Executive Summary

Introduction

NexGen Power Systems, Inc. (NexGen) was founded in March 2017. NexGen is headquartered in Santa Clara with its manufacturing headquarters in Syracuse, New York and has 54 current employees. NexGen operates a state-of-the-art gallium nitride (GaN) device fabrication facility in Syracuse, where it employs 40 people. NexGen is a well-funded company.

NexGen Power Systems Is Poised to Disrupt The $10B Power Devices Market

NexGen is the first company to commercialize GaN power devices built on a GaN substrate (GaN-on-GaN). These power semiconductor devices have inherently superior material properties and performance advantages when compared to both conventional silicon power devices and other alternatives, e.g. SiC or GaN-on-Si. NexGen's power devices are cost competitive with incumbent silicon power devices. NexGen's Vertical GaN™ power devices enable substantial improvement of power density in power systems driven by NexGen's cost effective power semiconductor solutions available for mainstream adoption.

NexGen is a Unique Semiconductor Company

1. Vertical GaN™ is a superior semiconductor enabling innovation and value creation in power systems
    - Vertical GaN™ devices address the majority of applications in the $10B power semiconductor market
    - Vertical GaN™ devices provide a strong value proposition in three key market segments: data centers, electric cars, and solar inverters
2. Strong early customer traction
    - As part of its Quick Start Program, NexGen has engaged with industry leaders in targeted market segments such as Data Center Power Supplies, Solar Inverters and Electric Vehicles and is developing highly compelling & unrivalled power systems with Vertical GaN™.
    - Early samples will be provided to these key customers in Q1 2020 & widespread customer samples are scheduled for Q3 2020
    - NexGens Applications team utilizes these early samples to create reference designs and development kits in Q2 2020
3. NexGen is the First Mover in this space, with an IP portfolio of 100+ fundamental patents in device architectures, process technology and circuits for Vertical GaN™ products
    - Investment in a state-of-the-art GaN Fab combined with the necessary metrology and failure analysis equipment enable NexGen to achieve fast cycles of learning in Vertical GaN™ technology development
4. New device architecture and proven manufacturing will lead to low cost production
    - NexGen's proprietary device architecture enables production of devices cost-competitive to Si power devices, even at currently high GaN substrate costs
    - Future reductions in GaN substrate costs as volumes increase through demand for Vertical GaN™ products will provide additional opportunities to reduce NexGen's cost
    - NexGen's manufacturing leverages the existing silicon infrastructure providing a proven path to high yields and very low operating costs
    - NexGen's Fab in Syracuse allows manufacturing of Vertical GaN™ devices at very low cost
5. World class team
    - NexGen is led by co-CEO's Dinesh Ramanathan Ph.D. and Shahin Sharifzadeh Ph.D.
    - Shahin Sharifzadeh has over 30 years of semiconductor experience and was most recently the SVP of World-wide Operations at Atmel. Before Atmel, Shahin was the EVP of Technology and World-wide Manufacturing at Cypress.

- NexGen was co-founded by Dinesh Ramanathan, who has 23 years of semiconductor experience including 4 years as CEO of Avogy Inc. and 9 years as the EVP of Cypress managing the Programmable Systems Division and the Data Communications Division.
- NexGen's technology effort is led by Chief Technology Officer, Cliff Drowley Ph. D. who has over 40 years of experience in semiconductor technology development and commercialization. His previous experience includes HP, Motorola, Cypress (VP), SMIC (Senior Fellow) and Ningbo Semiconductor (CTO).
- NexGen's management team also includes Paul Keswick, Chief Administration Officer, and Christopher Gaudet, Chief Financial Officer. Paul has over 40 years of experience in the Semiconductor industry including 32 years at Cypress in roles across Worldwide Development, Marketing, Applications, IT, Legal and HR. Christopher has 18 years of experience in Finance and Operations at SunEdison, Altierre and 3Degrees, leading multiple financing rounds and the IPO of Terraform Global.
- The NexGen team includes expertise in GaN epitaxial growth, materials characterization, device design and processing, electrical characterization, reliability testing, and manufacturingThe Chairman of NexGen's Board of Directors is Dan McCranie who is the former chairman of ON Semiconductor and Freescale.

Background: Power Electronics Are Pervasive and Currently Depend on Silicon Semiconductor Switches

Power conversion systems are used by all modern electronics. In order to produce the DC power required by all modern electronic systems, these power conversion systems either convert AC from the wall socket to DC power or convert DC power at one voltage to DC power at a different voltage. Global trends, such as the increase in mobile communications, renewable energy and electric mobility, are increasing the demand for power conversion systems. These power conversion systems are present in a range of products, including, but not limited to, mobile devices, portable computers, solar inverters, electric cars, motor drives, and data center servers. The total power conversion market is estimated to be $68B growing at 5.6% CAGR[(1)].

Power conversion systems, like the chargers for mobile phones and laptops, are requirements for these technologies as they convert and regulate the required power. Early power supplies were simple analog designs, but were bulky, inefficient and expensive. With the advent of inexpensive digital controllers and silicon power transistors, the power supply industry switched from analog to digital designs and developed switch-mode power supplies (SMPS). Digital SMPS units delivered decades of continuous improvement in power density, efficiency and cost. Every improvement in a SMPS depended on a better power transistor – one that could offer higher speeds, higher power and lower resistance. These power transistors, known as IGBTs and MOSFETs, are manufactured using silicon and drove the continuous creation of new and better power systems as semiconductor manufacturers made major improvements in their devices with each new innovation in power transistors. During this time, the power converter market followed 'Moore's Law' of semiconductors, whereby every important power converter parameter continuously improved with each new generation of power transistors.

However, this continuous improvement has now stalled. Silicon power transistors, the catalyst for increasing performance in power systems over the last 30 years had reached their theoretical performance limits by about 2010. Silicon devices can no longer deliver improvements in switching speed or resistance.

New Materials and Devices Needed - Silicon Technology for Power Has Reached Its Limits

While silicon has been the primary power semiconductor technology for over 30 years, it can no longer meet the needs of modern electronic products that require smaller, lighter and more efficient power systems.

NexGen's Vertical GaN™ Power Semiconductors Are the Solution for Today's Power System Needs

Vertical GaN™ outperforms silicon across virtually every parameter of a power device:

1. Operates at higher voltages, frequencies and temperatures than silicon
2. Creates 3X the system power density – ideal for applications where size or space constraints are critical
3. Reduces the total cost of power electronic systems by up to 30% - requires fewer and smaller passive components (inductors, transformers and capacitors) leading directly to overall cost savings for NexGen's customers

Vertical GaN™ devices can switch at high frequencies which reduces the total energy stored (or transferred) in each switching cycle. This results in a reduction in the size of passive storage elements such as inductors, transformers and capacitors. Smaller passive storage elements increase the power density, enabling generations of smaller, lighter and more efficient power systems. With Vertical GaN™, power electronics will once again restart its continuous improvements of power density.

Vertical GaN™ Stands Out From Other GaN Products Because It Combines Exceptional Performance With Industry Standard Reliability

Vertical GaN™ is inherently reliable:

- ✓ Vertical GaN™ devices meet or beat JEDEC, the industry standard
- ✓ Exceptionally high breakdown voltage
- ✓ Avalanche capability
- ✓ Designed with standard p-n junctions

The potential benefits of GaN as a semiconductor material are well known, and a number of competitors have attempted to utilize GaN in a variety of different substrates, including GaN-on-SiC and GaN-on-Si. However, their use of mismatched substrates is inherently flawed from a reliability perspective. Mismatched substrates have issues with the corresponding mismatch in the coefficient of thermal expansion (CTE) of the two materials, resulting in yield and reliability issues. Vertical GaN™ creates a homogeneous device ensuring that CTE mismatch does not cause yield or reliability issues.

Additionally, these hybrid substrate devices exhibit poor material quality due to high defect density caused by the differences in crystalline structure of the two materials. By definition, Vertical GaN™ technology does not exhibit such defects and, furthermore, NexGen has developed methods to ensure the optimal structure of Vertical GaN™ material through proprietary chemical recipes, equipment specifications and manufacturing procedures. Further, devices created on mismatched substrates are, by nature, lateral devices, where the current runs across the device laterally. This results in increased die size (and therefore cost) in order to meet the voltage requirements of 650V and above. Vertical GaN™ technology creates a vertical device (the current runs from the source at the bottom to the drain at the top), meaning that it can increase voltage without increasing die size allowing NexGen to control Vertical GaN™ cost.

Finally, lateral devices cannot provide avalanche capability, which further deteriorates the in-system reliability. Vertical GaN™ devices provide avalanche capability.

Vertical GaN™ Device Demonstrations in Various Applications

NexGen has successfully produced devices that demonstrate the superior performance and die size advantages of its Vertical GaN™ devices as shown in Figure 1.

- NexGen has produced a 110W, 200V to 800V Boost converter switching at 1MHz and up to 10MHz with its Vertical GaN™ devices. The inductor and capacitors used in the Boost system are standard off-the-shelf components. The efficiency of the Boost converter at 1MHz is 96.5%.
- Vertical GaN™ devices have also been demonstrated in a 65W AC-DC laptop power adapter running at 200MHz enabling a power density of 20W/in^3.
- Vertical GaN™ devices have been demonstrated in a 100W, 800V to 14V Buck converter switching at 1MHz.
- Drivers for Vertical GaN™ are standard, off-the-shelf, low-cost silicon MOSFET drivers which offer a simple path to migrate to Vertical GaN™ devices.

Figure 1: Demos of Vertical GaN™ Devices in Various Applications.

Case Studies: Vertical GaN™ Devices Are Ideal for Almost Any Power Application

While Vertical GaN™ can enhance almost any power application, there are three applications where its performance advantages make the value proposition particularly compelling. With Vertical GaN™, data centers can generate more revenue, electric cars can drive further, and solar systems can generate more energy. These three applications alone have an addressable semiconductor transistor market greater than $4B. NexGen is creating reference designs to showcase the value proposition of Vertical GaN™ in these three applications.

Data Centers

Vertical GaN™ reduces the size of the power supplies by 3X, enabling a 20% increase in compute density and a corresponding 20% increase in revenue

Electric Vehicles

Vertical GaN™ enables electric vehicles to drive 15% further on the same battery by increasing the efficiency and reducing the weight and cost of the power electronics in the car

Solar Electricity

Vertical GaN™ technology in solar system inverters generates more electricity at up to 20% lower cost