Sustainability Benefits of GaNFast Power ICs

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Navitas

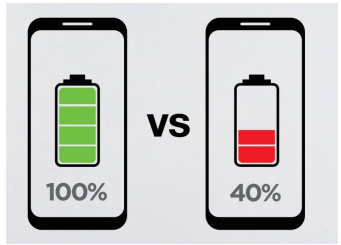
GaNFast Power ICs: Initial Design Focus – Mobile chargers

- Implement GaN Technology in the mobile charging market to:

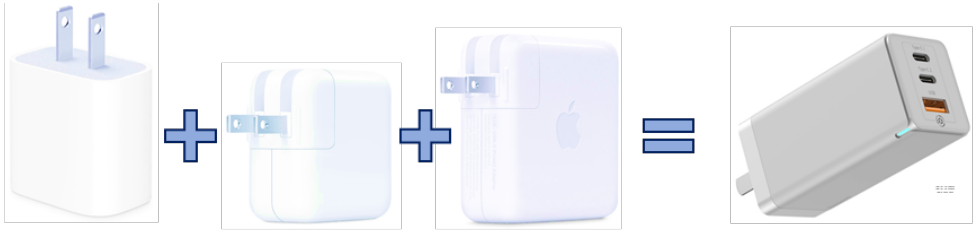
Reduce Size/Materials

Increased Efficiency
(less wasted energy)

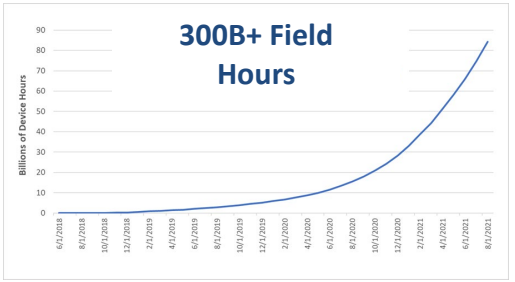
Reduce Charging Time



Enable Fewer Chargers

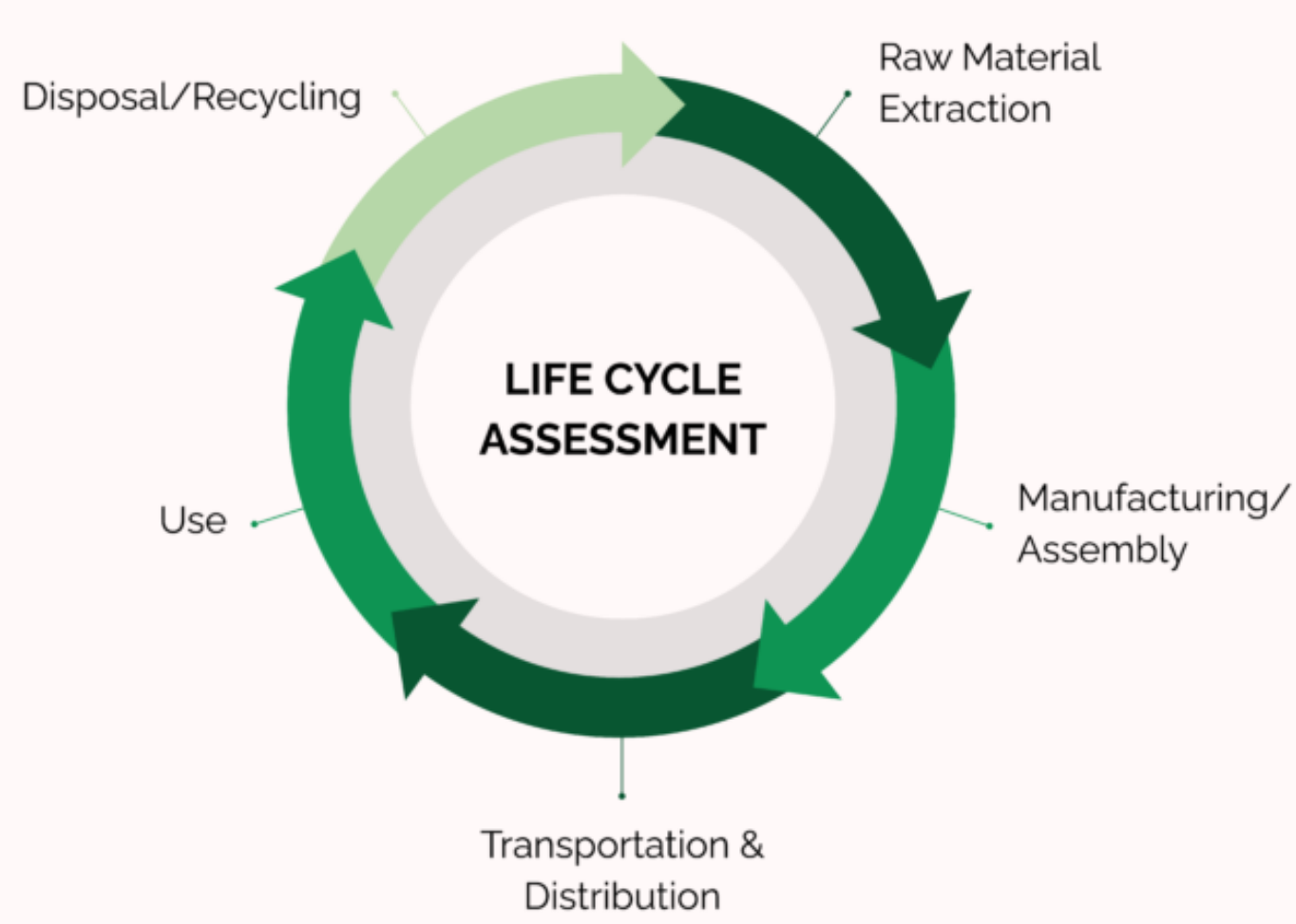


Prove Field Reliability



- With so much material and energy savings – how do we quantify the Sustainability benefits of GaN?

Product Lifecycle assessment (LCA)



Collect product data

Raw material impacts
Manufacturing impacts
Use phase impacts

Analyze data

Simulation software
Carbon emissions databases
Research studies

Report Results

LCA report

PDF

Navitas GaNFast Power IC and 65W USB-C Charger LCA Report 2022

LCA Study: Goal & Scope

- Assess the potential life cycle environmental benefits of GaN power semiconductors in place of conventional Si
- Confirm alignment of life cycle impacts with product intent
- Understand potential hotspots and design factors

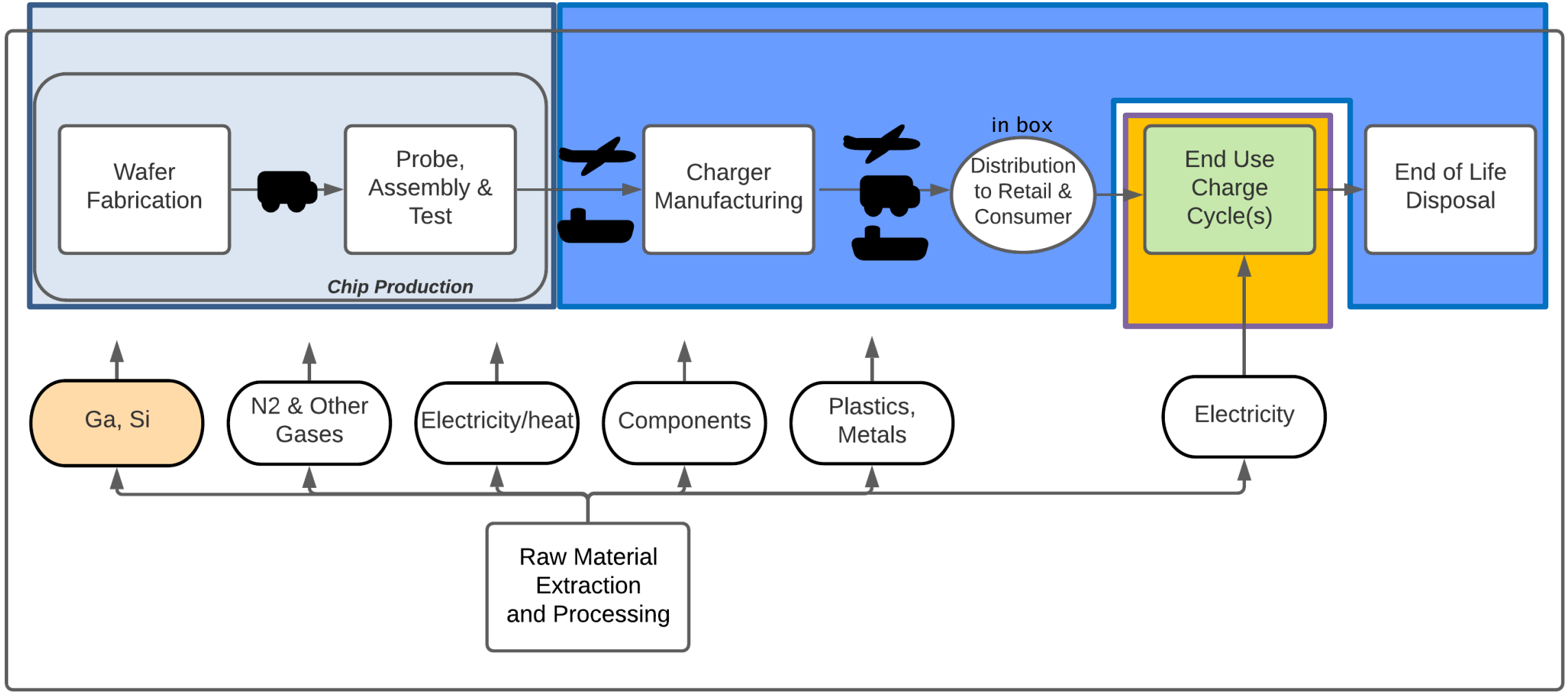
Functional Units I & II: 1 wafer, 1 die

- Production of GaN and Si power semiconductor wafers (6”, 8”, respectively) and dies

Functional Unit III: “charging a laptop over charger life”

- Provision of charging service in the US & China –with 65W GaN-based and Si-based chargers

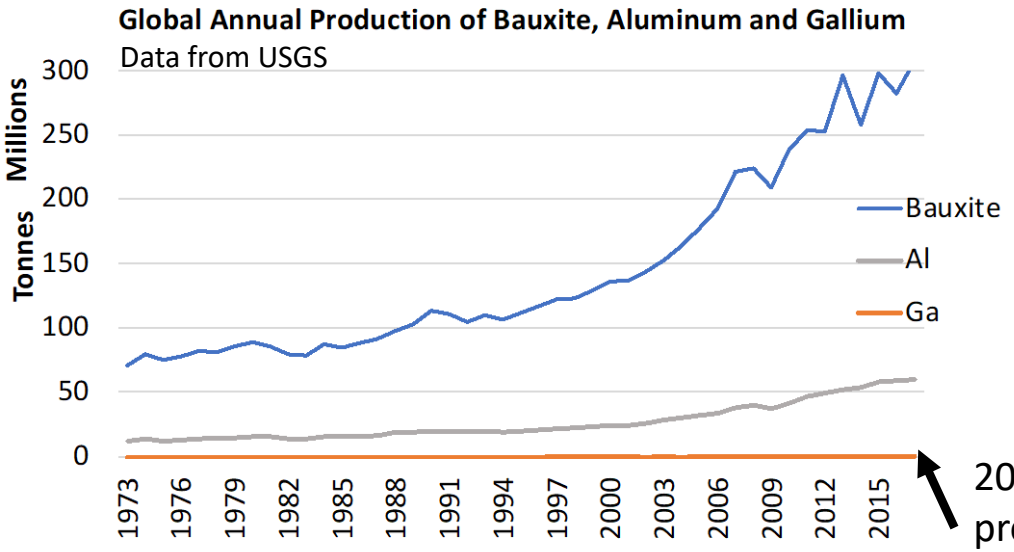
LCA: System Boundary Cradle to Grave



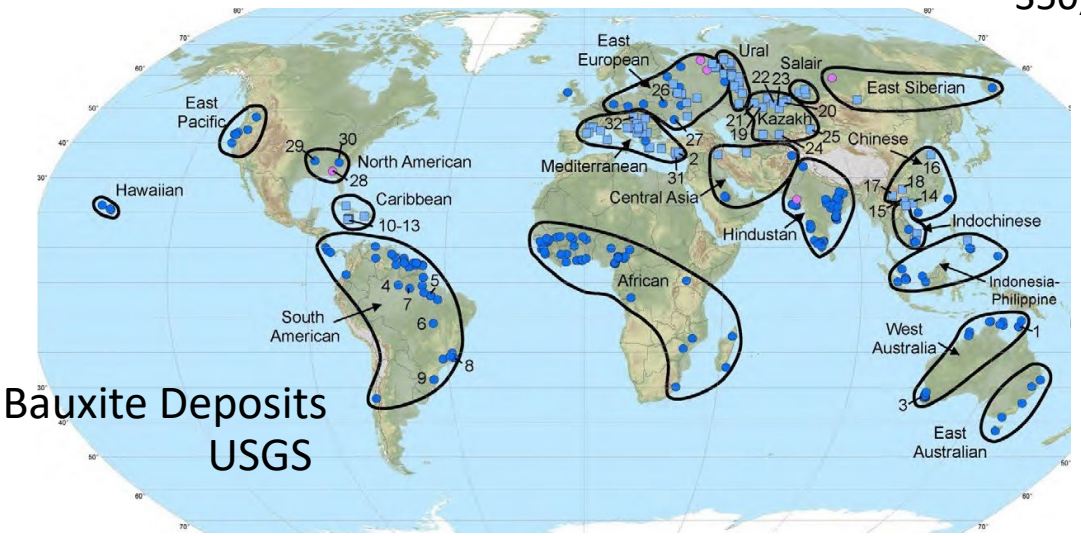
LCA: Technical Details (Data Sources, Simulation Tools)

Inventory	
Primary data	Test data (energy use & efficiency, including standby or parasitic energy consumption), product teardowns, BoM data **Primary component fabrication: literature, expert input**
Background data	Secondary components – library data (ecoinvent 3.7, GaBi electronics extensions 2021) ecoinvent 3.7, Market and literature values, expert consultation
Geography & Logistics	
Manufacturing	Fabrication (wafer, die) - Taiwan, Grid electricity Chargers – Guangdong, China, Grid electricity
US Use	West Coast US, WECC Grid or Household solar Via air from Taiwan, sensitivity for ocean transport
Chinese Use	Guangdong Province, Chinese Grid or Household solar Via air from Taiwan, sensitivity for ocean transport
Use/Operating	
Charger life (default)	3 years (used 50 weeks/year, 5 days/week for 3 years, charger unplugged rest of time)
Usage scenarios	Business travel, business office, business+home office, home use
Impact Model(s) & Tools	
IAMs	IPCC 2013 100y; ReCiPe 2016 Endpoint H/A; AWARE; CED
Tool(s)	SimaPro 9.1.1

LCA: Raw Material Extraction and Material Replacement

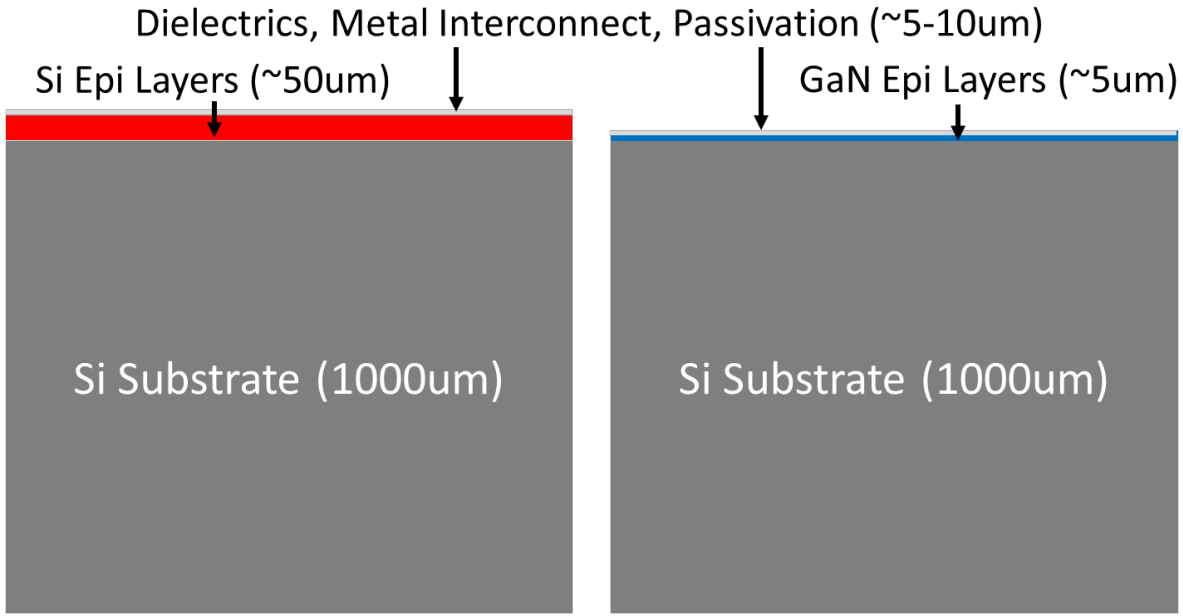


2019 Ga production 350,000 kg



Bauxite Deposits USGS

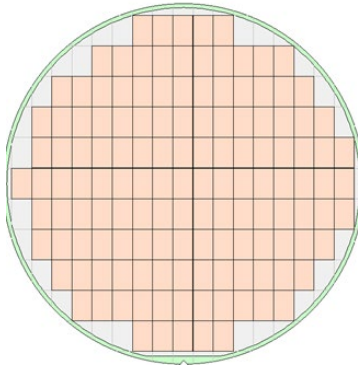
- Ga is a byproduct of bauxite processing with ample available supplies
- <1% of the Si material is replaced
- 1billion GaN chips uses <40kg of Ga

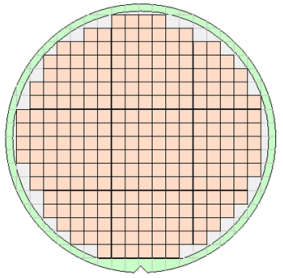


LCA: Manufacturing Carbon Footprint

- After GaN epi, GaN technology is similar to existing CMOS processing technology
- Existing (sometimes idle) 6” and 8” fab capacity/infrastructure can be used with small investment

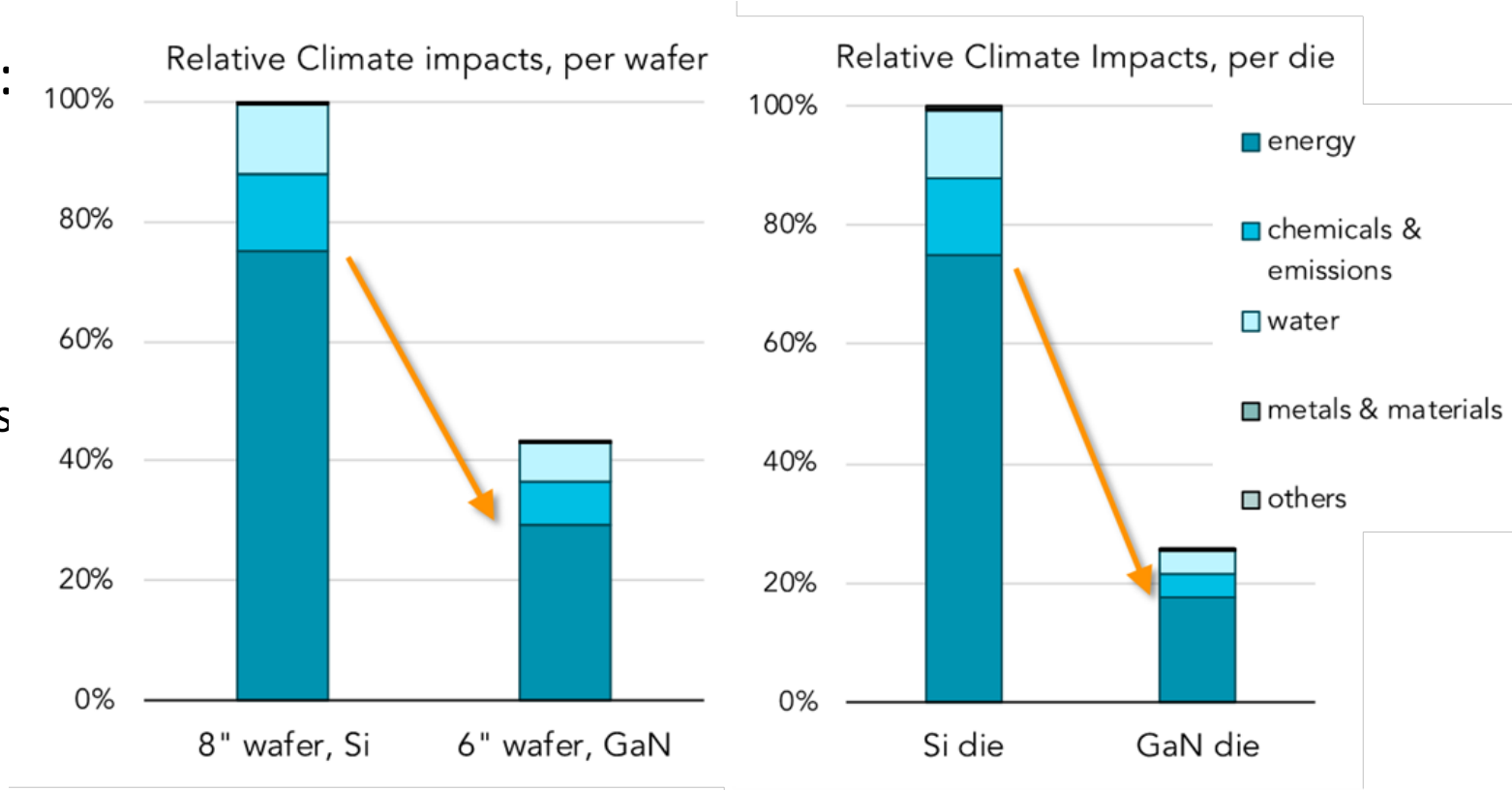
	Si HV MOSFET	**GaN 650V HEMT**
Material	Si wafer	Si wafer
Wafer Diameter	8”	6”
Starting Wafer Thickness	500-1000um	1000um
Finished Wafer Thickness	100-200um	250-300um
Die per wafer (equivalent device)	1	1.7





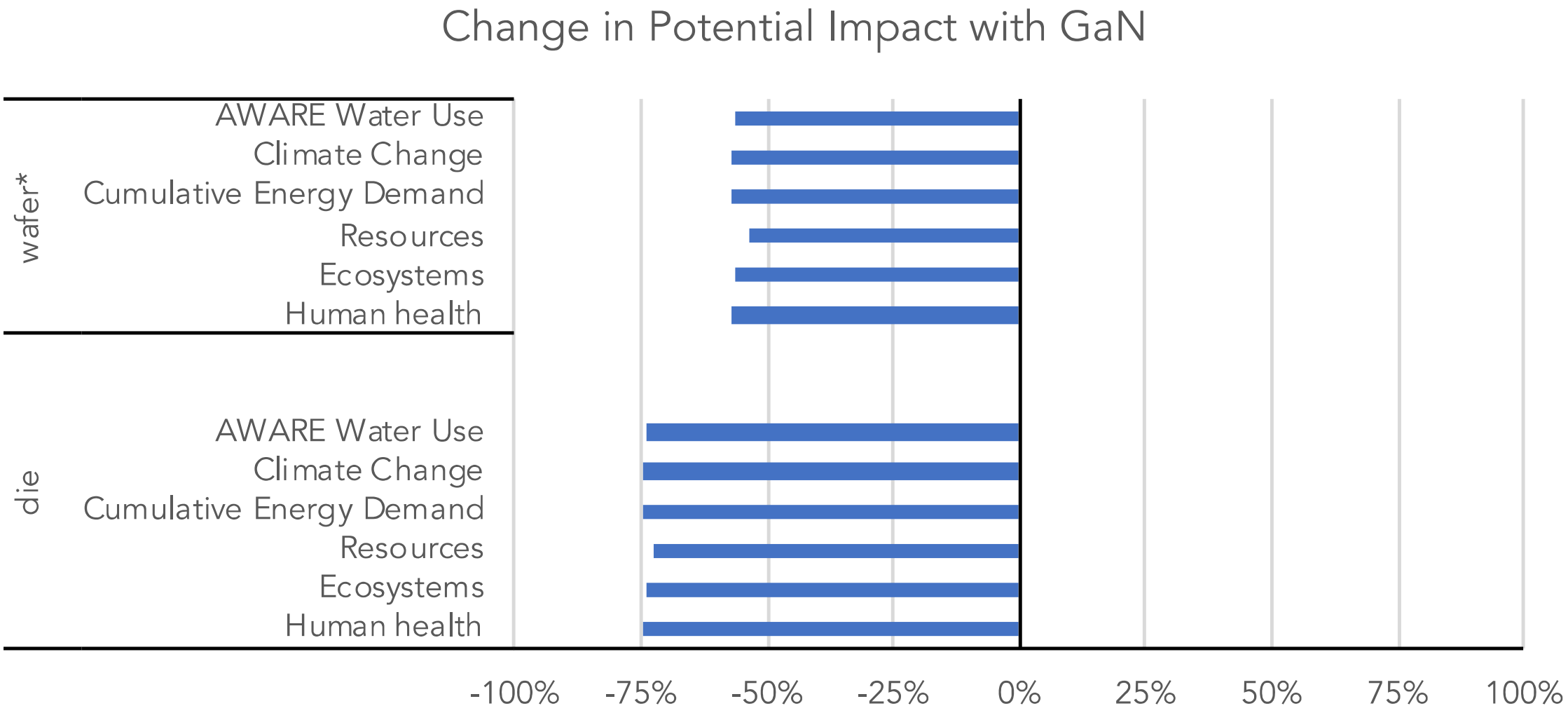
LCA: Manufacturing Carbon Footprint
Energy demand drives environmental impacts in fabrication

- Decreased impacts for GaN power semiconductors arise from:
  - Epi growth is the primary factor for energy use in the wafer fab process
  - The GaN Power IC process has significant less epi growth than super-junction high voltage MOSFETs
  - Overall decreased energy needs in fabrication across all process steps
- 70% smaller die for the same performance drives a 70%+ reduction in carbon footprint per unit

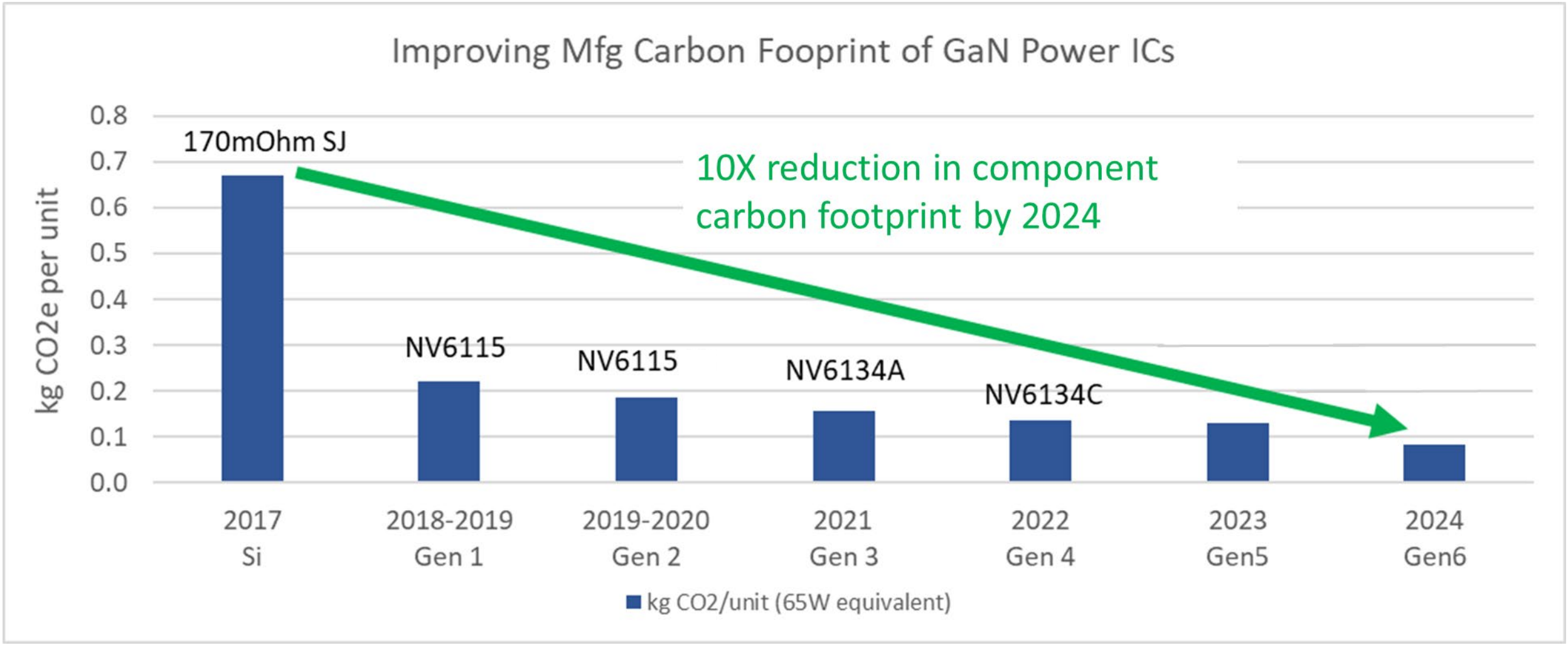


LCA: Manufacturing Carbon Footprint

GaN shows reduction in all assessed categories

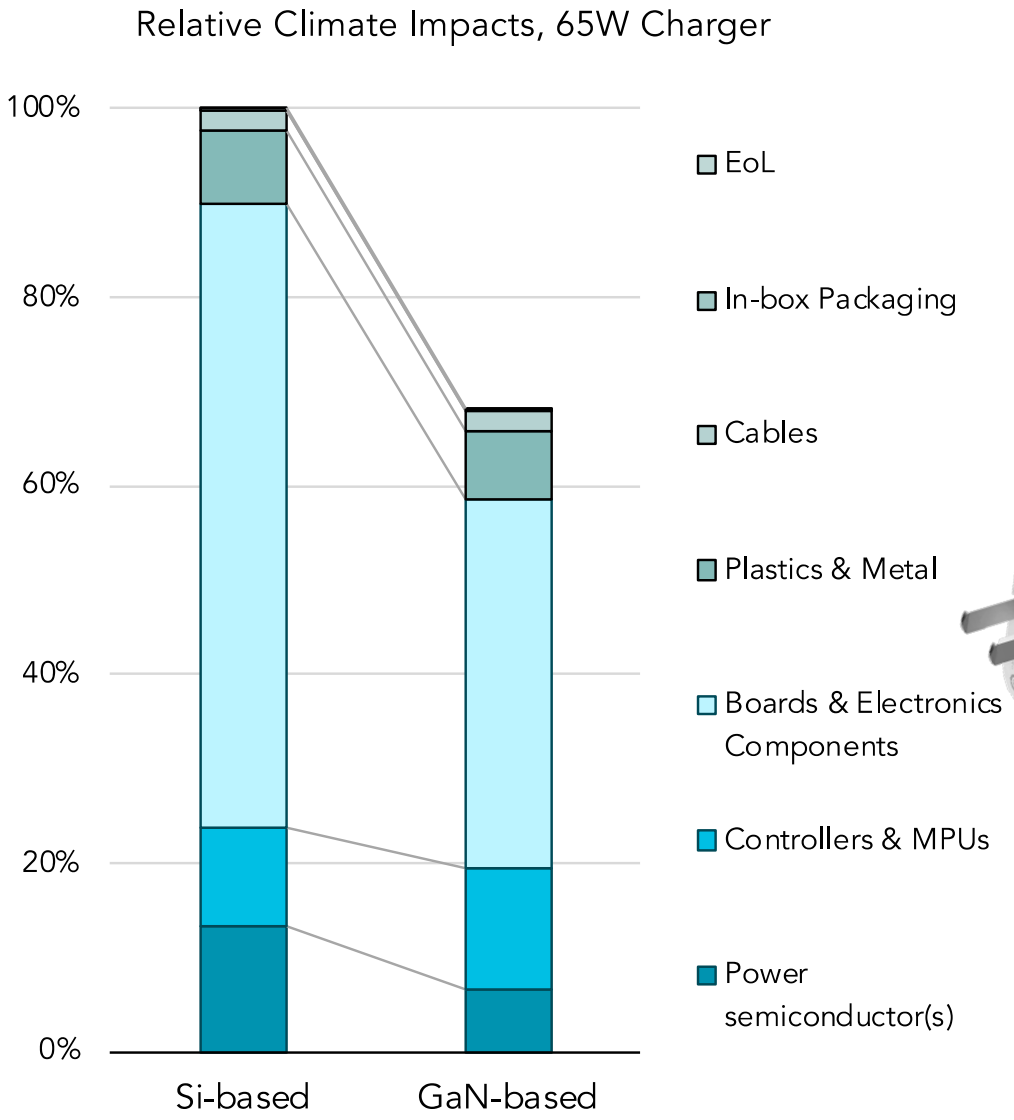


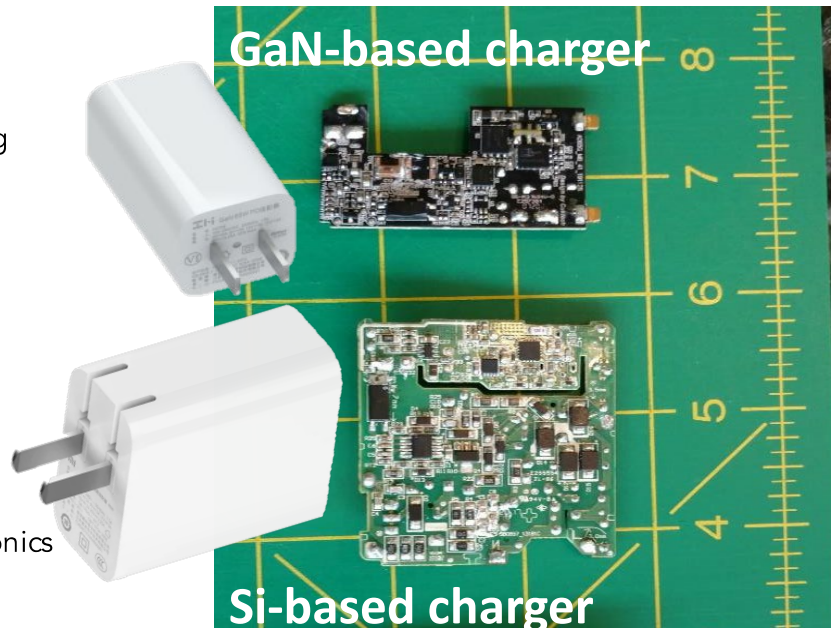
Carbon Footprint Reduces with GaN Tech/Product Advances

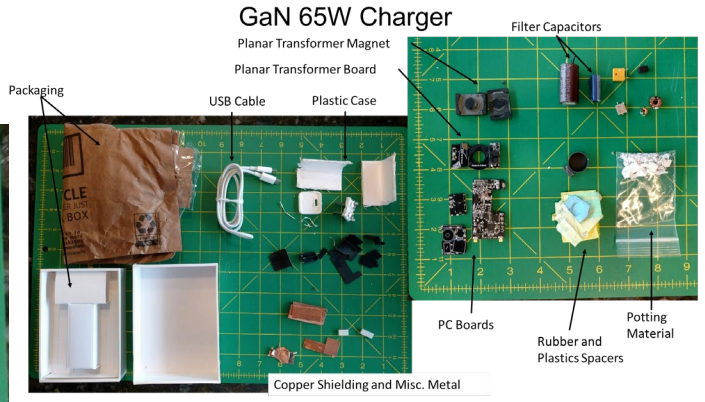


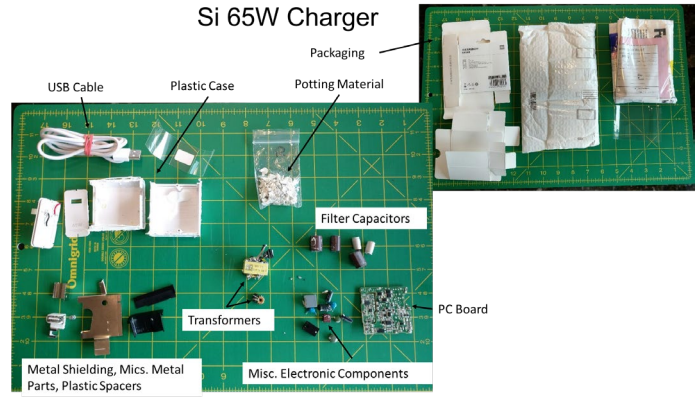
LCA: System Manufacturing Footprint

GaN Power IC decreases charger components, material, size, weight



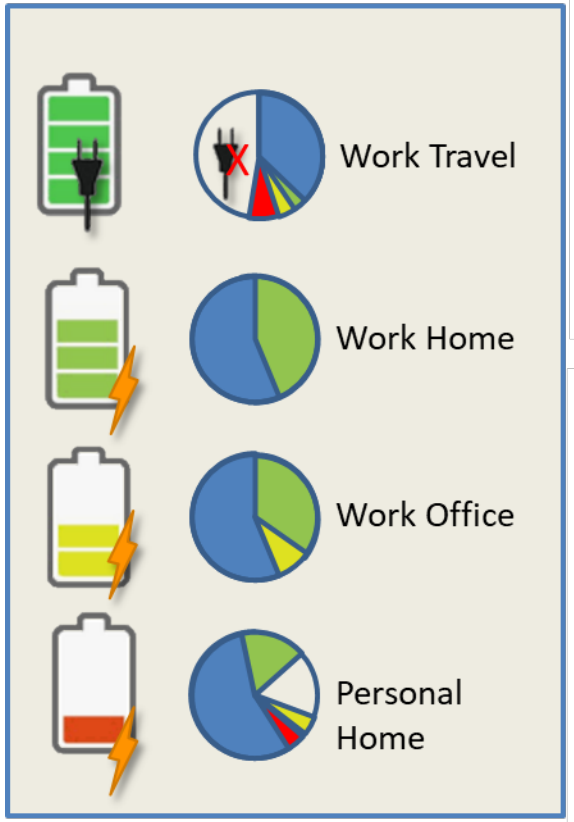


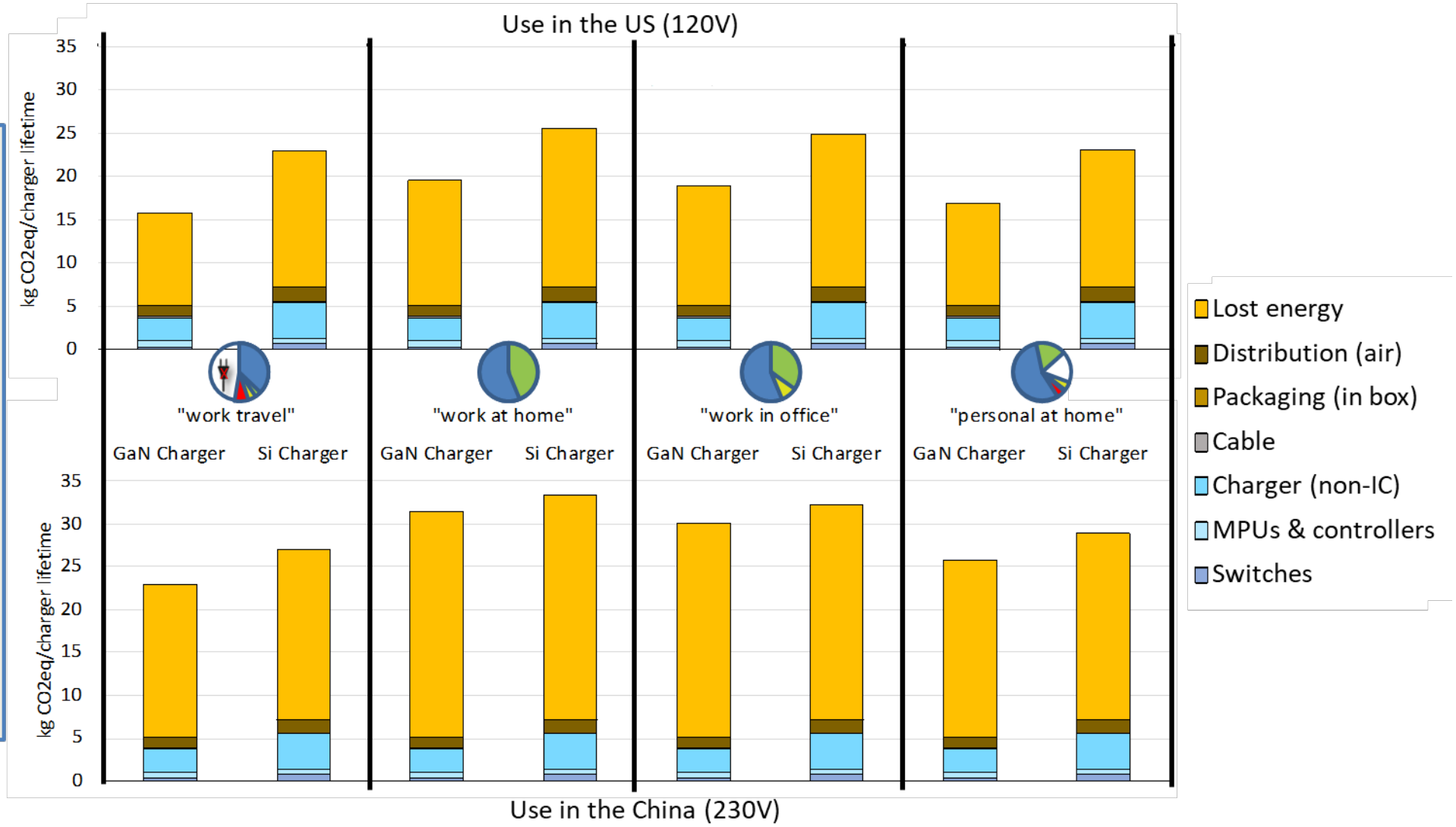




LCA: System Energy Use Carbon Footprint

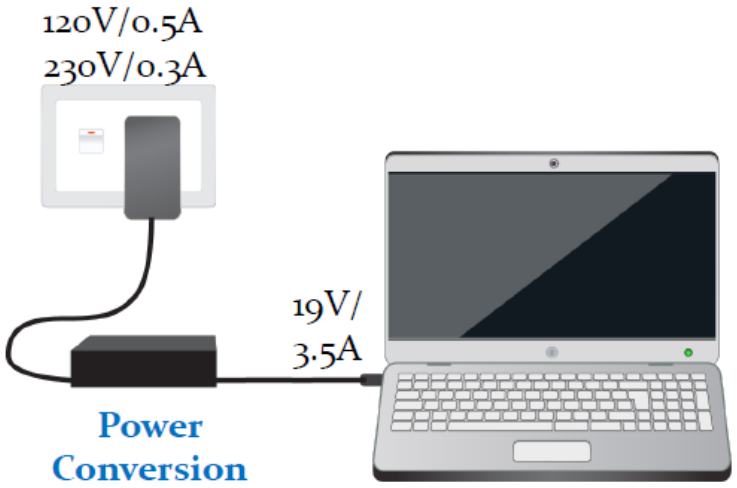
Use phase is the most significant contributor to impacts

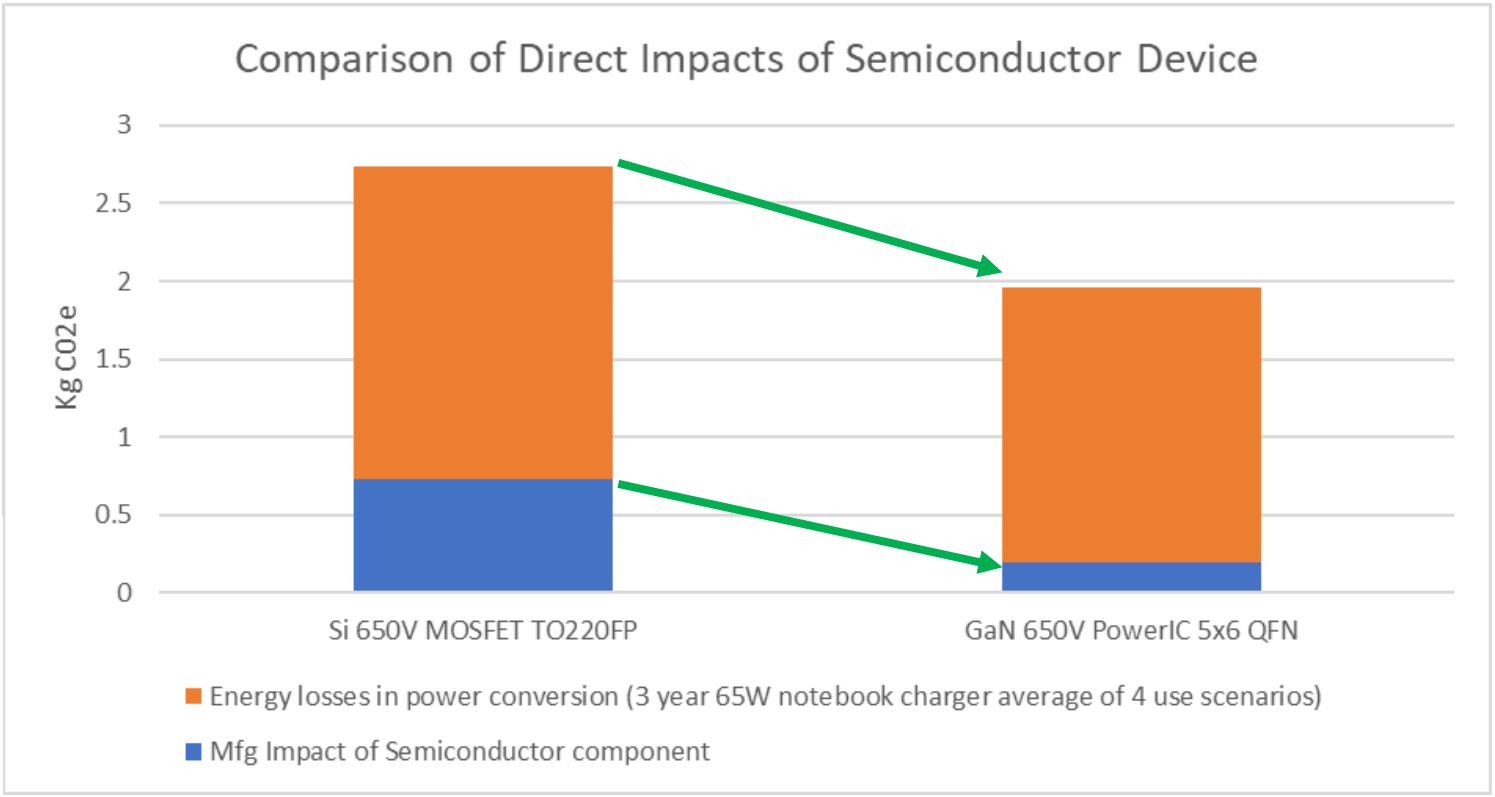




Product and System LCA Results

GaN device saves 0.8kg CO2e per unit

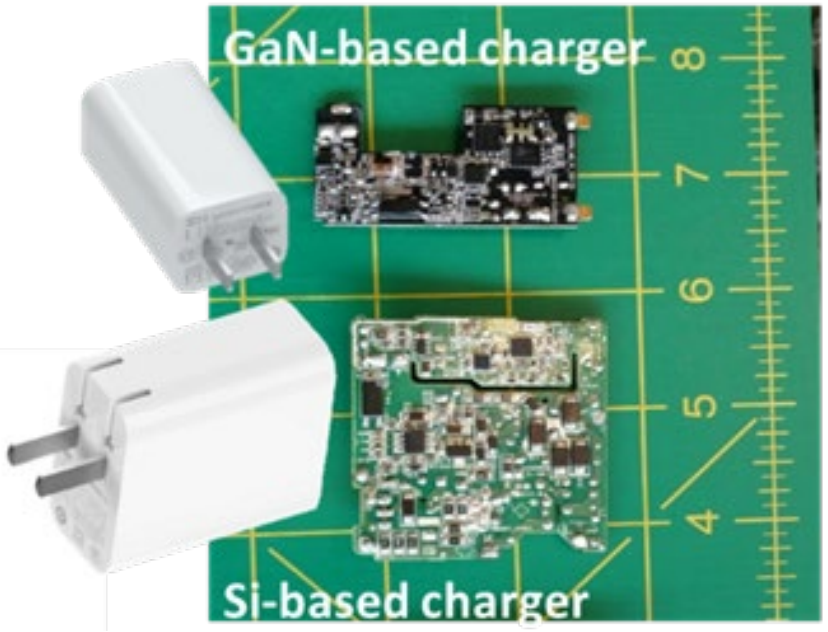


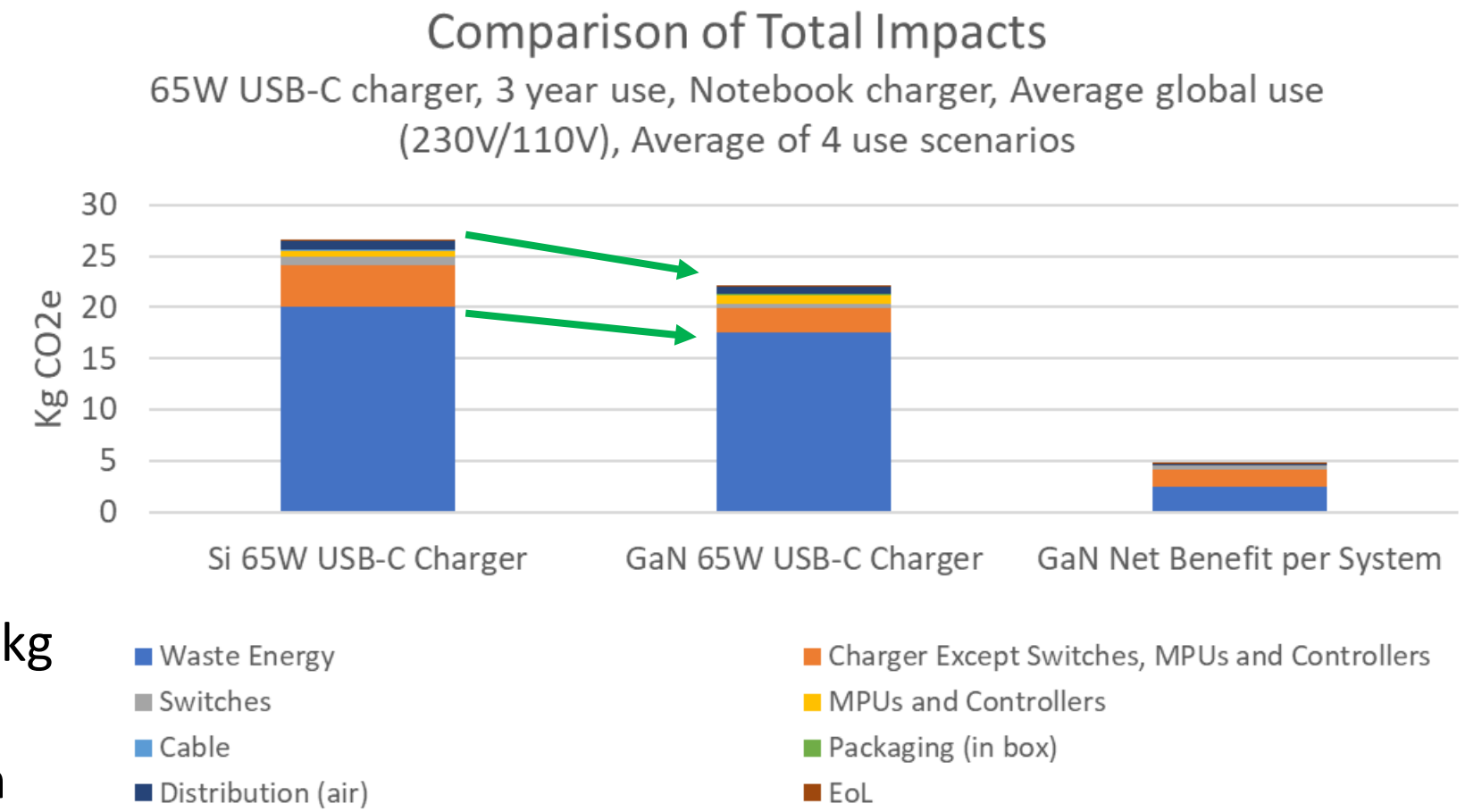


- Efficiency of GaN Power IC 0.3kg
- Lower Carbon Footprint of GaN Power IC 0.5kg
- Achieves 30% reduction in direct Carbon Footprint impacts

Product and System LCA Results

GaN based USB-C charger saves 4.6kg CO2e per unit





- Efficiency improvement 2.5kg
- Dematerialization 2.1kg
- Achieves 20+% reduction in Carbon Footprint impacts

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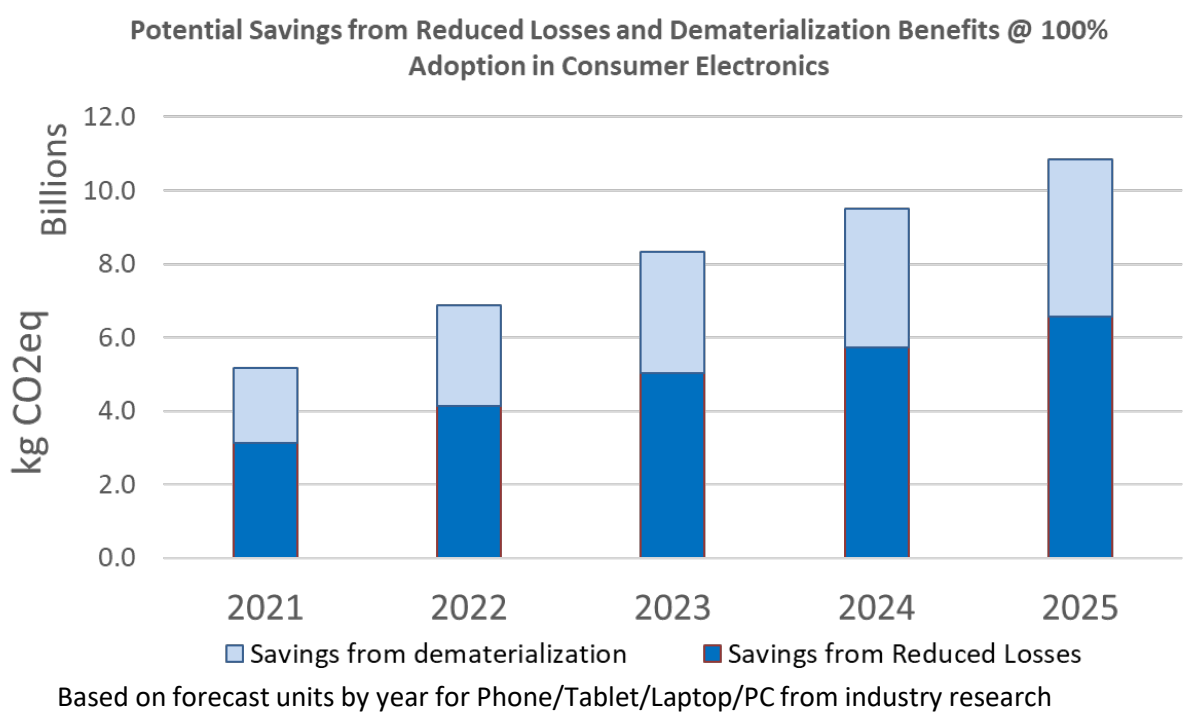
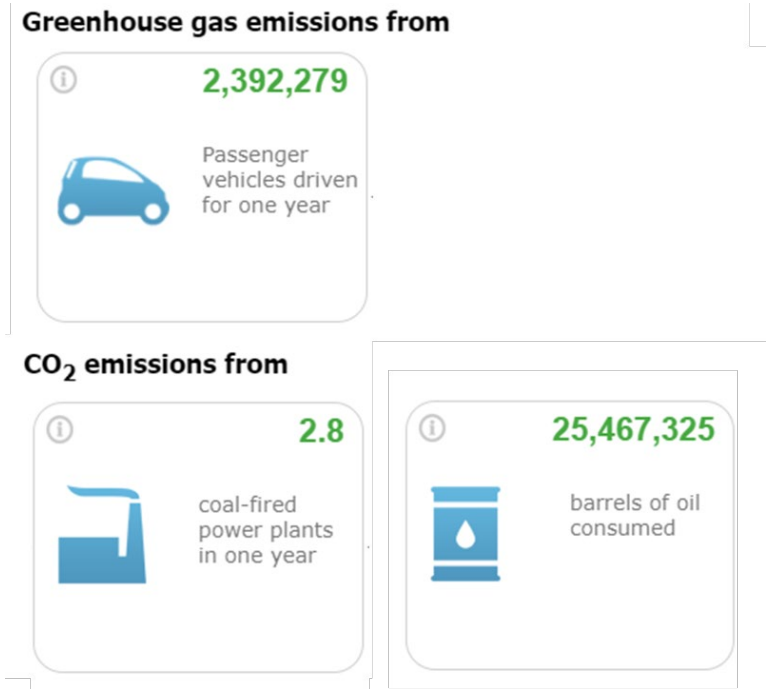


Based on forecast units by year for Phone/Tablet/Laptop/PC from industry research



Navitas Case Study

Total Company + Product Impacts in 2021

29.2 metric tons CO2e

Total Benefit of GaNFast IC's in 2021

109 metric tons CO2e

Power Semi Conversion from Si to GaN Drives Carbon Footprint Reduction and Accelerates the Global Path to Net Zero

Acknowledgements and Questions

- Special thanks to LCA experts:
  Lise Laurin, Caroline Taylor, Tom Etheridge (Earthshift Global)