equivalents.[10]

As more companies commit to net-zero initiatives, transitioning from silicon to GaNFast solutions can support their journey to reducing their own total CO_2 footprint, as well as creating more efficient, smaller solutions and improving overall cost structures.

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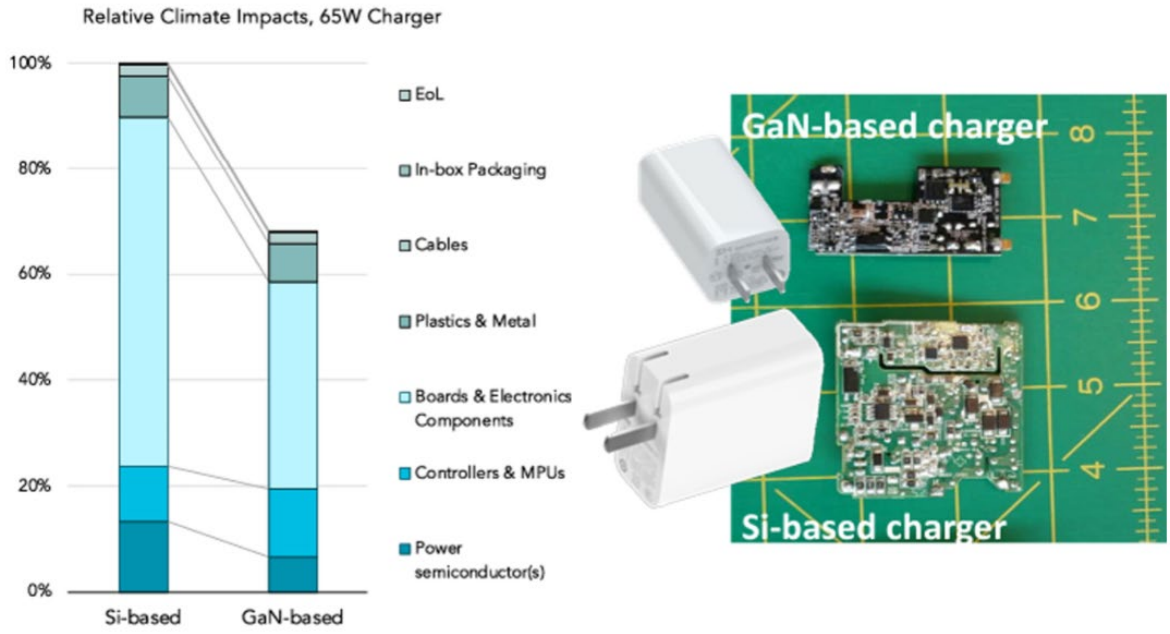

Figure 6: Converting from a silicon to a GaN solution in every mobile charger would save over 9 billion kWh and over 6 billion kg of CO_2 by 2025, equivalent to 1.3 million ICE passenger vehicles or almost 14 billion barrels of oil.[9]

Conclusion

GaN power ICs make electricity more efficient, more reliable, and lower-cost, all of which serve to accelerate the world's move from coal-fired power plants to solar- and wind-based energy sources and to evolve energy applications from gas-powered transportation, buildings, and industrial factories to clean, electricity-based energy.

In May 2022, Navitas became the world's first semiconductor company to achieve CarbonNeutral company status, as designated by the leading experts on carbon neutrality and climate finance Natural Capital Partners. Through extensive, third-party–verified analysis, Navitas has shown that producing GaN devices delivers a 70% reduction in carbon footprint versus silicon and drives a 30% reduction in manufacturing and use-phase impacts for customers.

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