This is the ElectroniCast forecast of global market consumption of packaged light emitting diodes (LEDs), also known as component-level bulbs, used in Night Vision Imaging System (NVIS) compatible lighting for non-civilian use, such as military, law enforcement, emergency medical services (EMS) and related.

A night vision device (NVD) comprises of an Infrared (IR) image intensifier tube in a rigid casing, commonly used by military forces and other non-civilian sectors; however, night vision technology has become more widely available for civilian use, for example, EVS, or enhanced vision systems are finding their way into private aircraft and vehicles. Infrared light is electromagnetic radiation with a wavelength between 0.7 and 300 micrometers, which equates to a frequency range between approximately 1 and 430 terahertz (THz).

Night vision goggles (NVG) combined with magnification lenses constitutes night vision binoculars. Other types include monocular night vision devices with only one eyepiece, which may be mounted to firearms as night sights. NVG and EVS technologies are becoming standard operating products on helicopter operations to improve safety. Light emitting diodes used in Night Vision Imaging Systems must provide an environment that will not have near infrared (NIR) noise, which would interfere with the nighttime sensitivity of the NVGs. It is important to note that night vision compatibility (NVC) is only achieved when the design of the lighting equipment allows for proper use with and without the NVIS, at night or during the day.

In this study report, we provide a detailed 2011-2018 market forecast for LEDs that have night vision compatibility in relationship to night vision imaging systems (NVIS).

NVIS are passive systems, which have a very high sensitivity to radiation in the approximate region of 600nm to 930nm (orange to near infrared). The NVIS work by converting photons from the outside night scene onto a micro-displayed visible image. The NVIS will amplify the nighttime scene approximately 2000 times. To protect the image intensifier assembly, the systems are equipped with an automatic gain control.
(AGC), which will aperture down the NVIS when exposed to bright lights in the region of approximately 600nm to 930nm. If displays or light sources are not NVIS compatible, the automatic gain control will activate and the NVIS will become proportionally less sensitive to nighttime objects outside of the cockpit.

The Department of Defense (United States) published the MIL-STD-3009 Standard for lighting, aircraft, night vision imaging system compatibility, which specifies the interface and performance requirements for aircraft lighting and display equipment that is intended to be used along with NVIS. This specification defines aircraft interior lighting standards for sources such as cockpit displays and caution / warning lights, for both day and nighttime operating conditions. NVIS filters designed for avionic applications must incorporate NIR attenuation properties, chromaticity, contrast for daylight readability and often EMI/RFI shielding. The MIL-STD-3009 superseded MIL-L-85762A standard. This standard also includes provisions for white light sources and for “leaky green” requirements.

The light emitting diodes in a display heavily influence its color, contrast, and NVIS radiance (NR) properties. White, green, and red light emitting diodes with certain spectral emission can be adjusted with filters to produce displays that comply with various NVIS color coordinates and NVIS Radiance (NR) specifications described in MIL-STD-3009. Meeting both color and Night Vision Imaging System (NVIS) Radiance limits can be challenging. Each application is unique and always involves certain constraints, such as space limitations or production methods, that may require a specific approach in order meet compliance.

Filters are ideal for many commercial and military applications, including crew-station displays for aircraft and ground vehicles, as well as portable display systems in personal digital assistants (PDA), palmtops, laptops, etc. Plastic Night Vision Imaging System (NVIS) filters are the ideal method for making virtually any light source compatible with NVIS, NVG, NVD, or any other night-vision apparatus. Plastic filters are extremely durable. Where all-glass filters might fracture, lightweight plastic material survives the most demanding real-world environments.

**Quantitative Analysis** LEDs face the challenge of creating definitive positions in the NVIS illumination market, as competing lighting solutions (technologies) are readily available and accepted. While this does not limit the potential success of LEDs, it does create some challenges. This report provides an independent examination and analysis of the changing market dynamics for LEDs used in selected end-use applications. The LED market forecast data are segmented by the following functions:

- Consumption Value (US$, million)
- Quantity (number/units)
- Average Selling Prices (ASP $, each)
Market Forecast and Analysis by Application

The Night Vision Imaging System LED market is segmented into the following application categories:

- **Military**
  - Aircraft
    - Cockpit / Display Panel / Instrument Lighting
    - Other Interior Night Vision Compatible (NVC) Lighting
    - Exterior Aircraft NVC Lighting
  - Ships/Watercraft
    - Bridge Display Panel / Instrument Lighting
    - Other Interior Night Vision Compatible (NVC) Lighting
    - Exterior NVC Lighting
  - Ground Vehicle
    - Display Panel / Instrument Lighting
    - Other Interior Night Vision Compatible (NVC) Lighting
    - Exterior NVC Lighting
  - Ground Field Command / Man-Portable Devices / Other
    - Display Panel / Instrument Lighting
    - Other Interior Night Vision Compatible (NVC) Lighting
    - Exterior NVC Lighting

- **Law Enforcement / EMS / Emergency Services / Other Non-Civilian**
  - Aircraft
    - Cockpit / Display Panel / Instrument Lighting
    - Other Interior Night Vision Compatible (NVC) Lighting
    - Exterior Aircraft NVC Lighting Aircraft
  - Ships/Watercraft
    - Bridge Display Panel / Instrument Lighting
    - Other Interior Night Vision Compatible (NVC) Lighting
    - Exterior NVC Lighting
  - Ground Vehicle
    - Display Panel / Instrument Lighting
    - Other Interior Night Vision Compatible (NVC) Lighting
    - Exterior NVC Lighting
  - Ground Field Command / Man-Portable Devices / Other
    - Display Panel / Instrument Lighting
    - Other Interior Night Vision Compatible (NVC) Lighting
    - Exterior NVC Lighting
Regional Segmentation  The market data are segmented into the following geographic regions, plus a Global summary:

- America
  - United States of America
  - The Rest of the American Region (ROA)
- EMEA (Europe, Middle Eastern countries, plus Africa)
- APAC (Asia Pacific)

LED Level Quantified in the ElectroniCast Study  A Light Emitting Diode (LED) is a solid-state semiconductor device that converts electrical energy directly into light. On its most basic level, the semiconductor is comprised of two regions. The p-region contains positive electrical charges while the n-region contains negative electrical charges. When voltage is applied and current begins to flow, the electrons move across the n region into the p region. The process of an electron moving through the p-n junction releases energy. The dispersion of this energy produces photons with visible wavelengths. Below, are four levels (or “food chain”) of LEDs. For the purposes of THIS ElectroniCast study, we quantify and provide a market forecast for “Level 2”

Level 1 - The chip or die
Level 2 - Packaged LED (component-level bulb)
Level 3 - LED array; may include optics, heat sink and/or power supply
Level 4 - LED luminaire

Ship/Watercraft Leads in Consumption  The use of LEDs in Night Vision Imaging System compatible lighting will continue to be dominated by the Military market sector. The market forecast, by ElectroniCast Consultants, provides second-level (or sub-level) applications under the Military and the Law Enforcement/EMS application sectors. The next-level of detailed is provided in the report text, as well as in the Microsoft Excel database worksheets found in the addendum of the study report. During the 2010-2017 forecast period, as the luminous efficacy techniques improve (Lumens per Watt: lm/W), the LED is being considered for more than (just) indicator lighting.

The conversion of interior lights in aircraft cockpits and cabins to meet MIL Specifications and civil CASA standards can involve the following conversion techniques, based on cost effectiveness and operational requirement:

- Replacement of instrument panel glass with filter material
- Installation of filter material to warning, caution and annunciator indicators
- Replacement of existing lamps with LED based modular lamps
- Installation of NVIS compatible bridge and bezel lighting
- NVG compatible floodlights
These same techniques are also used for the conversion of vehicle driving instruments, ships’ bridge, navigational and control lighting and communication equipment.

Exterior lighting for ships, aircraft and vehicles can be made Night Vision Goggles (NVG) friendly or dual mode Convert/NVG friendly through:

- Replacement of bulbs with form and fit compatible LEDs
- Installation of solid state LED based navigation and anti-collision lights
- Fitting filters to existing light fittings
- Addition of Infra Red LEDs for covert navigation and formation lights only visible through NVIS

**America Leads in Market Share**

The American region held the market share lead in the consumption value of LEDs used in NVIS compatible lighting in 2010. The American region, led by the United States, is forecast to maintain the lead in relative market share throughout the 2011-2018 forecast period; however, the Asia Pacific region is forecast for the fastest growth.

**LEDs Used in NVIS Compatible Lighting (2012)**

Global Consumption Market Share (%)

- **America (60%)**
- **EMEA (26%)**
- **APAC (14%)**

*Source: ElectroniCast Consultants*
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