IEEE★USA

POSITION STATEMENT

NATIONAL ENERGY POLICY RECOMMENDATIONS

Adopted by the IEEE-USA
Board of Directors (18 November 2016)

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I. INTRODUCTION

Energy policy recommendations of IEEE-USA will help ensure that the United States can meet its energy needs in an economical, reliable, secure, and sustainable manner. IEEE-USA does not represent any single stakeholder and considers energy to be a non-partisan issue. The recommendations in this report were developed using a balanced approach and are intended to serve the interests of the nation as a whole.

A. Summary

ENERGY underlies three (3) converging challenges facing the United States today:

1. Economic prosperity,
2. National security,
3. Environmental protection.

Electricity continues to be a key enabler of solutions that address these challenges, but there are substantial complexities in balancing the competing requirements while also maintaining reliability of the grid.

Advances in technology now require that the electric grid be considered as a single system encompassing not only large power plants and transmission lines but also equipment located in homes, factories, and businesses. New technologies are causing rapid changes in wholesale and retail electric energy markets as well. As always, financial constraints must be considered when developing energy policy for the United States.

1. Four Goals

To address the above challenges, a comprehensive national energy policy must seek to achieve four (4) primary goals for future development and operation of the energy system:

1. Economical Generation and Utilization Options: Assure reliable and cost-effective electricity supply to maintain U.S. competitiveness, and grow the economy
2. Reliable and Intelligent Grid Infrastructure: Improve facilities and develop new technologies needed to increase resilience[1] of the grid and deliver reliable electrical energy
3. National Security and Energy Security: Mitigate risks and manage energy system resilience in the national interest

[1] According to USDOE's Second Installment of the Quadrennial Energy Review (QER), January 2017, there are no commonly used metrics for measuring grid resilience although several resilience metrics and measures have been proposed, Summary for Policymakers, page S13.

4. Responsible Stewardship of the Environment: Preserve America's resources and increase the use of environmentally benign and sustainable energy supplies for future generations.

2. Recommended Actions

To achieve these goals, established and new technologies must be applied taking bold actions and making substantial investments within a clear national policy framework. Progress will depend upon funding and implementing advancements in R&D, commercialization of innovative technologies, and developing the necessary legal framework, regulations and technical standards at both federal and state levels.

These IEEE-USA National Energy Policy Recommendations discuss each goal and explain why IEEE-USA believes these are critical priorities. Specific recommended actions and investments are provided for consideration by both government and industry. These goals should be considered as a comprehensive basis for setting national energy policy.

II. GOAL 1: ECONOMIC GENERATION AND UTILIZATION OPTIONS

Low cost energy supply and efficient energy utilization are two sides of the same coin. Supply (generation) and demand (load) are linked through the markets and through energy prices. Therefore, supply side and demand side factors must be considered in combination when developing strategies to optimize overall cost and reliability for the nation.

Four actions needed to achieve this goal are improving efficiency of energy usage, improving transportation efficiency, adding low cost reliable generation and expanding utilization of energy storage.

A. <u>Improve the Efficient Use of Energy</u>

New technologies now enable consumers, industry, and businesses to use energy more efficiently and to take more control of their own costs. Federal and state governments should compile the necessary resources to equip customers and energy stakeholders with information on existing programs, studies, methods, and data used for energy management.

Energy efficiency[2] and demand response[3] are essential elements in any comprehensive national energy policy because the energy that does not need to be produced is often the cleanest, safest, and the least expensive option for users. Demand response

[2] Energy efficiency is the ability to provide the same or better, product or service, using less energy

[3] Demand response is a capability to modify customers' energy use over time, so as to provide a resource for power system operations.

provides the customer with an additional means of reducing electric consumption and cost.

While much of the demand response effort to date has concentrated on residential customers, better options are available for industrial, commercial, and business customers having building or facility energy management systems whose operation can be coordinated with the operation of a modern grid. More intelligent control systems using predictive/adaptive techniques to manage energy use, costs, productivity, and product quality of the entire system are becoming available. Such systems will also incorporate gateways for interfacing with power system operations.

It is advantageous for state and local governments to improve energy efficiency and create demand response options in the public sector. They can also become leaders in promoting these measures in the private sector among households, businesses, and industries.

IEEE-USA RECOMMENDS that federal, state and local governments, along with quasi-governmental and private sector organizations, work to improve energy efficiency, and pursue demand response opportunities as follows**:**

Education: Energy providers and governments should provide energy users with educational resources to increase knowledge of energy efficiency and energy management best practices.

Standards: Government and standards organizations should continue developing and implementing methods, standards, and codes for sustainable products and buildings, consistent with lifecycle analysis.

Electric Grid Efficiency: Strengthen federal R&D by the national labs to reduce energy losses and improve performance of electric power generation, transmission, and distribution.

Market Price: Improve market designs to send better energy market price signals to consumers.

B. <u>Expand Reliable Generation Supply</u>

In 2016, EIA reports that about 65 percent of U.S. electricity was generated from fossil fuels, with most of the rest provided by nuclear (20%), and renewables (15%), including hydro at 6.5% and wind at 5.6%. In 2016 electricity generated by natural gas (34%) exceeded electricity generated by coal (30.5%), and pumped storage provided about 0.2%[4]

[4] Energy Information Administration, Table 7.2A Electricity Net Generation Total (All Sectors), 2016

IEEE-USA expects gas, coal and nuclear power to remain an important part of the electric generation mix until overtaken by other technologies, but solar and wind power are now economic competitors to existing coal and gas generation in growing areas of the country. A July 2017 report by Morgan Stanley states: "Numerous key markets have reached an inflection point where renewables will have become the cheapest form of new power generation by 2020."[5]

Many large American businesses and financial firms have recognized the changing markets and rapidly declining costs of the new technologies and have begun turning to them to meet their energy supply needs.[6] Nuclear has an important continuing role, but existing plants are threatened by low cost renewables and gas fueled combined cycle competitors and regulatory uncertainties and new units carry large construction risks and are expensive relative to other options.

Natural gas fired combined cycle units and non-dispatchable technologies, such as wind, solar and hydro, have competitive estimated levelized cost of electricity[7] ($/MWh) for new units coming on line in 2022.[8] These same technology units coming on line in 2022 are also projected to have a levelized cost of electricity lower than the levelized avoided cost of electricity ($/MWh)[9] of the power plants being replaced.[10] However, estimated costs can vary by region or over time as the costs of plant equipment, labor, fuel, and operations vary and may be affected by the proximity to transmission lines.

Renewable generators, in some parts of the country, are able to submit negative bids to grid operators ("negative price") to take their generation during periods of surplus supply because they receive a federal production tax credit for every MWH generated. This can distort price signals in wholesale electricity markets by providing an incentive for renewable producers to sell electricity at a loss to earn tax subsidies. The failure of renewable generators to curtail output when wholesale prices approach zero makes it more difficult for system operators to maintain reliability, is more costly to operate in the long run and has an adverse impact on existing nuclear plants in particular because this technology lacks the operational capability to reduce output in response to low bid prices.

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[5] https://www.morganstanley.com/ideas/solar-wind-renewable-energy-utilities

[6] http://there100.org/companies

[7] Levelized Cost of Electricity (LCOE) represents the per-kilowatthour cost of building and operating a generating plant over an assumed financial life and activity level

[8] Energy Information Administration, Leveleized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2017, Table 1b, page 8 (https://www.eia.gov/outlooks/aeo/electricity_generation.cfm)

[9] Levelized Avoided Cost of Electricity (LACE) represents the value to the electric grid of adding generating capacity using a specific technology to the system. LACE reflects the cost that would be incurred to provide the same supply to the system if new capacity using that specific technology was not added.

[10] Energy Information Administration, Leveleized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2017, Table 3, page 10

The market for conventional electricity generators is significantly harmed by negative prices, both in terms of near-term daily operational decisions, as well as long-term decisions to build or retire existing plants.[11] Negative market prices have been a factor in recent shutdowns of nuclear plants, which exposes the grid to an exchange of base-load generation for intermittent, non-dispatchable generation by renewables, resulting in increased use of fossil-fueled generation, with attendant increases in emissions.

Planning for new construction for the generation fleet must take into account diversity of generation technologies and fuels to mitigate changes in fuel prices or availability, and changes to regulatory or tax impacts. The congressional practice of authorizing incentives for short periods of years, with the threat they might be discontinued, has created disruptive "boom and bust" cycles of renewable development. Energy policy should be based upon a long-term view to provide a stable basis for private sector investment decisions and to protect reliability as conditions change.

1. Developing New Generation Options

New commercialized generation options include wind, photovoltaic solar and thermal solar, all of which vary in output and predictability. While most wind installations are grid-scale generation sources, many solar and a few wind sources are connected to distribution grids, presenting additional challenges. Geothermal generation is commercially applied but is limited to geographic sites with geothermal capability.

Advanced combustion turbines in combined cycle configuration increase reliance on natural gas, even for base load generation. The markets for wholesale electricity are very different from those for natural gas. These differ both geographically, and in scheduling approaches. It will be important to provide for better coordination of these markets to eliminate potential challenges, as electricity generation competes with other consumers for natural gas.

IEEE-USA RECOMMENDS:

Stable Incentives: Any financial or tax incentives for renewables should be stable and sufficiently predictable to allow long-term planning by renewable power purchasers, project developers and equipment manufacturers.

[11] "Negative Electricity Prices and the Production Tax Credit Why wind producers can pay us to take their power – and why that is a bad thing", Frank Huntowski, Aaron Patterson, and Michael Schnitzer, The NorthBridge Group, 9/14/2012, pages 2-5

Stable Incentives: Any financial or tax incentives for renewables should be stable and sufficiently predictable to allow long-term planning by renewable power purchasers, project developers and equipment manufacturers.

Regional Planning: The U.S. DOE and FERC should continue supporting regional and interconnection-wide transmission planning practices and system operating procedures, to support integration of variable renewable generation for public benefit.

Market Design: FERC and system operators should evolve market designs to accommodate a high penetration of renewable resources because of their security of supply, distributed and modular nature, reduced environmental impact and increasingly competitive cost.

Regulatory Policies: Regulatory policies at the state level should accommodate use of on-site renewable generation installed by customers. Retail market designs at the state level should align with, and be compatible with, wholesale market designs approved by FERC in order to provide accurate price signals to consumers and to avoid adverse unintended consequences for bulk power system grid reliability as more generation and storage technologies are deployed at the distribution level.

Market and Infrastructure Coordination: U.S. DOE, FERC, NERC, RTOs/ISOs and utilities should continue working on better coordination of electricity and gas markets and infrastructure to mitigate potential new reliability and cost issues due to increasing reliance on natural gas generation.

2. Revitalizing Nuclear Power Generation

Nuclear power must remain an essential part of our generation technology to provide diversity and maintain reliability.[12] Nuclear power has a highly reliable track record and is insulated from supply and price volatility in fossil fuel markets and can reduce America's dependence on fossil fuels.

Existing nuclear plants in the United States are cost competitive with both conventional fossil fuels and renewable sources, and through license renewal, could operate for many decades. Nuclear-fueled reactors also are capable of producing high temperature process heat that is suitable for industrial use in place of fossil fuels.

Although progress is being made toward smaller, more modular designs, the near-term emphasis should be on getting advanced nuclear plant designs built and operating. Small Modular Reactor (SMR) technology is an attractive alternative to the current

[12] USDOE "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste" issued January 2013, Cover Letter from Secretary of Energy Steven Chu

advanced nuclear plant design and should be pursued in the long term.[13] Nuclear power is, and must remain, an important part of a balanced portfolio of energy sources.

There are both technical and business cases to be made that nuclear fuel should be recycled, extracting the energy component and processing those fissile materials for use in existing light water reactors, advanced reactors and small modular reactors. Currently spent nuclear fuel is stored safely at reactor sites in 35 states awaiting development of centralized permanent-disposal facility. There are no permanent-disposal facilities or geologic repositories in the United States at the present time.[14]

Properly designed re-processing of spent fuel can reduce both the volume and the toxicity of the nuclear waste by-product for ultimate permanent disposal. The U.S. Department of Energy must continue its advanced fuel cycle R&D to demonstrate more proliferation-resistant separation processes and the commercial viability of such processes.

IEEE-USA RECOMMENDS:

R&D: Continue support of fundamental R&D in industry, academia and government, to continue exercising world leadership in nuclear fission and fusion science.

Reprocessing of Spent Fuel: Continue advanced fuel cycle R&D to develop nuclear fuel reprocessing technologies.

Spent Fuel Management and Storage: The U.S. DOE should propose, and Congress should enact, a comprehensive spent nuclear fuel management program that would close the fuel cycle, and develop a disposal facility as mandated by the Nuclear Waste Policy Act of 1982.

Process Heat Applications: Develop and demonstrate applications of nuclear process heat/cogeneration in chemical and petroleum industries. The NRC should devise safety regulations for the commercial deployment of nuclear process heat technologies.

Licensing and Construction: DOE and NRC should actively support provisions of the Energy Policy Act of 2005 pertaining to the construction of new power plants, and the Next Generation Nuclear Plant; and support development and licensing of small modular reactors.

[13] "Small Modular Reactors: Opportunities for the US Supply Chain", Nuclear Insider White Paper, page 2
[14] USDOE "Transforming the Nation's Electricity System: The Second Installment of the QER | January 2017, Summary for Policymakers", page S10

C. Expanding Energy Storage: Bridging Supply and Demand

Electric power production and consumption are constantly changing yet must always remain in balance. The addition of renewable generation with variable output like wind and solar can complicate the ability to keep the system in balance. Energy storage technologies can help to bridge this gap. The use of energy storage can increase the reliability of electric power supply by providing service continuity for momentary supply interruptions and increasing power quality.

Large-scale, grid-level energy storage must be developed and deployed if intermittent sources of electric power, such as wind and solar are to reach full potential. As it becomes available, additional energy storage can be integrated into market based real time operation and be included in long range plans to complement variable generation and reduce fossil plant usage. Some markets already include pumped storage and batteries in their market operations.

New generation sources, such as solar, will often be connected to the distribution grid. Adding generators to the distribution grid can create flow patterns that the grid was not initially designed for. Recent studies from DOE's national labs and Regional Transmission Organizations suggest that higher levels of renewable generation can be reliably integrated into the bulk power systems. The analysis also finds that this transformation would face significant institutional and technical challenges, including the need for increased electric system flexibility from other resources, to enable electricity supply-demand balance. Demand response, fast ramping natural gas generation and storage are options to increase electric system flexibility.[15]

Connecting an energy storage device to the distribution grid to operate as both a load and as a distributed energy resource (DER) offers integration challenges, but it also offers opportunities for increased reliability and adds geographic diversity to power generation sources. Accommodating new loads and generation sources will require bridging the gap between the transmission and distribution grids and crossing the chasm between federal regulation of the transmission grid and individual state regulation of electric distribution.

1. Technology and Timing

A wide array of technologies comprises energy storage, including various types of batteries, flywheels, pumped hydropower, compressed air, and thermal storage. By far the largest energy storage technology in the world today is pumped hydropower. Opportunities to expand pumped hydropower are limited by geography however, so other technologies must be developed to make significant expansion of energy storage possible.

[15] USDOE "Transforming the Nation's Electricity System: The Second Installment of the QER | January 2017, Summary for Policymakers", page S

Energy storage systems provide time shifting between generation and demand. Time-shifting may also postpone the need for additional generation and transmission capacity as well as reduce environmental impact from fossil-fuel plants by allowing them to run more constantly at their most efficient operating level.

2. Technical and Economic Benefits

Energy storage systems facilitate the integration of renewable resources (solar PV and wind) by smoothing out the inherent variability in their outputs. Storage systems can make the grid more efficient by reducing the output variations required by intermediate-load generators and peaking plants and by reducing congestion on transmission lines. Energy storage can compensate for the lack of operating flexibility of nuclear units.

High power storage systems can be used for frequency regulation more effectively than spinning reserves and provide the opportunity to compensate for varying grid conditions by providing or absorbing energy as needed to help correct system voltage or frequency. Storage systems can also have an impact in reducing energy prices through arbitrage in the markets. On the customer-side of the meter, energy storage can: 1) provide back-up power to increase customer service reliability; 2) reduce customer costs through arbitrage and 3) provide backup and operating reserves in wholesale markets.

IEEE USA Recommends:

Energy Storage Technology: Advance the research, through our national labs, and development of battery storage, thermal storage, flywheel applications and compressed air applications as energy storage technologies.

Regulatory Policies: Amend regulatory policies and recognize the value of storage applications in transmission and distribution and in the energy and capacity markets.

Resolve Energy Storage Regulatory Gap: Bridge the gap between federal regulation of the transmission grid and individual state regulation of electric distribution. Regulators should resolve this gap to facilitate implementation of energy storage.

D. <u>Improve Transportation Efficiency</u>

Electric motors are inherently more efficient than internal combustion engines and can be used in mass transit, passenger and commercial vehicles, buses, and rail. Electric vehicles, which convert about 59%–62% of the electrical energy from the grid to power at the wheels, are more efficient than conventional gasoline powered vehicles, which convert only about 17%–21% of the energy stored in gasoline to power at the wheels.[16]

[16] USDOE, Energy Efficiency and Renewable Energy, www.fueleconomy.gov

Automobile, bus, ship, train, and truck vehicle manufacturers are now rapidly developing and, commercializing more efficient electric drive train technologies. In the US, Tesla, Chevrolet, Most manufacturers have now released all electric or plug-in hybrid designs for the mass market. Toyota, GM, Ford, Mercedes, BMW, Hyundai, Tesla and others offer electrified vehicles for sale in the US. China has established a goal to have 5 million electric vehicles on the road by 2020. India has announced a target to sell only electric vehicles by 2030. The world is moving toward electric vehicles and the US is positioned to do likewise as they become more cost effective to buy.

The US electric infrastructure already in place is sufficient to permit a significant reduction in dependence on liquid fuels through greater penetration of plug-in electric vehicles (PEVs), including all electric and plug-in hybrid electric vehicles (HEVs). Electrification of vehicles would produce a direct and immediate domestically produced substitute for oil along with commensurate benefits for energy efficiency, national security and the environment.

Stable, predictable incentives need to be continued for the electric vehicle market in the near term. These market development measures should be combined with further technology advances, particularly in battery systems, and development of economy of scale to improve cost competitiveness with conventional internal combustion technology.

IEEE-USA RECOMMENDS: Governments, and the private sector, develop and pursue a strategy to electrify transportation systems as follows:

Efficiency and Deployment: Increase transportation efficiency and promote the rapid deployment of PEVs and HEVs through federal, state, and city incentives for electric vehicle purchase and use

Battery Charging Infrastructure: Promote the development of battery charging infrastructure, and its deployment by cities, states, and private companies.

Battery R&D: Increasing federal and private sector R&D aimed at improving automobile battery technology through improved energy storage density, increasing battery life, and implementing rapid battery recharge or change-out strategies

Charger Technology R&D: Increase research and development to advance the technology of chargers for faster charging times of automobile batteries used in PEV and HEV

Grid Integration R&D: Continuing federal and industry research on the integration of PEVs on the electric grid, and developing and implementing industry consensus standards to achieve integration.

Power Electronics and Electric Machine R&D: Accelerating federal and industry R&D aimed at reducing weight and volume, and increasing reliability and capability of power electronics, coupled with electric machines for electric vehicles.

II. GOAL 2: RELIABLE AND INTELLIGENT GRID INFRASTRUCTURE

The National Academy of Engineering classified electrification as the number one engineering achievement of the 20th century. A panel of national experts judged electricity to be the second most important innovation in the history of mankind. (The printing press ranked first.) Today, the U.S. electric grid is a network of approximately 10,000 power plants, 170,000 miles of high-voltage (>230 kV) transmission lines, and more than six million miles of lower-voltage distribution lines, and more than 15,000 substations. The transmission system is an interstate grid whose primary purpose is to connect generating plants with electrical load centers, like cities, with high-demand commercial and industrial facilities. In turn, the local distribution system provides for service to residential, commercial and small business customers.

Most of the systems currently in place were built by and for the regulated monopoly utility industry and are not fully prepared to handle the increasingly larger and faster changes in markets and technologies on both the supply and consumer-side. In particular, the system is largely unidirectional; and its planning, design, operation and control assume that all flow is from generation to a readily predictable load. The change in customers' ability to generate power and proactively manage energy consumption requires that the infrastructure become more flexible and adaptable. The system must be reconfigured into one capable of transmitting power and data in multiple directions.

A strong transmission grid provides the flexibility and robustness required to maintain reliability for future conditions that may be difficult to predict. For example, introduction of Flexible AC Transmission Systems (FACTS) allow for dynamic voltage regulation that helps to smoothly incorporate variable generation resources, control loop flows, and optimize the throughput of transmission lines. The North American SynchroPhasor Initiative (NASPI) supports next generation monitoring equipment to increase reliability and reduce cost for consumers through development of secure, high-speed, time synchronized data about bulk power system conditions.

Much of the current federal effort is focused on transmission. Yet, it is essential that market design and grid expansion programs for both the transmission and distribution systems work together to maintain adequate levels of grid reliability, security of the power supply, and provide customers with the services and choices they demand.

At the minimum, the system must support the addition of both conventional and renewable generators along with demand response; and enable implementation of technologies like electric vehicles and solar on the distribution system. In addition to technology aspects, this will require a radical change in regulatory structure and market

design; to enable better choices and trade-offs between generation, transmission and distribution.

A. Making the Network More Intelligent

Adding more intelligence — sensors, communications, monitors, optimal controls and computers — to our electric grid can lead to substantially improved efficiency and reliability through increased data availability, situational awareness, reduced outage propagation, and improved response to disturbances and disruptions. Situational awareness can be expanded through the use of new measurement technology, such as the North American SynchroPhasor Initiative (NASPI).

This so-called "Smart Grid" could also facilitate transparent pricing of electricity and better customization and differentiation of service options available to customers. It will also allow consumers to manage their energy costs and facilitate distributed generation, opening the door to wider use of variable renewable generation sources and supporting expanded use of electric vehicles.

The federal government recognized this potential by implementing the Energy Independence and Security Act (EISA) of 2007. Title XIII of the Act mandates a Smart Grid that is focused on modernizing and improving the information and control infrastructure of the electric power system. Among the areas being addressed in the Smart Grid program are: transmission, distribution, home-to-grid, industry-to-grid, building-to-grid, vehicle-to-grid, integration of renewable and distributed energy resources (such as wind and solar), and demand response.

The Federal Energy Regulatory Commission, the National Association of Regulatory Utility Commissioners, and their joint Smart Grid Collaborative should work with state regulators to resolve issues of customer involvement — especially for standards having benefits focused on national security, energy security, or difficult-to-quantify issues.

IEEE-USA RECOMMENDS:

Smart Grid Standards: Continue federal government support to NIST and the Smart Grid Advisory Committee (SGAC) for developing the Framework and Roadmap for Smart Grid Interoperability Standards as the principal coordinator of Smart Grid standards under EISA 2007 Title XIII to ensure the viability and continued operation of this evolving private-public partnership.

Standards: Improve the timely development of Smart Grid standards, and promote their widespread deployment. Develop testing and certification of products for compliance with Smart Grid standards.

Broadband Communications: Support the advancement and the deployment of broadband and other communication technologies that help maximize Smart Grid benefits.

B. Expanding the Transmission System

Much of the renewable energy and natural gas potential in the United States is located in areas that are remote from population centers, lack high demand for energy, and are not well connected to our national infrastructure for transmission of bulk electrical power. The recent expansion of natural gas production in the United States has affected grid development.

To achieve public policy objectives, sufficient transmission capacity must link new natural gas generating plants, on-shore or off-shore wind farms, solar plants, and other renewables to customers. Installing the necessary electrical infrastructure will require both significant financial investments and cooperation at all levels on politically challenging items, such as siting facilities and routing new transmission lines.

New transmission will play a critical role in the transformation of the electric grid to enable public policy objectives, accommodate the retirement of older generation resources, increase transfer capability to obtain greater market efficiency for the benefit of consumers, and continue to meet evolving national, regional and local reliability standards.

IEEE-USA RECOMMENDS:

Development of Regional Plans: Continue federal and state government support of the development of regional plans that include both federal and state public policy goals, such as the Eastern Interconnection Planning Collaborative, MISO's Multi-Value Projects and Illinois' Next Grid Initiative.

Industry Support: ISOs/RTOs and industry should support goals for integrated interregional, regional and local transmission system planning (FERC Order 1000) — to increase system efficiency, achieve public policy objectives, and continue to meet evolving reliability standards.

C. Transmission Stressed; New Demands on Distribution

Over recent decades, the transmission grid has been stressed by an increase in electric demand, and changes in the location and characteristics of generating plants, such as the recent shift to natural gas generation. The introduction of new sources of renewable wind and solar power must also be managed, because of the inherent variability in output. Further, the increasingly complex and competitive regional power markets can add stress to the grid. These conditions can create grid congestion, reliability risks and higher transmission losses, all of which can result in higher rates for electricity. Reinforcing the grid and deploying advanced technologies will help address some of these concerns, and increase physical and cyber security of the grid.

Distribution systems are operated by local utilities under state regulation (or for some municipals and cooperatives, state authority to self-regulate); but as new types of technologies are employed, their operation becomes more closely linked with that of the inter-regional transmission grid, and wholesale electric trading markets. More transparent, participatory, and collaborative discussions among federal and state agencies, transmission and distribution asset owners, and RTOs/ISOs and their members to improve understanding of impacts, interactions, and benefits must take place to resolve issues such as grid congestion, reliability risks and higher system losses.

Operation of technologies such as demand response (DR) and distributed energy resources (DER) as well as electric vehicles are inextricably linked to operation of both the local distribution system, and the regional transmission grid. Distribution system design, operation and regulation must accommodate the evolution of technology and technical and jurisdictional issues associated with devices, such as battery storage and rooftop solar, that simultaneously serve both the distribution and transmission grids and operate across institutional, regulatory, and information technology boundaries.

Another technology that has received renewed interest is direct current (DC), especially in localized grids called “microgrids.” For example, solar photovoltaic produces DC, batteries store DC, and loads such as computer equipment and variable speed motors operate on DC. The grid operates mainly on alternating current (AC), and conversions need to take place between AC and DC to interconnect DC generation or loads to the AC grid. Efficiency considerations suggest minimizing the number of such individual conversions, leading to exploration of new concepts for managing electricity at locations involving these local generation sources, storage methods, and loads.

IEEE-USA’s long-term vision is to tie generation, transmission, distribution, and use into a common network with each stakeholder having access to data, information, and knowledge to enable faster, predictable and more accurate decision-making.

IEEE-USA RECOMMENDS:

State Approval Process: Reforming the state-by-state approval process for routing and siting, to ensure that delays in transmission construction do not also delay progress in expanding the use of renewable energy, and achieving national clean air goals.

Grid R&D: Increase federal research and development, through the national labs, for emerging technologies that may impact the transmission and distribution grids; with an additional focus on integrating such technologies to improve reliability, efficiency, and grid management.

Application of DC Systems: Increase the development of direct current (DC) power systems that connect solar PV, batteries and computer equipment to reduce the conversions from AC to DC, increasing system efficiency.

IV. GOAL 3: NATIONAL SECURITY AND ENERGY SECURITY

Energy policy and national security are inextricably linked. Improving national security involves both security of supply, ensuring access to sufficient energy sources, and economic security by ensuring that price disruptions in energy markets do not damage our economy. IEEE-USA believes that the steps taken to assure low cost electrical supply and improve our infrastructure are critical to national security since they help insulate the country from supply disruption and move the country toward increased use of domestic sources of energy whose availability and cost of operation is not affected by international events. Advancements in strengthening cyber, critical power and energy infrastructure security could greatly improve national security.

IEEE-USA believes that strong physical and cyber-security policies will be essential to maintaining reliability and improve national security.

A. Renewables and Distributed Generation

Renewable sources of power generation are distributed and modular in nature, which reduces vulnerability of the power supply to terrorist attack. Distributed generation presents less exposure to transmission system disruptions or single point terrorist attacks on large power stations. Renewables and distributed generation also eliminate exposure to terrorist attack on fuel supply infrastructure like pipelines or rails.

IEEE-USA RECOMMENDS:

Recognize Value of Renewable Power for National Security: Policy makers should explicitly recognize and identify the potential added value that renewable generation and distributed generation provide for national security, grid reliability and economic security when considering legislation and regulatory policy.

B. Electrify the US Vehicle Fleet; Use of Alternative Fuels

The America First Energy Plan on Whitehouse.gov states a goal to advance "independence from the OPEC cartel and any nations hostile to our interests." Electrifying the country's vehicle fleet will be a key component of achieving that objective. Nearly all electric generation in the US is produced using either domestic fuels or renewables. Almost no oil is used for generating electricity. Therefore, electrifying transportation and expanding use of alternative fuels reduces US exposure to both supply disruptions and oil price shocks.

Our ability to substantially reduce petroleum's use for transportation will be essential to reducing the national security risks inherent in dependence on a single energy source for transportation. An efficient way to reduce dependence on petroleum is to expand electrification of mass transit, passenger and commercial vehicles, buses, and rail.

Continuing the development of alternative liquid fuels, and implementation of natural gas vehicles are also necessary to satisfy the continuing requirement for liquid fuels.

IEEE-USA RECOMMENDS:

Electrify Vehicle Fleet: Reduce US exposure to disruption of oil supplies and price volatility in oil markets through electrification of the vehicle fleet.

Alternative Fuels: Replace conventional fuels with domestically produced alternative liquid fuels, and expand the use of natural gas for heavy-duty vehicles.

C. Energy Storage Technologies

Energy storage offers secondary benefits to national security and contributes to the flexibility and resilience of the grid. The use of energy storage can increase the reliability of electric power supply by providing service continuity for momentary supply interruptions and increasing power quality.

IEEE-USA RECOMMENDS:

Integrate Energy Storage into the Grid: R&D to reduce the high cost of energy storage and to develop models to indicate best locations, sizes, and types of energy storage systems.

D. Nuclear Fuel

Developing and deploying nuclear fuel reprocessing technologies to improve economics and reduce proliferation concerns need to be further developed. As part of the commitment to a reliable and diverse generation fleet, safe, long-term management, transportation, and disposal of used nuclear fuel and high-level radioactive waste must remain a national priority.[17]

IEEE-USA RECOMMENDS:

Reprocessing: Develop reprocessing technologies and facilities with high security to mitigate the risk of proliferation.

[17] USDOE "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste" issued January 2013, Cover Letter from Secretary of Energy Steven Chu

Proliferation: Implement R&D to improve transportation and storage technology and procedures to reduce the risk of proliferation of nuclear fuels and nuclear waste products.

E. Cyber and Physical Security of Critical Power and Energy Infrastructure

The existing end-to-end energy and power-delivery system is vulnerable to natural disasters and intentional cyber-attacks. Virtually every crucial economic and social function depends on the secure, reliable operation of power and energy infrastructures. Energy, electric power, telecommunications, transportation, and financial infrastructures are becoming interconnected posing new challenges for secure, reliable, and efficient operation.

All of these interdependent infrastructures are complex networks, geographically dispersed, non-linear; interacting both among themselves, and with their owners, operators, and users. Challenges to the security of the electric infrastructure include:

Physical security – The size and complexity of the North American electric power grid and its supply chain makes it impracticable both financially and logistically to physically protect the entire end-to-end and interdependent infrastructure.

Natural gas fueled generation, which is a likely near-term fill-in for the highly variable renewable sources, creates challenges as it exposes much of the electricity supply to potential interruptions in gas supply. Adequate natural gas storage, and other measures, will be needed to help guard against these potential risks.

Cyber security – Threats from cyberspace to our electrical grid are rapidly increasing and evolving. While there have been no publicly known major power disruptions in North America due to cyber-attacks, public disclosures of vulnerabilities are making these systems more attractive as targets. Currently more than 90 percent of successful intrusions and cyber-attacks take advantage of known vulnerabilities and misconfigured operating systems, servers, and network devices.

Technological advances targeting system awareness, cryptography, trust management and access controls, such as Advanced Metering Infrastructure (AMI), are underway and continued attention is needed on these key technological solutions. Wireless access and the public Internet increase vulnerability to cyber attack.

Cyber connectivity has increased the complexity of the control system and facilities it is intended to safely and reliably control. Operations Technology (OT) engineers have a priority for the safe, efficient and continuous running of the plant, whereas the main priority for Information Technology (IT) engineers is security. Adding security to a device

or system could result in unexpected incompatibilities between the security and operating systems.[18]

Cyber security and interoperability are two of the key challenges of smart grid transformation. Security must be built-in as part of its design and not glued on as an afterthought. FERC should require asset owners to practice due diligence in in providing security for their infrastructure as a cost of doing business.

One important constraint on regulatory oversight of security protection is the split jurisdiction over the grid. The bulk electric system is under federal regulation; but the distribution grid, metering, and other aspects of the grid are regulated by individual states. As a result, the oversight of cyber security is split along with other regulatory functions.

IEEE-USA RECOMMENDS

Infrastructure Design: Federal and state governments and utilities should take those actions necessary to facilitate, encourage, or mandate that secure sensing, "defense in depth," fast reconfiguration and self-healing be built into the infrastructure to increase resilience.

Protective Measures: Promote security for Advanced Metering Infrastructure (AMI) by providing protection against personal profiling; guaranteeing consumer data privacy; conducting real-time remote surveillance; protecting against identity theft, home invasions and activity censorship.

Jurisdiction: Government should address bridging the jurisdictional gap between Federal/NERC, and the state commissions on cyber security.

Threat Coordination: The DOE should develop hierarchical threat coordination centers — at local, regional, and national levels — that proactively assess precursors and counter cyber attacks.

Accelerate Standards: FERC should speed the development and enforcement of cyber security standards, compliance requirements and their adoption, into existing facilities and into the design of new facilities.

Grid Investment and R&D: The DOE should increase R&D in areas that assure the security of the cyber infrastructure using algorithms, protocols, and chip-level and application-level security.

[18] "Cyber Security and the Digitization of Nuclear Power Plants", Nuclear Insider White Paper, page 4

Grid Segmentation: The DOE should investigate methods, such as self-organizing micro-grids, to facilitate grid segmentation that limits the effects of cyber and physical attacks. Distributed renewable generation should be considered as a potential component of resilient grid architectures.

V. GOAL 4: RESPONSIBLE STEWARDSHIP OF THE ENVIRONMENT

Quality of life depends not only on low cost supply and security, but also on preserving the resources we all enjoy and rely on, such as clean air and water. With the rapid advance of new technologies like wind, solar, batteries and electric vehicles, simultaneously achieving low cost supply, energy security and environmental protection is now an attainable goal for the nation.

Historically, the shift from burning fuels at the point of use to producing electricity at central power plants increased the efficiency of electricity production, greatly reduced the emissions at the point where energy is used, enabled less costly control of emissions, and reduced the total environmental impact of energy use. The United States needs to further reduce the environmental footprint of the electric power supply to continue its longstanding effort to reduce criteria pollutants and toxic emissions.

Achieving such reductions requires a portfolio of cleaner energy resources and generation technologies. Technologies that can reduce the environmental footprint of the power supply include nuclear and renewables such as: hydroelectric, geothermal, wind, solar, direct combustion of biomass, and biofuels. Nuclear power is an abundant energy source and can provide large-scale electricity generation that is essentially carbon free, and has an ample fuel supply that is recyclable. Wind, hydroelectric, geothermal, solar and biomass combustion are now commercially available, and with the right policy support, can continue to grow, mature, and become more affordable.

National policy should support renewable energy development. Society benefits even with subsidies to renewable generation because renewables and other clean technologies avoid some of the un-priced externalities of combustion technologies. For project developers and the investment community, the best-case scenario would be a stable and predictable price offer for all renewable energy resources stimulating private investment and jobs.

A shift from coal to gas generation is also expected to continue, with more than 60 GW of coal capacity already scheduled for retirement over the next few years. Compared to coal technologies, efficient gas generation reduces GHG emissions by about 50 percent.

Nevertheless, coal is still one of the most abundant domestic resources, and its continued use would be greatly bolstered by carbon capture options, along with technologies for reuse and sequestration of CO2. Carbon capture is only now being demonstrated for a full commercial-scale electric generating plant, and enhanced oil

recovery operations are utilizing captured carbon and could provide a market for the deployment of carbon capture, utilization, and storage (CCUS).[19]

A. Expanding Renewable Electric Generation

Renewable electric generating technologies can be deployed to the extent that they are technologically and economically practical, and have an acceptable impact on the environment and aesthetics.

Many states are pursuing actions to reduce the environmental footprint of their power systems, including adopting renewable portfolio standards and are well down the path to achieve their goals. Some states, such as California, have already achieved high penetration of renewable electric generation using portfolio standards and are considering whether to increase their long-term goals.

As previously noted, many major corporations have also committed to renewable energy. In July 2017 Wall St. banking firm JPMorgan Chase announced a switch to 100% renewable energy by 2020.[20] Over 100 diverse companies including Coca Cola, Proctor and Gamble, Apple, Bank of America and GM are on a path to 100% renewable energy.[21] Technological progress and higher manufacturing levels of renewable generating equipment have caused costs to drop, therefore, decreasing the premium over conventional fossil fuel generation.

IEEE-USA RECOMMENDS:

Portfolio standards: Implementation of portfolio standards to increase the application of renewable generation and reduce the environmental footprint of power systems.

Regulatory policies: Revision of regulatory policies to reduce barriers to the development of renewable energy systems while retaining fair compensation to the energy producer and energy distributor.

Utilization: States and cities should pursue plans to encourage and increase utilization of renewable energy consistent with local needs and preferences.

[19] USDOE "Transforming the Nation's Electricity System: The Second Installment of the QER | January 2017, Summary for Policymakers", page S10

[20] https://www.cnbc.com/2017/07/28/jpmorgan-chase-says-it-will-rely-solely-on-renewable-energy-by-2020.html

[21] http://there100.org/companies

B. Nuclear Power

Commercial nuclear power is essentially carbon free, it has a positive impact on the environment by generating base load electrical energy without releasing carbon dioxide to the atmosphere. Additionally, because the uranium fuel has higher energy density compared to coal, there is a significant reduction in carbon emissions delivering fuel and removing waste from a nuclear plant.

High quality steam and process heat generated by next generation nuclear could be used in place of coal, natural gas and oil in industrial, chemical and petrochemical facilities, which preserves natural gas as a feedstock and reduces greenhouse gas emissions at the same time.

IEEE-USA RECOMMENDS:

Carbon Free Energy Generation: Recognize comparability of nuclear generation and renewable energy generation in terms of emissions compliance and incentives to level the market for fair completion and maintain a diversity of carbon free generation resources.

C. Electrifying Transportation

We need a radical change in the transportation sector to reduce emissions from transportation, particularly in large cities. Transportation emissions are widely dispersed so it is impractical and uneconomical to capture transportation emissions. Hence, the principal option is to change from oil to alternate energy sources such as electric drives and alternative fuels.

Electrifying the transportation sector as previously described will increase transportation energy efficiency and reduce greenhouse gas and other emissions, even with the current fuel mix for electric power generation including the coal fired power plants. In addition, electrification opens up a clear pathway to near-zero “well-to-wheels” emissions in the transportation sector.

IEEE-USA RECOMMENDS:

Mass Transit: Increase investment in electrified mass transit and the installation of charger infrastructure.

Clean Generation R&D: Congress and the U.S. DOE should continue R&D to develop and demonstrate other clean fuel generation technologies, including biomass fuel and other fossil fuels.

D. Reducing Carbon Emissions from Fossil Power Plants

Coal is our nation's most plentiful domestic fossil fuel resource, and is important to the economic vitality of some areas of the United States. Coal, however, is also one of the major sources of carbon dioxide (CO2), and emissions such as sulfur oxides (SOx) and mercury.

The capture, transport, utilization, and storage (or sequestration) of carbon, or its combustion products, is a daunting challenge — because of the enormity of the necessary infrastructure, the loss in efficiency and plant output, and the very high cost. Yet, because coal is our nation's most extensive energy resource, the effort to keep this option open may be worthwhile if we are to address the long-term challenge of mitigating greenhouse gas emissions.

IEEE-USA RECOMMENDS:

CCUS R&D: Congress and the U.S. DOE should maintain long-term R&D efforts to develop and test pre- or post-combustion carbon capture and storage or reuse technologies that would make coal a viable energy resource in a future, carbon-emission constrained world.

VI. CONCLUSION – NEED TO TAKE ACTION NOW

It is imperative that we as a nation strive to achieve the four goals to maintain US competitiveness, and grow the economy:

1. Expand Options for Economic Power Generation and Efficient Energy Utilization, which improves diversity of generation technologies and primary energy sources
2. Provide Reliable and Intelligent Grid Infrastructure, which increases the resilience of the grid
3. Protect National Security and Energy Security by reducing and controlling risk to improve energy system reliability and resilience in the national interest
4. Maintain Responsible Stewardship of the Environment

Urgent action is needed now because, with each passing year, U.S. options to respond to large local and global uncertainties will diminish. We cannot allow low prices to again lull our country into complacency. The need for a comprehensive sustained energy vision, strategy, policy, and regulatory structure is real — no longer just important, but urgent. Now is the time to invest in new and established technologies to guide our nation to become better energy stewards, reduce environmental impacts, and secure energy supplies for the future. Electricity has a major role to play in reaching these objectives.

This statement was developed by the IEEE-USA Energy Policy Committee and represents the considered judgment of a group of U.S. IEEE members with expertise in the subject field. IEEE-USA advances the public good and promotes the careers and public policy interests of nearly 180,000 engineering, computing and allied professionals who are U.S. members of the IEEE. The positions taken by IEEE-USA do not necessarily reflect the views of IEEE, or its other organizational units.