Navitas Semiconductor
“Electrify Our World™”

Pure-Play
Next-Generation
Power Semiconductors

March 7th, 2023
The Fossil Fuel Challenge

Energy Supply

Renewables

2020

Fossil Fuels
80%

Low Efficiency

Direct Use

Energy Consumption

Electrical

Combustion
80%

Only 20% Electrified
The Electrified World

**Energy Supply**

**2020**
- Fossil Fuels: 80%
- Renewables

**2050**
- Fossil Fuels
- Renewables: 80%

**Energy Consumption**

- Electrical: 80%
- Combustion: 80%

**2020**
- Low Efficiency
- Direct Use

**2050**
- High Efficiency
- Direct Use

Target: 80%
August 15th, 2022: Navitas Semiconductor, industry-leader in gallium nitride power ICs, acquired GeneSiC Semiconductor, silicon carbide pioneer and industry leader.
The Only Pure-Play, Next-Gen Power Semi Player

- Faster Switching
- Smaller & Lighter
- Higher Power Density
- Faster Charging
- Lower System Cost

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

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$22B ‘Pure-Play’ Market Opportunity (1)

1) 2026E potential, Source: Yole, DNV, IRENA, Fraunhofer ISE, IHS, Cisco, Hyperscale, Peer annual reports, Wall Street research.

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The Second Revolution in Power

- 1977: Linear Regulators
- 1987: Switching Regulators
- 2014: 65 kHz
- 2018: 1 MHz

Power Density (W/in³)

- Si Bipolar & Si FETs
- New Magnetics
- New Controllers
- New Topologies

- 2x Lower Loss
- 3x Lower $/W

- 50 Hz, 30 kHz, 65 kHz, 1 MHz

- 1977: 40% efficiency
- 1987: 80% efficiency

- 5x Increase in 10 years
- <10%/yr improvement in over 30 years

- 2014: Founded
- 2018: MP
- 2028: GaN Fast Power IC

New GaN Power ICs
- New Magnetics
- New Controllers
- New Topologies

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Accelerating Growth

Headcount, Valuation & Revenues


World's 1st GaN Power IC Prototype
World's 1st GaN Half-Bridge Prototype
World's Smallest 25W USB-A
World's Smallest 25W USB-A
World's Smallest 150W
World's Smallest 27W USB-PD
World's Smallest 65W USB-PD
World's Smallest 65W USB-PD
World's Smallest 65W
World's Smallest 65W
World's Smallest 300W
World's Smallest 300W
World's Smallest 150W
World's Smallest 65W USB-PD
World's Smallest 27W USB-PD
World's Smallest 65W USB-PD
World's Smallest 65W USB-PD
World's Thinnest 45W USB-PD
World's Thinnest 45W USB-PD
Mass Production
Mass Production
30+ Patents
30+ Patents
3.2kW Data Center Prototype
3.2kW Data Center Prototype
120+ Patents
120+ Patents
3kW EV Prototype
3kW EV Prototype
100+ Patents
100+ Patents
Fast Charger Design Center
Fast Charger Design Center
Innovation Award Honoree
Innovation Award Honoree
20M Shipped
20M Shipped
IPO: NVTS
IPO: NVTS
70M Shipped
70M Shipped
GaNSense Control
GaNSense Control
World's 1st GaNSense Half-Bridge
World's 1st GaNSense Half-Bridge

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The GaN Revolution: Ultimate Integration

**GaNFast™**

- 200-300 kHz
- • Old, slow
  • High Qg
  • High COSS
  • FSW < 100 kHz

**GaNSense™**

- 500 kHz
- • External gate drive
  • dV/dt sensitivity
  • Layout sensitivity
  • ESD sensitivity
  • Unknown reliability
  • Unknown robustness

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

**GaNFast plus:**

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

**GaNSense Half-Bridge**

- 1 MHz
- 800 Vmax
- 24V ESD

- Autonomous Standby Mode
- Over-Temperature Protection
- Loss-Less Current Sensing
- Enlarged cooling pads

- ✓ Highest integration
- ✓ integrated HS and LS FETs
- ✓ Integrated level-shift isolation
- ✓ integrated boot-strap
- ✓ Shoot-through protection
- ✓ Fastest switching
- ✓ Highest efficiency

© Navitas Semiconductor 2023
Navitas GaN IC: Smaller, Faster, Robust

**Discrete dMode GaN**
- dMode GaN Discrete (3.7mm²)
- **Silicon FET** (3.8mm²)

**Discrete eMode GaN**
- eMode GaN Discrete (4.5mm²)

**Navitas eMode GaN IC**
- Integrates drive circuit & more
- Monolithic GaN IC (1.4mm²)
- No extra circuits
- No parasitics & delay
- Drive & power matched in GaN
- Integrated features, functions
- Highest speed & efficiency
- Highest robustness and reliability
- Simple customer design
- 50-80% smaller chip

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(1) 'dMode' = depletion mode = 'normally on' transistor, causes short circuit unless additional transistor added.
(2) 'eMode' = enhancement mode = 'normally off' transistor.
Foundational Reliability

• **Design** for Reliability
  • Integrated drive, sensing and protection
  • Component reliability, and **system** reliability

• **Testing** for Reliability:
  • Proprietary production test methods
  • GaN ICs tested 400% (multi-temp, high-frequency)

• **Characterization** for Reliability
  • Exhaustive, proactive, and unique Navitas reliability program
  • 5.8 B equivalent device hours tested\(^{(1)}\)
  • Proprietary, highly-accelerated Op-Life, plus JEDEC, plus ELFR monitoring
  • Founder member of JEDEC JC70.1

\(^{(1)}\) As of September 2022
© Navitas Semiconductor 2023
# GaNFast Power ICs

<table>
<thead>
<tr>
<th>Family</th>
<th>Part #</th>
<th>Type</th>
<th>$V_{DS(\text{CONT})}$ (V)</th>
<th>$V_{DS(\text{TRAN})}$ (V)</th>
<th>$R_{DS(\text{ON})}$ (mΩ, typ)</th>
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<td>Half-Bridge</td>
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<td>800</td>
<td>275/275</td>
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Datasheets, electrical (SPICE) and mechanical (.stp) models available at: [https://navitassemi.com/download/](https://navitassemi.com/download/)
**GaNSense Control**

- Integrated LV Si controller + HV GaNSense power IC
  - Smaller, cooler, lighter fast chargers
- Previously JV with Halo Micro\(^{(1)}\)
- Foundation for low-voltage, high-speed Si controller capability
  - Wide range of applications and markets
  - Smartphone chargers to data centers, home appliance / industrial, solar etc.
  - Adds $1B+/year to market opportunity
  - Immediate revenue
- Full market launch in March ‘23
  - Asia Charger Expo (Shenzhen, CN)
  - APEC conference (Orlando, US)

\(^{(1)}\) Completed February 2023
GaN Integration Drives Speed, Efficiency, Stability

Discrete GaN Half-Bridge
- 33 components
- 250 mm² footprint
- External HB driver HVIC
- External HV bootstrap
- 2x HV bypass diodes
- 2x external gate drives
- Exposed gates

61% fewer components

GaNSense Half-Bridge IC
- 13 components
- 90 mm² footprint
- Level shifters
- Bootstrap
- Gate drivers
- No exposed gates

64% smaller footprint

Complete integration

Severe Ringing & Glitching!

No Ringing, No Glitching!
True GaN Integration Drives Speed, Size

GaN MCM 45W

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)
© Navitas Semiconductor 2023
Typically, slow-speed designs have ~70% of volume used by transformer, capacitors, EMI filter, etc.

High-speed GaN IC designs **shrink** ‘passive’ components by ~50%\(^{(1)}\)

Half-Bridge IC delivers ~2x the power, or ~2x faster charging in the **same size**\(^{(1)}\)

~65 kHz Silicon
65 W 43 cc

~75 kHz GaN Discrete / MCM
65 W, 46 cc

~400 kHz GaN IC
65 W, 31 cc

~750 kHz peak Half-Bridge GaN IC
120 W, 44 cc

~2x faster charging!
### 100% Tier 1 Mobile OEMs Adopting Navitas

**Tier 1 OEMs**

<table>
<thead>
<tr>
<th>Company</th>
<th>GaN Chargers Mass Production&lt;sup&gt;(1)&lt;/sup&gt;</th>
<th>GaN Chargers In Development&lt;sup&gt;(1)&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>SAMSUNG</td>
<td></td>
<td>240+</td>
</tr>
<tr>
<td>moto X30 Pro</td>
<td></td>
<td>250+</td>
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<tr>
<td>LG Electronics</td>
<td></td>
<td>100% Mobile OEMs Designing With Navitas GaN ICs</td>
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<tr>
<td>Let’s go GaNFast</td>
<td></td>
<td></td>
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<tr>
<td>oppo</td>
<td></td>
<td></td>
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<td>Lenovo LEGION</td>
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<td>Dell</td>
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<td>70M+ GaN ICs Shipped&lt;sup&gt;(2)&lt;/sup&gt;</td>
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<td>Redmi Note 2</td>
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<td>World’s Fastest Charging Technology</td>
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<tr>
<td>Xiaomi</td>
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<td>realme</td>
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<td></td>
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<tr>
<td>Let’s go GaNFast</td>
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<td></td>
</tr>
</tbody>
</table>

**Aftermarket Examples**

- World’s first 30W GaN Fast Charger for iPhone 12
- The Ultimate Charging Experience with Navitas GaN ICs

<sup>(1)</sup> as of Q4'22 report
<sup>(2)</sup> GaN ICs Shipped

© Navitas Semiconductor 2023
Now Ultra-Fast Chargers

- Major trend
- New, fast-growth market: $1B opportunity by 2025\(^{(1)}\)
- Full charge in <10 mins (200W)
- Increased GaN$ per charger
- World’s highest power density 120W, 150W, 200W, 240W

\(^{(1)}\) Navitas estimate

RedMi (Xiaomi) F1 Mercedes 120W
Realme (OPPO) GT Neo 3 150W
iQOO (vivo) 10 Pro, 200W
Powering the World’s Fastest-Charging Smartphone

*The charging dock shown in the video is a special 240W superfast charging dock, which charges the smartphone in the original position and more positions for ease.*
GaNFast Exceeds “Titanium”, >2x Power Density

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

\begin{itemize}
  \item \textbf{Slow Silicon AC-DC 3,200W}  
  \begin{itemize}
    \item 47 kHz
    \item 325 x 107 x 41 mm
    \item 2.2 W/cc
  \end{itemize}
  \textbf{GaNFast AC-DC 2,700W}  
  \begin{itemize}
    \item >2x higher power density
    \item >30% reduction in energy loss
    \item 300-500 kHz
    \item 185 x 73.5 x 39 mm
    \item 5.1 W/cc
  \end{itemize}
\end{itemize}

\textbf{“GaN is a breakthrough new technology that is enabling dramatic reductions in size, energy savings and power density”}  
\textbf{“Navitas is an excellent partner with industry-leading GaN ICs”}

Robin Cheng, VP R&D

\textsuperscript{(1)} European Union ‘Directive 2009/125/EC, 2019 Annex’, power supplies must be >96% efficiency peak.
\textsuperscript{(2)} CRPS = Common Redundant Power Supply standard, defined by Intel for standardized mechanical form-factors, targets hyper-converged compute, storage and networking eqpt.
\textsuperscript{(3)} Navitas est. based on a) Navitas server/datacom forecast & AAAS data, b) $0.12/kWhr, 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.
Largest range of SiC FETs & diodes (650 V to 6.5 kV)

Fast Switching
Highest efficiency hard-switch, soft-switch (Lowest E_{ON}, E_{OFF}, E_{DS} 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

High-Power Paralleling
Matching currents (Stable V_{th})

Based on Navitas testing of 1200V SiC MOSFETs vs. competitor products
© Navitas Semiconductor 2023
### Broadest SiC FET Portfolio

**650–6,500V Trench-Assisted Planar SiC FETs**

- 50+ SiC MOSFETs, array of standard packages
- Only supplier with 650V to 6,500V SiC MOSFETs

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>1000 mΩ</th>
<th>500 mΩ</th>
<th>100 mΩ</th>
<th>50 mΩ</th>
<th>10 mΩ</th>
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<td>160 mΩ</td>
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<tr>
<td>750V</td>
<td>1000 mΩ</td>
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<td>3300V</td>
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<td></td>
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<td>15 mΩ</td>
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**Most 1,700V SiC FETs**

- Broadest industry offering for 1700V SiC MOSFETs

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<tr>
<th>Voltage (V)</th>
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<td>450 mΩ</td>
<td>160 mΩ</td>
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<td>750 mΩ</td>
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<td>750 mΩ</td>
<td>10 mΩ</td>
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1) based on GeneSiC voltage range of production released SiC MOSFETs compared to all publicly identified voltage ranges of other SiC suppliers.
### Best High-Speed, High-Temp Performance

**Supplier** | **Resistance** | **Energy Loss** | **Figure-of-Merit (Low number is better)**
---|---|---|---
| | $R_{DS(ON)}$ @ 25°C (mΩ) | $R_{DS(ON)}$ @ 175°C (mΩ) | $E_{ON}$ @ 25A (µJ) | $E_{OFF}$ @ 35A (µJ) | $E_{OSS}$ @ 800V (µJ) | $E_{ZVS}$ | $E_{OFF}$ - $E_{OSS}$ (µJ) | Hard-Switching | Soft-Switching |
| **GeneSiC** | 40 | 57 | 600 | 80 | 34 | 46 | **38.8** | **2.6** |
| #2 | 40 | 68 | 600 | 80 | 40 | 40 | 46.2 | 2.7 |
| #3 | 40 | 80 | 850 | 390 | 35 | 355 | **99.2** | **28.4** |
| #4 | 40 | 71 | 550 | 150 | 35 | 115 | 49.7 | 8.2 |
| #5 | 45 | 85 | 520 | 65 | 29 | 36 | **49.7** | **3.1** |

Reference 1200V SiC FET, 40-45mΩ devices; GeneSiC = Trench-Assisted Planar G3R40MT12J; based on Navitas test result & competitive data sheet parameters.

**Lowest power loss at high temp, high speed** = **Highest Efficiency, Energy Savings**

Small Size, Light Weight, Low System Costs!
Faster, Cooler, Longer Lifetime

- GeneSiC trench-assisted planar FET vs. Competitor SiC FET
  - 1,200 V, 40 mΩ, D2pak in half-bridge
  - Represents 7.5 kW DC-DC converter (e.g. data center, EV)
  - 150 kHz switching = ~10x faster than Si IGBT example

- GeneSiC: >80% energy savings (>3,000 kWh/yr) vs Si IGBTs
  -25°C cooler = 3x longer life vs other SiC (reduced maintenance / repair costs)
High Quality, High Reliability

100%-Tested Avalanche

Highest published capability to handle excess energy in fault condition

- Critical in applications like motor drives to withstand unclamped inductive load (UIL) energy dump in situations like motor open-circuit (O.C.)

High Power Paralleling

Matching currents (Stable Vth)

- Competitor products allow threshold voltage to drop under high voltage, creating risk of turn-on error

- GeneSiC packaged and bare-die FETs can be paralleled reliably for high-power applications

Long Short-Circuit Withstand Time

World-class survival duration in fault condition

- Critical to prevent failures like motor short circuit where the FET faces full voltage (Vdd) in ON-state.

2) 1,200 V, 20 mΩ FET
**GaN + SiC for Solar & Energy Storage**

**Market Potential** *(2)*
- Residential Micro >$1.4B (GaN)
- Residential String >$1.0B (SiC)
- Commercial String >$1.0B (SiC)
- Energy Storage >$1.25B (SiC) *(50% attach rate)*

Total = >$4.65B

**Navitas Strength & Opportunities**
- Solar up 3x 2022-2027, more capacity than natural gas by 2026, coal by 2027
- Inflation Reduction Act: >$50B to solar, storage and wind
- Bus voltages rising to 1,500V – matches GeneSiC 3,300V capability
- Immediate SiC revenue, GaN revenue from 2024

*(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*
Pure-Play EV: The Largest Opportunity

>$11B/year Opportunity\(^{(1)}\)

(On-board >$10B/yr + Roadside >$1B/yr)

Navitas EV System Design Center

- 5 platforms, for 10 customer projects, including:
  - 400V, 800V and 6.6-22 kW, bi-di charger (2-in-1), bi-di + DC-DC (3-in-1)
  - Increasing bus voltages play to Navitas 3,300 V strength

Navitas + Geely Joint EV Design Center

Customers in Production, Development

Navitas + Geely Joint EV Design Center

- AMG
- BYD
- INOVANCE
- EVTECH
- SHINRY
- GEELY
- LG
- MAGNA
- JAGUAR
- LAND-ROVER
- BRUSA

“10-80% charge in only 18 minutes!”\(^{(2)}\)

\(^{(1)}\) Estimate 2030, 30M EV/yr, based on DNV and Navitas analysis. Note: Assumes 150 kW traction inverter, 100 kWh battery, $100/kWh battery cost and typical 230 mile range.

\(^{(2)}\) Level 3 800V 350 kW DC charger 10-80% in 18 minutes for Genesis GV70 SUV
Home Appliance & Industrial

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

Navitas 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

>$/1.5B/year Opportunity for 50-300W Motors

45 new motor-drive customer projects in development (GaN+SiC)

Inflation Reduction Act: $9B to upgrade US home appliance efficiencies

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

- Tier-1 foundry partners, excellent manufacturing support
- High yields, low costs, flexible supply chains
- Long-term capacity agreements: GaN up 3x, SiC up 5x starting in 2023
- 50% shorter lead-times than industry typical

1) Industry lead-times per Jefferies Equity Research, August ‘22
High Volume, High Quality

Over 70,000,000 shipped,\(^{(1)}\)
Over 9,000,000 shipped,\(^{(1)}\)

(1) Shipments as of March 2023.
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Leader in Sustainability

Every GaNFast™ IC saves 4 kg CO₂

- 4x-10x lower component CO₂ footprint than silicon
- 28% lower lifetime CO₂ footprint for chargers / adapters
- Accelerates transition from ICE to EV by 3 years, saving 20%/yr of road-sector emissions by 2050
- GaN + SiC save up to 6 Gton / year by 2050

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 CO₂ saved

October ’22 Recognized for industry-leading sustainability reporting

(1) Navitas estimates based on Earth-Shift Global, DNV life-cycle analysis, market growth. See 2021 Sustainability Report for more details
Mission: Electrify Our World™

Energy sources and uses are being electrified...

...creating a $40B GaN + SiC opportunity by 2050

Fossil-fuel vs renewable ratios adapted from IRENA 2020 “Global Renewables Outlook”. Shift required to meet “Transforming Energy Scenario, 9.5 Gton target in 2050”, per Paris Agreement’s 1.5°C rise.

Market opportunity $ from Yole Développement, 2020 and Navitas analysis.

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Navitas Fundamentals

- Industry’s only pure-play next-gen power semi company, $23B/yr market
  - Founded 2014, 220+ employees
  - Nasdaq: NVTS (IPO October 2021)
- Leading power GaN IC and power SiC technology, 185+ patents
  - >70M GaN, >9M SiC Shipped
  - 3x (GaN), 5x (SiC) capacity expansion starting in 2023
  - Major diversification in markets, regions
- Mission to Electrify Our World™
  - Industry leader in mobile fast, ultra-fast chargers
  - Market expansion on track / accelerated into data center, solar, EV

(1) See Navitas New York Investor Meeting September 13th, 2022, and Navitas’ Q3’22 earnings November 9th, 2022, for details
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Revenue Growth, Diversification & Expansion

Quarterly Revenue (1)

Diversification (1)

Market Mix 2021

Market Mix 2022

Appliance / Industrial, 30%

Mobile / Consumer, 40%

Solar / Storage, 12%

EV, 5%

Other, 13%

Region Mix 2022

US, 24%

Europe, 32%

Asia, 44%

(1) Reflects results as of Q4’22 earnings report, February 23rd 2023 (not updated).
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