Electrifying Our Future: Building America’s 21st Century Infrastructure
Introduction

Most people agree that America’s infrastructure needs repair and modernization. People, goods, and services all suffer when our physical and digital connections degrade or fall behind. The time is past due for policymakers to decide what infrastructure America needs today—and for the rest of this century—if we are to maintain our competitiveness and provide the products and services that citizens deserve.

The National Electrical Manufacturers Association (NEMA) represents nearly 325 electrical equipment and medical imaging manufacturers that make safe, reliable, and efficient products and systems serving a wide range of sectors. Our combined industries account for 360,000 American jobs in more than 7,000 facilities covering every state. Our industry produces $106 billion of shipments of electrical equipment and medical imaging technologies per year with $36 billion worth of exports.

Core Principles

NEMA strongly believes that any plan to repair and update America’s infrastructure needs to be comprehensive, modernizing, and realistic. A comprehensive plan will cover traditional physical infrastructure aspects such as roads, bridges, and electricity but also foster forward-looking advanced technologies. A modernizing plan will ensure that America meets its infrastructure needs in the future in addition to patching today’s potholes. Finally, a realistic plan will focus resources on those areas that ensure safety, reliability, and efficiency using proven cost-effective technologies.

The recommendations below are from the NEMA Electrifying Our Future plan and fall into the following categories:

- Transportation Systems
- Building Systems/Infrastructure and Industrial Products and Systems
- Lighting Systems
- Utility Products and Systems
- Developing a 21st Century Workforce

Each category represents a central aspect of American life. The comprehensive, modernizing, and realistic infrastructure approach will help America’s economy by improving productivity and competitiveness.
Transportation Systems

We are at the front edge of a transportation technology transformation. It is clear that we are moving into a future that will be connected, electrified, occasionally shared, and ultimately autonomous. Just in the past few years, there have been rapid advances in transportation technology, further complemented by the Internet of Things (IoT). This exciting new data-rich environment will be the genesis for a multitude of mobile applications that will help to keep traffic flowing and make it easier for people to plan their travel.

There are some challenges that the U.S. should address to realize these benefits, and chief among them is modernizing our infrastructure. With the coming wave of electrified, connected, and autonomous automobiles, vehicles will need to communicate between and among vehicles, infrastructure, and potentially more in the connected world, all to create a safer, more efficient transportation system with information at the user’s fingertips.

NEMA Members’ Transportation Systems solutions:

- Comprise intelligent transportation systems that help realize integrated inter- and multi-modal transportation information management and control systems that enable users to be better informed and make safer, more coordinated, and smarter use of transport networks
- Provide the products and assemblies to safely deliver and manage electrical energy between an electric vehicle (EV) and an electrical source
- Provide an integral component in Vehicle-to-Grid (V2G) technologies that allow energy stored in EVs to potentially be fed back into the electric grid during times of peak demand
- Encompass outdoor and roadway lighting solutions ranging from traditional or stationary illumination methods to intelligent lighting that adapts to movement in its surroundings

The Case for a Modernized Transportation Infrastructure

Congressional action to invest in modernized transportation infrastructure can jump-start the use of advanced technology. We need this action for several reasons:

- **Enhancing driver safety.** Traffic fatalities are rising despite state and federal attempts to improve roadway safety. According to the U.S. Department of Transportation, approximately 39,000 people lost their lives on all modes of our transportation system in 2017 with the vast majority—37,133 deaths—from motor vehicle crashes. No other form of transportation comes close to this dismal record.
• **Reducing congestion.** Rising traffic congestion seems to be an inescapable condition in metropolitan areas around the world. According to the INRIX Global Traffic Scorecard, the U.S. accounted for 10 of the top 25 cities worldwide with the worst traffic congestion. Los Angeles tops the list as the world’s most gridlocked city, with drivers spending 102 hours in congestion in 2017 during peak periods. This is a 20th century problem we can and need to solve now.

• **Improving Commerce.** According to INRIX, in the U.S. alone, congestion cost $305 billion in 2018, an increase of $10 billion from 2016. Not surprisingly, traffic takes the biggest economic toll on the largest, most economically vibrant cities. Los Angeles drivers have the dubious honor of leading the way, spending an average of 102 hours sitting in traffic every year. That costs the city more than $19 billion annually. But total traffic costs are even higher in New York City, where the burden adds up to $33.7 billion. San Francisco, Atlanta, Miami, Washington, D.C., and Boston round out the American cities where traffic costs more than $2,000 per driver per year on average. Those numbers come from the lost productivity of workers sitting in traffic, the increased cost of transporting goods through congested areas, and wasted fuel, among other factors.

• **Benefiting the Environment.** The U.S. transportation sector accounts for more than a quarter of all U.S. energy consumption with the vast majority of this from petroleum-based fuels. Light-duty vehicles (including personal vehicles) account for the single-largest energy-consuming transportation segment, but freight trucking and air travel also use significant amounts. Recently, the energy density and cost of electric batteries has improved to the point where electrification of passenger cars, delivery trucks, and transit buses is a cost-effective alternative to petroleum-based transportation. Factor in direct benefits to the environment, such as dramatically decreasing airborne emissions of all types, and the call to action is compelling.

Transportation infrastructure policies should encourage the deployment of connected vehicle-to-everything (V2X) technologies to help improve road safety, advance travel efficiency, and complement automated driving. In general, V2X directly connects vehicles to everything, including each other (V2V), to pedestrians (V2P), and roadway infrastructure (V2I), providing real-time, reliable, and actionable information to drivers and roadway operators. V2X will enable vehicles to travel safely in dense traffic situations and support new automation solutions such as truck platooning. These applications will also enable energy cost savings and avoid expanding public highways to support increased traffic flows.

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Airport and Seaport Electrification

U.S. Seaport and private sector partners are projected to spend more than $150 billion on seaport related infrastructure through 2020. We believe that state and local programs should allocate a sizable portion of these investments to make port operations more energy efficient. This would lower overall fuel costs but also represent millions of dollars in savings for business and customers.

Methods for improving operational efficiency at both seaports and airports include connecting ships and airplanes to the electric grid when docked, electrifying harbor craft, cranes, and container handling and other ground support vehicles. Deploying modern grid management capabilities and technologies like demand response and energy storage offer further efficiency opportunities.

Outcomes-Based Contracting

A series of ideas are gaining consensus and converging to form the basis of outcomes-based contracting (OBC) in roadway and traffic infrastructure management. For example, governments (frequently at the instigation of their citizens) are good at identifying problems, but may not have the range of experience at finding the most up to date solutions. Significant private-sector involvement should be accessed in order to rebuild America’s transportation infrastructure for the 21st century and beyond. Government at all levels might consider using their finite resources to purchase outcomes not assets. Finally, roadway infrastructure has evolved from traditional concrete and asphalt to one that now uses information and communication technologies virtually for every mile of roadway.

OBC has been used effectively in recent years in several areas, including healthcare, environmental restoration, and energy efficiency. It can also be adapted for roadway networks as governments are increasingly realizing that to meet their goals and objectives they must begin operating their streets and highways as networks. OBC is a companion to public-private partnerships in which governments have leased roadways to private operators who recoup their investments by charging for better services. Following an OBC approach, the government would set goals, objectives, and outcomes and task the private sector to choose the technologies and methods that enable achievement of those objectives, all while optimizing for the taxpayer. NEMA supports the concept of OBC and stands ready to assist governments as they transition to this approach.
Looking Ahead

This transportation future can lower traffic fatalities and injuries, make our streets safer, improve access to mobility, enhance economic development and quality of life by improving traffic flow, allow for more efficient logistics, and lower vehicle emissions, thereby improving public and environmental health. This should decrease household and business transportation costs apace. And these are all things technology can do today! Imagine what we can achieve 10 plus years from now?

Addressing the associated challenges will require a coordinated and collaborative effort between key participants such as federal and state governments and the private sector. NEMA and its Member companies are eager to be a key part of building the high-technology and high-efficiency 21st-century transportation ecosystem.

Building and Industrial Products and Systems

The Building Systems, Industrial Products, and Building Infrastructure Divisions of NEMA represent a vast array of NEMA Members’ products and systems for commercial, industrial, and residential buildings of all sizes and uses. These include products most people rarely see, from cable management systems, low voltage distribution and industrial automation controls to things more apparent products like smoke detectors and fire alarms, as well as wall receptacles and circuit breaker varieties.

The Case for a U.S. National Approach to Electrical Code Adoption

The way electric codes are adopted reflects the relationship of a national government to its states. And while that serves us well in most areas, in the case of electrical and building safety, it risks an inefficient patchwork of different levels of adoption of national consensus codes. States are free to choose the process they use regarding electric (and building) codes. States are also free to choose which version of the national consensus codes is adopted, or whether to adopt them at all.

In some cases, there is not a state code adoption process in place, and it is left to local jurisdictions to make these decisions. There are also other local jurisdictional processes in place at the city level. A more uniform approach among the states could yield more cost-effective mechanisms to help ensure a consistent minimum level of safety and environmental performance across the nation.
The U.S. has a robust code and Standards development process that includes input from experts from industry, regulators, consumers, and academia. The American National Standards Institute (ANSI) empowers its members and constituents to strengthen the U.S. marketplace position in the global economy while helping to assure the safety and health of consumers and the protection of the environment. The government should rely on the rigorous consensus process of ANSI accredited codes and Standards developers, such as the National Fire Protection Association (NFPA) and NEMA, to set the minimum requirements for electrical safety and performance.

**NEMA proposes the development of a U.S. code adoption approach among federal, state, and local authorities so that states adopt codes to the latest published versions more uniformly and transparently**

Mandating the adoption of updated electrical, fire, life safety, and building codes would help ensure that the latest innovative and safe technologies developed by industry are used and installed to:

- Improve safety to homeowners, office workers, and factory employees;
- Significantly reduce the risk of property damage due to fire and adverse weather events;
- Help strengthen U.S. environmental performance; and
- Stimulate U.S. economic development for much-needed infrastructure improvements.

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**Lighting Systems**

As the world continues to move to an ever-increasing demand for all things “connected,” reliance on these technologies will grow apace. Since the advent of practical LED products a decade ago, the indoor lighting market has shifted to this technology rapidly, unlike anything the industry experienced in history. The same, however, cannot be said for the entire outdoor lighting market.

While large Investor-Owned Utilities (IOUs) are now replacing older technologies with LED fixtures regularly, smaller jurisdictions, including electric co-ops and small cities, have not been able to justify the cost of retrofit installations even if they fully appreciate the overall lower life-cycle costs. Capital costs of these new fixtures in a given budget year may be too high for some jurisdictions to justify the cost of replacing products that are still functioning at acceptable levels, albeit at a higher annual cost.

Another difference in installation is the location of the outdoor lighting. IOUs located in geographical areas often damaged by storms are required to replace outdoor lighting fixtures on a somewhat cyclical basis. With the cost of new LED fixtures falling to near equivalent price points as traditional high-pressure sodium fixtures, using the old technology is no longer a consideration.

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Small jurisdictions, electric co-ops and small cities that do not face the challenge of repeated storm damage have no incentive to retrofit to newer LED technology before necessary.

An infrastructure bill or program that includes product incentives, creative financing models, or targeted rebates would assist these end users in the replacement of decades-old technology. The more efficient, entirely recyclable LED fixtures provide energy savings, lower maintenance costs, improved roadway lighting, and the opportunity to begin considering a connected lighting system.

NEMA statistics indicate that the sale of outdoor lighting products has stagnated over the last two years. An infrastructure program that includes assistance for the installation of energy efficient products invigorates the production and sale of the products, provides energy cost savings, and improves the appearance and quality of light for many small U.S. cities, towns, and municipalities.

Utility Products and Systems

NEMA Member companies do not manage the power grid … we manufacture it. The NEMA Utility Products and Systems Division represent products that transmit and distribute electricity from the power plant to the outlet receptacle in a house. From switchgear to surge arresters, from connectors to capacitors, if it is on the grid NEMA Members make it and sell it to electric utilities. Increasingly, NEMA Members are developing the software and systems that control and automate smart versions of these products (e.g., smart meters), a trend recognized as the Internet of Energy.

Three themes dominate our customers’ decisions about how to operate the grid and, by extension, equipment manufacturer decisions about product innovation: reliability, resiliency, and efficiency. Indeed, every aspect of grid modernization aims to improve the flow of electricity in accordance with one or more of these goals.

- **Reliability.** Without electricity, almost every major U.S. industry would fail. A constant and dependable supply of electricity is imperative for society as we know it. Fortunately, the power grid currently operates at well over 99% reliability. Unfortunately, the risks to that reliability are real and growing. For example, the risk of cyberattacks increases as the grid becomes more automated. Whether the blackout is the result of human-made or natural events, the result could be hundreds of millions of dollars in economic loss per event, depending on the length and breadth of the event. Grid modernization is the single best step to assuring the same high level of reliability in the future.
• **Resilience.** It is impossible to eliminate all the risks that might cause a blackout, which is why the power grid must continue to improve its resilience—the ability to resume functions quickly after an incident. The more resilient the grid, the sooner the lights come back on. Utilities are increasingly distributing (i.e., decentralizing) generation resources to accomplish a higher level of resiliency and are becoming somewhat less reliant on large power plants. Solar Photovoltaic and wind turbine-technologies that are scalable and practicable in any region where the sun shines or wind blows—are two good examples of this. Further, they rely on free, unlimited energy sources, making them cost-effective in the long term. But these technologies pose challenges for grid operators because, unlike human-made power generation (coal, gas, and nuclear) which is very controllable, utilities cannot dictate when the sun shines or when the wind blows. The legacy power grid is not built for high degrees of variability of electricity generation sources, so NEMA Members are constantly innovating to develop products that can “smooth out” the electricity generated from wind and solar in harmony with power-plant electricity.

• **Efficiency.** There is an economic and environmental case to be made for increased energy efficiency, measurable in several ways: 1) the cost to produce electricity; 2) the loss of effective electrical power during transmission and distribution; and 3) the power factor, which measures the relationship between the power provision and consumption. Items #2 and #3 are squarely within the purview of NEMA Members, who strive to make equipment that runs as efficiently as possible to reduce cost to the utilities and ratepayers, and to reduce the environmental footprint.

Federal action is a necessary element in modernizing the power grid toward the threefold end of maintaining its reliability in the face of growing and evolving risks, improving resilience, and facilitating even greater efficiency. Many grid modernization initiatives are state specific and, therefore, beyond the direct reach of federal programs. However, there are several areas where federal agencies can play a key role.

**U.S. Department of Energy**

- Incentivize electric utility and telecommunications industry investment into 5G communications technology. Many functions of an autonomous smart grid (such as artificial intelligence) are latency-sensitive and require operational capabilities at the speed that only SG can support.
- Enhance existing reserve program requirements for large power transformers (LPTs). LPTs perform a vital function at one of the earliest stages of electric distribution; if an LPT goes offline, millions of customers could lose electricity. LPTs take up to 18 months to manufacture, and utilities should be required to maintain a reserve.

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• Create federal grant programs for large-scale grid modernization projects. Current rate base models for electric utilities can be a deterrent for needed grid modernization investments. Federal funds to support grid modernization will facilitate utility investment.

• Incentivize (via National Science Foundation and American universities and laboratories) research and investment into next-generation (post lithium), at-grid scale, battery storage.

**Federal Energy Regulatory Commission**

• Decrease permitting times for transmission lines and other advanced energy projects. Time consuming bureaucracy acts as a deterrent to innovation because it delays investment pay-out. Reducing the time it takes for regulatory agencies to review and make a decision will incentivize project developers.

• Require Independent System Operators and Regional Transmission Organizations to create markets for distributed energy resources (DERs). Many tools that promote resilience, reliability, and efficiency are now much closer to the customer. However, utilities are not always incentivized to install and maintain DERs under the current economic models. Energy markets must evolve to allow flexibility in how customers recuperate these costs.

**National Institute of Standards and Technology**

• Complete and publish the latest Smart Grid Framework document to guide federal, state, and business collaboration

• Create a cybersecurity certification program based on industry-developed cybersecurity Standards. As more and more functions of the power grid become automated through digital networks, cyber risk increases. Grid operators should be required to purchase products that comply with industry-developed Standards.

**Bureau of Land Management**

• Create a cobalt reserve program to mine and store cobalt found in the metallic crusts of the Pacific and Atlantic Oceans: Cobalt is a critical material for construction of lithium-based energy storage devices which, in turn, are critical for the incorporation of renewable energy onto the power grid.
Developing a 21st Century Workforce

U.S. manufacturing is facing a digital skills gap among its workforce, and the electrical manufacturing subsector is no different. Companies struggle to fill open positions requiring the skills of today, let alone positions requiring the skills of tomorrow. These 21st century skills are digital by nature and will require interaction between humans at all levels of the manufacturing process and the systems, robots, and computers that will further automate the production environment. Many of these roles have not been invented yet, but the technologies exist, are viable, and are on their way to adoption. The industry will need workers that have the digital skills to deploy them.

A digital skillset is hard to define precisely, but here are some examples by way of digital manufacturing domains that will be relevant 10 years from now and imperative in 20:

- Manufacturing cybersecurity
- Digital architecture
- Virtual/augmented reality
- Machine learning
- Predictive analytics and maintenance
- Operational technology systems

Beyond their existence and viability, many manufacturing experts see the mass adoption of these technologies into the industry as a necessity to expand current production capabilities and keep the U.S. competitive as a mass producer of products.

The skills to operate in these domains will come from two places: industry (by way of apprenticeships and re-training) and academia. Resources from both groups are spent primarily addressing the skills shortages of today. Support from and leadership by the government at all levels will be dispositive in driving the nationwide “boot-strapping” necessary for the digital manufacturing skills renaissance needed for tomorrow.
The U.S. Department of Labor, for instance, could provide support by incentivizing the creation of, and industry investment in, apprenticeships and re-training programs in digital manufacturing skills. Both apprenticeships and re-training should follow the Industry Recognized Apprenticeship Program (IRAP) model, where private stakeholders lead the development of their programs and seek certification by an accredited body. Beyond the IRAP model, employers with programs geared toward digital manufacturing skills should be eligible to receive some form of financial relief such as tax credits or grants.

The U.S. Department of Education can provide support for high schools by creating a program providing grants to state departments of education to support state investment in materials and resources to teach students intermediate digital skills. These skills might include robotics; information and data management; network architecture; and computer programming, along with many other foundational digital skills that could facilitate a career pathway in a digital manufacturing domain. This level of engagement could provide invaluable exposure to young people in general and particularly to historically disadvantaged demographics to equip them in the early years of their workforce participation.

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