“Electrify Our World™”

Gene Sheridan
CEO, Co-founder
The 80% Fossil Fuel Challenge

Energy Supply

- Renewables
- Fossil Fuels 80%

Energy Consumption

- Low Efficiency
- Direct Use
- Electrical
- Combustion 80%
The 80% Electrical Solution

Energy Supply
- 2020: Fossil Fuels 80%
- 2050: Renewables 80%

Energy Consumption
- 2020: Low Efficiency, Combustion 80%
- 2050: High Efficiency, Electrical 80%
Legislation Catching Up

1992 Voluntary. 3x reduction in refrigerator energy use since 1980

2004 Voluntary. ~60% energy savings for server AC-DC.

2023 Compulsory. ‘Titanium plus’ (>96%) data center power

2022 Compulsory. 50 California cities banned gas stoves in new buildings.
2030 Compulsory. No natural gas-powered furnaces and heaters
2035 Compulsory. No gas-powered “small off-road engines”
2035 Compulsory. Advanced Clean Cars II – 100% zero-emission sales

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Critical Upgrades in Power Semiconductors

Note: Navitas estimate of GaN- & SiC-based power systems compared to silicon in the 2024-2025 timeframe.
The GaN Revolution: Ultimate Integration

**GaNFast™**

- **200-300 kHz**
- **SiC FET**
- **Discrete GaN**

- Old, slow
- High Q\_g
- High C\_oss
- F\_SW < 100 kHz

- Exposed gate
- External gate drive
- dV/dt sensitivity
- Layout sensitivity
- ESD sensitivity
- Unknown reliability
- Unknown robustness

**GaNFast plus:**

- Autonomous Standby
- Autonomous Protection
- Loss-less Current Sensing
- High Precision
- High Efficiency

**GaNSense™**

- **500 kHz**
- Internal Gate
- Integrated Gate Drive
- dV/dt Immunity
- Layout Insensitive
- 2 kV ESD rating
- Proven Reliability
- Proven Robustness

**GaNSense Half-Bridge**

- **1 MHz**
- Highest integration
- Integrated HS and LS FETs
- Integrated level-shift isolation
- Integrated boot-strap
- Shoot-through protection
- Enlarged cooling pads
- Fastest switching
- Highest efficiency

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Largest range of SiC FETs & diodes (650 V to 6.5 kV)

Lowest $R_{DS(ON)}$ at high temperature (25% lower than industry typical)

World-class survival duration in fault condition

Based on Navitas testing of 1200V SiC MOSFETs vs. competitor products


Fast Switching

Highest efficiency hard-switch, soft-switch
(Lowest $E_{ON}$, $E_{OFF}$, $E_{ZVS}$ losses)

Cool Operation

Lowest $R_{DS(ON)}$ at high temperature
(25% lower than industry typical)

100%-Tested Robust Avalanche

Highest published capability to handle excess energy in fault condition

Long Short-Circuit Withstand Time

World-class survival duration in fault condition

Matching currents (Stable $V_{TH}$)

High-Power Paralleling
From:

20 W Mobile fast-chargers, and
20 kW EV on-board chargers, to
20 MW Grid-tied systems

Navitas GaNFast power ICs and GeneSiC power FETs and diodes drive efficiency, power density and lower system costs
True GaN Integration Drives Speed, Size

GaN MCM 45W

Speed Shrinks Passives

65 kHz
Bobbin Transformer (23 mm thick)
Electrolytic Capacitors
52 x 53.1 x 30.1 mm = 83 cc Case + pins
0.5 W/cc

6x Faster

3x Smaller

400 kHz
Planar Transformer (8 mm thin)
No Electrolytic Caps
82.2 x 39.0 x 10.5 mm = 34 cc Case
1.5 W/cc

(1) Samsung 45W charger (GaN MCM) vs. OPPO 50W SuperVOOC Cookie (Navitas GaN IC)
GaNFast Exceeds “Titanium” with >2x Power Density

- Euro ‘Titanium plus’ standard from January 1st, 2023\(^1\)
- Design Center: 4 platforms, 8 customer projects (1.3 kW, 1.6 kW, 2.7 kW, 3.2 kW CRPS\(^2\))
- GaN can reduce electricity use by up to 10%, save >15 TWh or $1.9B/yr \(^3\)

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**Slow Silicon AC-DC 3,200W**

- 47 kHz
- 325 x 107 x 41 mm
- 2.2 W/cc

**GaNFast AC-DC 2,700W**

- >2x higher power density
- >30% reduction in energy loss
- 300-500 kHz
- 185 x 73.5 x 39 mm
- 5.1 W/cc

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“**GaN is a breakthrough new technology that is enabling dramatic reductions in size, energy savings and power density**”

“Navitas is an excellent partner with industry-leading GaN ICs”

Robin Cheng, VP R&D

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\(^{2}\) CRPS = Common Redundant Power Supply standard, defined by Intel for standardized mechanical form factors, targets hyper-converged compute, storage and networking eqpt.

\(^{3}\) Navitas est. based on a) Navitas server/datacom forecast & AAAS data, b) $0.12/kWh, c) Si vs. GaN $/W and d) data center loading profile. Estimated based on known existing Si-based solutions to deliver >500A next-generation data processors to Navitas targets for new GaN-based AC/DC and DC/DC for these same next-generation data processors.
**GaN + SiC for Solar & Energy Storage**

**Synergistic & Engaged Customers**

- **Lower Inverter Cost**
  - Silicon: $0.100/W
  - GaN: $0.075/W
  - 25%+ Savings

- **Less Inverter Power Dissipation**
  - Silicon: 158 W
  - GaN: 94 W
  - 40%+ Energy Savings


**Market Potential for GaN/SiC**

- **5-10kW Residential** >$1.40B
- **1kW residential (micro)** >$1.00B
- **Energy Storage** >$1.25B (50% attach rate)
- **Commercial (string)** >$1.00B
- >$4.65B

(1) Navitas est. 6.2 kW residential installation with silicon inverter at 97.5%, GaN at 98.5% efficiency.
(2) Market estimates for 2030, based on DNV and Navitas analysis.

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$12B/yr Potential for GaN/SiC by 2030(1)

OBC > $38
DC-DC > $12
Traction drive >$286

• Total: >$330 per EV = $10.1B
...and >$1.9B in road-side chargers

4 platforms in development, for 8 customer projects

• 400V 6.6 kW W bi-directional charger (2-in-1)
• 800V 6.6 kW bi-directional charger and DC-DC (3-in-1)
• 22 kW wall charger (400V and 800V versions)

Dedicated EV System Design Center

Synergistic & Engaged Customers

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90% Energy Saving vs. AC Motors

Legacy Si-Based Brush-less DC (BLDC) Motor & Inverter for Washing Machine (~80% efficiency)

GaN-Based 300W 3-phase Platform for Inverter-Motor Integration

- 2x higher frequency
- >60% fewer components, PCB area
- 95-97% efficiency
- 80% energy savings vs Silicon BLDC
- 90% energy savings vs AC motors
- High reliability
- Fast time to market
- 50-300W Motors = $1.5B/yr GaN Opportunity

(1) Navitas estimate 50-300W motors, including circulators, hydronic pumps, aircon IDU/ODU fans, HVAC, air purifiers, hair dryers, refrigerator compressors, dishwashers, washing machines.

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GaN ICs: significant reductions in device carbon footprint

Enable significant reductions in application size, CO₂ footprint

Third-party life-cycle analysis (LCA): ISO14040/44-compliant
Navitas saved almost 140,000 metric tons CO₂e to date

Sustainability Benefits of GaNFast ICs

Navitas Energy Savings Benefits

33.6 GWhr energy / 23,756 tons CO₂e saved in application use

Navitas Dematerialization Benefits

115,629 tons CO₂e saved from application size and weight reductions

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Leader in Sustainability

Every GaNFast™ IC saves\(^{(3)}\) 4 kg CO\(_2\)

4x-10x lower component CO\(_2\) footprint than silicon\(^{(1)}\)

28% lower lifetime CO\(_2\) footprint for chargers / adapters\(^{(2)}\)

Accelerates transition from ICE to EV by 3 years, saving 20%/yr of road-sector emissions by 2050 \(^{(3)}\)

GaN saves up to 2.6 Gton / year by 2050 \(^{(4)}\)
SiC saves up to 3.4 Gton / year by 2050 \(^{(5)}\)

February ’22 First GaN sustainability report based on global standards.

May ’22 World’s first semiconductor company CarbonNeutral® certified

August ’22 First 100,000 tons CO\(_2\) saved

October ’22 Recognized for industry-leading sustainability reporting

(1) Earth-Shift Global LCA, Navitas data. (1) Earth-Shift LCA. (3) DNV assessment based on LCA, Navitas data. (4,5) Navitas estimate based on DNV data, Yole projections, Navitas system estimates.

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