



ASME ENERGY GRAND CHALLENGE ROADMAP



August 2009

Prepared by:



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United States Senate

March 12, 2009

Michael Tinkleman, Ph.D., Director, Research
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Dear Members of ASME,

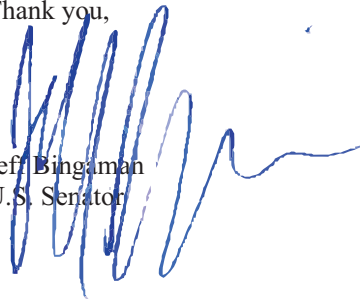
As you convene this ASME Energy Grand Challenge Visionary Roadmap Workshop, I wish to welcome you, as well as convey my gratitude for the initiative and leadership that ASME has shown in holding this critical event in order to fully explore looming energy challenges, potential energy breakthroughs and identify the proper course of action for fulfilling our national energy goals.

As you know, ASME has convened members of its society, as well as representatives from private and public industry, to lead a thorough discussion on effective means for transforming the nation's current energy landscape to not only enhance energy security but also usher in present and future economic growth. Through a series of breakout sessions, ASME will seek to identify existing barriers to energy security, while also crafting bold technical and political solutions to national implementation of an energy roadmap.

I do not believe that anyone would disagree that our nation is currently at an energy crossroad, and the decisions and actions that we make now could affect our nation for generations. Finally, it is critical that engineers, who will likely be entrusted with the development of many of these systems that we will rely upon to power our homes and our places of work, be afforded a role in the development of a energy policy. I offer my full endorsement of this activity and, additionally, I challenge my friends within the ASME to provide public servants such as myself with ideas and solutions that will shake our current energy foundation and pave the way toward a brighter, more sustainable future.

Thank you,

Jeff Bingaman
U.S. Senator





Executive Summary

Energy is a global commodity that is integral to nearly every aspect of society. The energy sector contains some of the oldest functional mechanical equipment and technology in the nation and is currently undergoing major changes in all aspects of the energy value chain. These changes reflect an increased emphasis on climate change and sustainability and range from the diversification of fuel sources to the implementation of end-use energy efficiency programs.

The American Society of Mechanical Engineers (ASME) is the premier organization for promoting the art, science, and practice of mechanical and multidisciplinary engineering and allied sciences to diverse communities throughout the world. ASME has dedicated itself to promoting and enhancing the technical competency and professional well-being of its members and, through quality programs and activities in mechanical engineering, to better enabling its practitioners to contribute to the well-being of humankind. ASME's mission is "to serve our diverse global communities by advancing, disseminating and applying engineering knowledge for improving the quality of life and communicating the excitement of engineering." ASME develops standards and certification programs that enhance public safety, and provides lifelong learning and technical exchange opportunities benefiting the engineering and technology community.

ASME boasts particular strengths in energy. Its members design the generation equipment, operate the power plants, and develop the technologies that comprise the energy sector. Today, over one-third of ASME's technical divisions are focused on or strongly related to today's foremost energy concerns, producing a wide variety of energy-related programs, products, and activities. With these vast capabilities in mind, ASME recognizes it can significantly contribute to the development and integration of technologies to improve energy production, transmission, and use nationwide. ASME also recognizes its role in continuing to lead the discourse on the ways in which the United States and other areas of the world can secure the energy future for generations to come.

ASME Vision – "ASME will be the essential resource for mechanical engineers and other professionals throughout the world for solutions that benefit humankind."

Why ASME?

- Unbiased, technically informed voice
- Diverse membership from industry, academia, and government
- Convener/facilitator of innovation networks
- Global reach, supporting workforce growth
- Collaboration opportunities that advance knowledge
- R&D advocacy to stimulate innovation
- Standards and certification programs

This ASME Energy Grand Challenge Roadmap is among the first steps ASME is taking to identify, organize, and build upon existing energy capabilities, products, and services to better serve those who rely on and expect the highest quality energy information and expertise.

ASME's reach—its members, programs, products, services, and robust volunteer structure and capabilities—extends into all parts of the energy value chain. This wealth of capability gives ASME the ability to offer unique value in addressing energy issues using a holistic, systems-level approach. ASME's ability to offer both deep technical expertise in individual parts of the value chain and broad technical expertise across the entire chain is a valuable capability that ASME can build on and leverage to make increased contributions to major national and global energy challenges.

ASME's Energy Grand Challenge Strategy

The ASME Energy Grand Challenge embodies ASME's commitment to making meaningful contributions to energy challenges facing the United States and other areas of the world. The ASME Board of Governors established the Energy Grand Challenge in 2008 as one of three ASME strategic priorities, along with globalization and engineering workforce development.

The strategy for the Energy Grand Challenge is bold:

ASME will serve as an essential energy technology resource for business, government, academia, practicing engineers, and the general public and as a leading energy policy advocate. As a credible, unbiased voice, ASME will be a key source of energy technology information and standards. We will achieve this by leveraging our knowledge-based communities, expanding our energy portfolio, building a more effective energy workforce, and supporting balanced energy policies in the United States and other areas of the world.

ASME will implement this strategy by internally aligning its vast energy-related capabilities and resources and leveraging these resources with those of its many partners.

ASME Priorities for Energy

ASME recognizes that, as a professional engineering society, it can make the most meaningful contributions to energy by optimizing its volunteer and staff resources and by partnering with other organizations. These two approaches allow ASME to achieve a much greater impact than it could alone and form the foundation of the successful ASME approach to the Energy Grand Challenge.

- **Create a cohesive, unified presence for ASME in the energy sector.** ASME is deeply involved in many aspects of the energy sector, a broad presence resulting from the critical role engineers play in the energy workforce. Seven ASME technical divisions and two technical institutes serve as major players in the energy sector with many other ASME technical divisions serving in supporting roles. ASME's energy efforts also include numerous codes and standards, certification, training, conferences and workshops, and technical publications. ASME will align its internal resources to create a cohesive, unified presence in the energy sector. This approach better positions ASME to address energy issues holistically along the energy value chain, ensure consistency in public policy and public outreach messages, and help partners and other interested parties understand ASME's diverse energy activities. Doing so will allow ASME to build on and leverage its vast energy capabilities to make increased contributions to addressing major energy challenges.
- **Build partnerships to increase the effectiveness and impact of ASME initiatives.** Despite ASME's broad energy presence, the energy sector extends well beyond its reach. To fully address energy challenges facing the nation, ASME must leverage its capabilities with those of partner organizations. Strong partnerships with leading companies, government agencies, academic institutions, and other professional societies will bring different perspectives, skill sets,

Trends and Drivers Shaping Future Energy Needs and Requirements

- Increased emphasis on climate change and sustainability creates the need for holistic approaches
- Growing recognition of the need for a National Energy Policy
- Increased energy diversification and use of renewables creates challenges for grid reliability and drives the need for smart grid and energy storage
- Increasing need for codes and standards to facilitate greater commercialization of renewables and other innovative energy technologies in the United States and globally
- Increasing concerns about energy security and resilience drive the need for new metrics
- Aging infrastructure requires new materials and standards
- Aging workforce drives the need to attract new talent
- Shifting economic landscape leads to insufficient investment in energy
- Increasing recognition of the link between energy and water stimulates the need for innovative approaches to the energy-water nexus

and resources to help ASME address the most complex energy issues and achieve far more than it could alone.

The two organizational priorities described above—focused internally and externally, respectively—anchor ASME's overall approach to the Energy Grand Challenge. Optimized internal organization and external partnerships will allow ASME to pursue the four following priorities as the core contributions ASME will make in the energy sector:

- **Serve as an impartial, authoritative, rational voice in energy matters by offering technical expertise to regulators and policymakers.** To assist in the development, evaluation, and integration of current and future energy technologies, ASME must maintain its reputation as an unbiased and authoritative voice. With an objective stance, ASME can become the “go-to” organization for energy technical expertise that can help develop policies, codes and standards, and certification programs to support existing and emerging energy technologies.
- **Develop and promote codes and standards and related products and services to support energy technology innovation and commercialization.** Codes and standards are needed in many parts of the rapidly changing energy sector, particularly around renewable and emerging energy technologies. Standards for energy lifecycle analysis that support a holistic view of energy will inform policy and

business decisions and encourage energy technology innovation. The development of ASME codes and standards is a transparent, consensus-driven process that involves code committees who represent a balance of engaged individuals with the necessary technical expertise.

- **Support the expansion and development of a more effective energy workforce.** A significant portion of ASME's 127,000 members work in energy industries or teach mechanical engineering to undergraduate and graduate students. ASME will leverage this great member resource through its engineering workforce development initiative to bolster the size and technical ability of the energy sector workforce to meet the quickly changing needs of the sector. This strategic objective complements ASME's ongoing advocacy to improve science, technology, engineering, and mathematics (STEM) education initiatives nationwide.
- **Increase public awareness and knowledge of the energy sector.** As an organization representing those who envision, design, build, operate, and maintain modern energy technology, ASME is positioned to offer an experienced, informed, and unbiased voice to a public in need of credible information. By working with the public, ASME can promote understanding of basic scientific and energy realities, leading to increased interest in energy engineering and greater public acceptance of effective and responsible energy solutions.

Top-Priority Opportunities for ASME Action

ASME has established a bold strategy for its Energy Grand Challenge and has identified priorities to implement that strategy. Effective implementation will require the active development and deployment of ASME's energy capabilities. ASME has identified nine top-priority opportunities to focus its efforts in achieving its Energy Grand Challenge strategy. These opportunities cut across the full spectrum of ASME's strategy and serve to expand ASME's professional offerings as an energy technology resource.

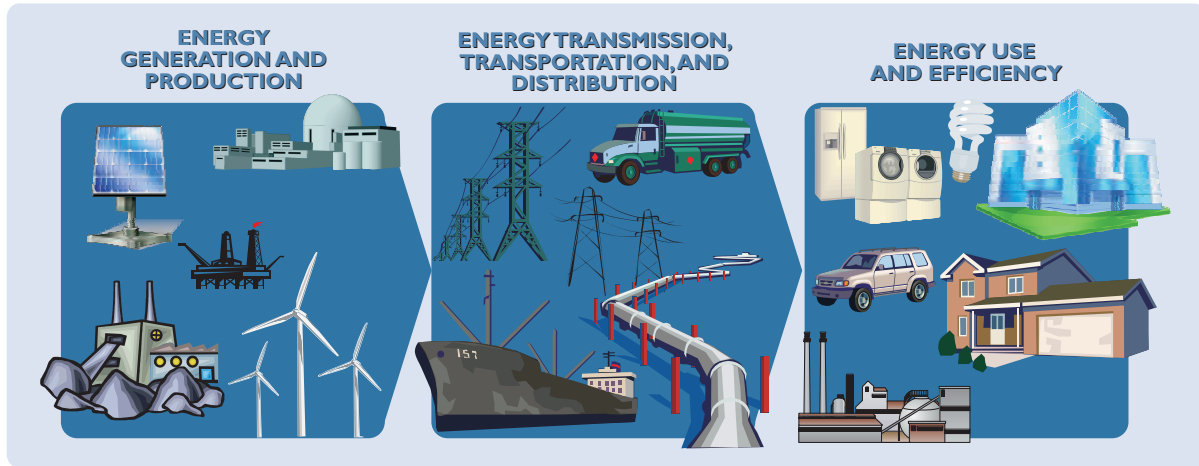
The top-priority opportunities for ASME's Energy Grand Challenge are listed in Figure ES-1. Chapter 5 of this roadmap presents a series of one-page action plans for each top-priority opportunity. Each action plan provides a more detailed description of the priority; identifies the key challenges addressed by the activity and the desired outcomes of ASME's efforts; and presents a preliminary list of tasks, potential partners, key milestones, and immediate next steps. These one-page plans are intended to jump-start the implementation of ASME's energy strategy and set a precedent of action to address the energy challenges facing the United States and other areas of the world.

Figure ES-1. Overview of the ASME Energy Grand Challenge Vision and Roadmap

STRATEGY

ASME will serve as an essential energy technology resource for business, government, academia, practicing engineers, and the general public and as a leading energy policy advocate. As a credible, unbiased voice, ASME will be a key source of energy technology information and standards. We will achieve this by leveraging our knowledge-based communities, expanding our energy portfolio, building a more effective energy workforce, and supporting balanced energy policies in the United States and other areas of the world.

ENERGY VALUE CHAIN



ASME PRIORITIES

BUILD AND LEVERAGE ASME CAPABILITIES IN ENERGY TO MAKE INCREASED CONTRIBUTIONS TO MAJOR ENERGY CHALLENGES



TOP OPPORTUNITIES

- Form a self-sustaining energy focal point within ASME to maintain a holistic approach to internal and external communications
- Strengthen alliances with other societies and international organizations to address energy issues and challenges
- Increase ASME's profile in renewable and emerging technologies
- Provide a rational, informed voice for political engagement
- Increase ASME's understanding, profile, and contributions regarding the energy-water nexus
- Build on existing ASME capabilities and expertise in the nuclear area
- Identify gaps in current and emerging technologies and related standards for energy generation, production, electricity transmission (including smart grid and energy storage), distribution, transportation, and efficiency
- Develop a new generation of engineering workforce
- Develop a comprehensive web-based clearinghouse of energy information and a search engine to facilitate the efficient retrieval of relevant information



I. Introduction

The American Society of Mechanical Engineers (ASME) is the premier organization for promoting the art, science, and practice of mechanical and multidisciplinary engineering and allied sciences to diverse communities throughout the world. ASME has dedicated itself to promoting and enhancing the technical competency and professional well-being of its members and, through quality programs and activities in mechanical engineering, to better enabling its practitioners to contribute to the well-being of humankind. ASME develops codes and standards and certification programs that enhance public safety, and provides lifelong learning and technical exchange opportunities benefiting the engineering and technology community.

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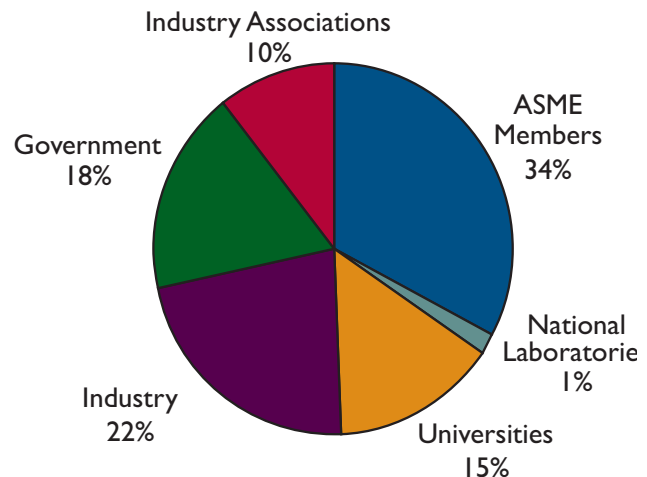
The ASME Energy Grand Challenge embodies ASME's commitment to making meaningful contributions to energy challenges facing the nation and the world. The ASME Board of Governors established the Energy Grand Challenge in 2008 as one of three strategic priorities, along with globalization and engineering workforce development. This *ASME Energy Grand Challenge Roadmap* is among the first steps ASME is taking to identify, organize, and build upon existing energy capabilities, products, and services to better serve those who rely on and expect the highest quality energy information and services.

ASME Mission – “To serve our diverse global communities by advancing, disseminating and applying engineering knowledge for improving the quality of life; and communicating the excitement of engineering.”

In November 2008, ASME formed its Energy Grand Challenge Vision and Roadmap Steering Committee, which included ASME volunteer leaders from across the energy industry and key ASME staff (Steering Committee members are recognized in Appendix A). The Steering Committee served a critical role in establishing the scope of the *ASME Energy Grand Challenge Roadmap* and engaging the broader energy community in the roadmap process, and will ensure that the ASME activities outlined in this roadmap are implemented and lead to action and real results that address key energy challenges.

Much of the *ASME Energy Grand Challenge Roadmap* content was developed at an expert workshop sponsored by ASME on March 12-13, 2009 at the Grand Hyatt Hotel in Washington, D.C. At this workshop, 62 ASME members and other key stakeholders in the energy sector from industry, government, and academia (Figure 1) collaboratively defined an appropriate ASME role in this

Figure 1. ASME Energy Grand Challenge Roadmap Contributors



key area. Appendix B recognizes and appreciates the valuable contributions these experts made to this roadmap.

ASME will use the Energy Grand Challenge Roadmap to guide its efforts to develop value-added products and services in the energy sector that benefit ASME members, the nation, and the global community.



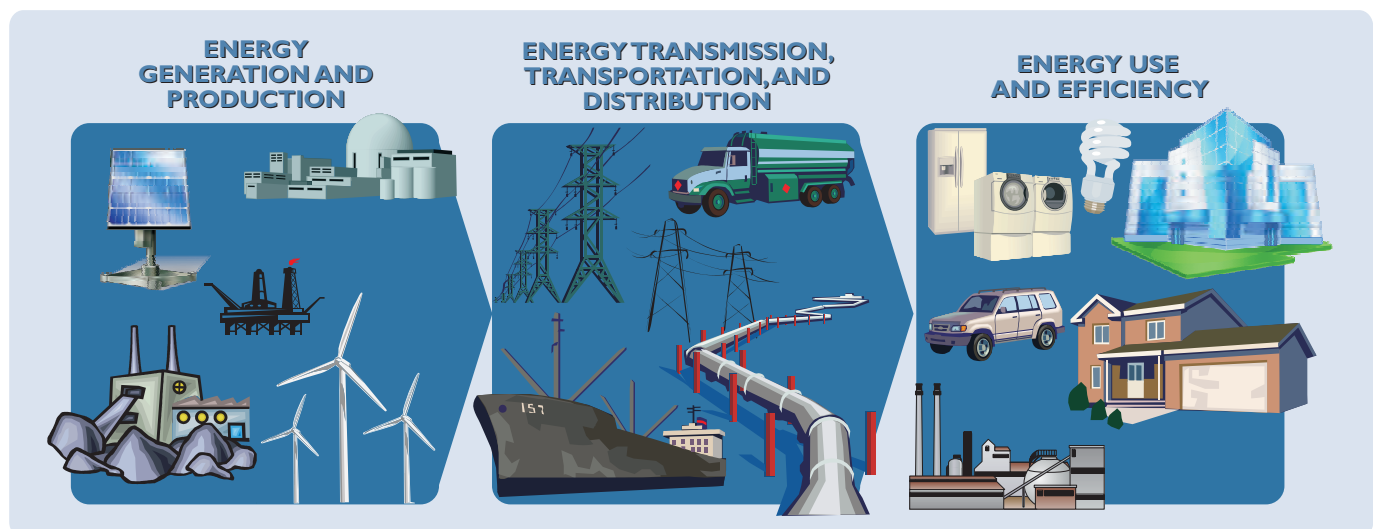
2. The Energy Sector as a Value Chain

The energy sector is extremely complex and directly involves millions of people and thousands of organizations across industry, government, and academia. Despite the diversity of the parties and their interests, the energy sector can be accurately viewed as a value chain that begins with the identification of natural energy resources, proceeds to the extraction or capture of the resource, continues to the conversion of the resource into a suitable energy form, progresses to the transportation of the energy to its place of use, and ends with the consumption of the energy to produce a useful outcome, such as mechanical work or heat. There are three major stages along this chain, each adding value to the product of the previous stage (Figure 2):

- Energy Generation and Production** refers to those activities, facilities, and processes by which energy carriers, in the form of a fuel or electricity, are refined from an energy source. Conventional sources include coal, natural gas, oil, hydroelectric, and nuclear. Other newer or emerging energy sources and carriers include hydrogen, biomass, geothermal, solar, hydrokinetic, and wind.
- Energy Transmission, Transportation, and Distribution** refers to those activities, facilities, and processes by which energy carriers, in the form of a fuel or electricity, are taken from the point of generation or production and delivered to the point of use. Infrastructure, such as the electric grid, fueling stations, and pipelines, falls into this category, as do instruments of transport and storage, such as batteries, fuel tanks, ships, and trucks.
- Energy Use and Efficiency** refers to those activities, facilities, and processes by which energy carriers, in the form of a fuel or electricity, are put to use toward a purpose. There are thousands of energy use applications which are often grouped into general categories of industrial, transportation, residential, and commercial uses. A significant portion of the energy that passes through the value chain is also lost due to both inefficiencies and to the basic laws of physics throughout the entire energy value chain.

Many organizations in the energy sector operate primarily within the boundaries of a particular stage. Other organizations span multiple stages and frequently choose

Figure 2. The Energy Sector as Value Chain



to keep their operations distinct and somewhat separate in pursuit of efficiencies within each stage. Such an approach has many advantages, including a degree of simplicity and more well-defined boundaries. However, this approach also inhibits systems-level thinking when addressing energy challenges, allowing many challenges and inefficiencies to “slip between the cracks” of typical organizational divisions.

In contrast, ASME has members, programs, products, services, a robust volunteer structure, and capabilities that reside in all parts of the energy value chain (Table 1). This wealth of capability gives ASME the ability to offer unique value in addressing energy issues using a holistic, systems-level approach. ASME’s ability to offer both deep technical expertise in individual parts of the value chain and broad technical expertise across the entire chain provides it with a valuable capability that ASME can build on and leverage to make increased contributions to major national and global energy challenges.

Table 1. Select ASME Capabilities in the Energy Sector

	Energy Generation and Production	Energy Transmission, Transportation, and Distribution	Energy Use
Energy-Focused Divisions	Advanced Energy Systems Division		
	International Petroleum Technology Institute		
	Power Division		
	International Gas Turbine Institute		
	Nuclear Engineering Division		
	Solar Energy Division		
Energy-Related Divisions	Plant Engineering & Maintenance Division		
	Dynamic Systems and Control Division		
	Environmental Engineering Division (Carbon Sequestration Committee)		
	Heat Transfer Division		
	Materials Division		
	Technology & Society Division		
	Fluids Engineering Division		
	Pressure Vessels and Piping Division		Nanotechnology Institute
	Solid Waste Processing Division	Internal Combustion Engineering Division	
		Process Industries Division	
Publications	Mechanical Engineering Magazine		
	Journal of Engineering Materials and Technology		
	Journal of Fuel Cell Science and Technology		
	Journal of Solar Energy Engineering: Including Wind Energy and Building Energy Conservation		
	Journal of Heat Transfer		
	Journal of Engineering for Gas Turbines and Power		
	Journal of Energy Resources Technology		Journal of Applied Mechanics
	Journal of Fluids Engineering		
	Journal of Offshore Mechanics and Arctic Engineering		Journal of Manufacturing Science & Engineering
	Journal of Pressure Vessel Technology		Journal of Mechanical Design
	Journal of Turbomachinery		
	Practical Guide to Energy Management (book)		
	Energy, Technology and the Environment (book)		
	Handbook for Cogeneration and Combined Cycle Plants (book)		
		Energy Supply and Pipeline Transportation: Challenges and Opportunities (book)	

Table I. Select ASME Capabilities in the Energy Sector (continued)

	Energy Generation and Production	Energy Transmission, Transportation, and Distribution	Energy Use
Standards and Certification	Pressure Technology: Fitness for Service, Boiler and Pressure Vessel Code (BPVC) Section I – Power Boilers, Section VIII – Pressure Vessels		
	B31 Code for Pressure Piping Standards Committee (includes B31.1 – Power Piping, B31.3 – Process Piping, B31.4 – Liquid Pipelines, B31.8 – Gas Pipelines, and B31.12 – Hydrogen Piping and Pipelines)		
	Nuclear: Operation & Maintenance		
	Performance Test Codes (PTC) includes PTC 4 – Fired Steam Generators, PTC 6 – Steam Turbines, PTC 22 – Gas Turbines, PTC 40 – Flue-Gas Desulfurization, PTC 42 – Wind Turbines, PTC 46 – Overall Plant Performance, PTC 47 – Integrated Gasification Combined Cycle Power Generation Plants, PTC 50 – Fuel Cell Power System Performance, PTC 52 – Concentrating Solar Power Plants		
	Reliability, Availability, and Maintainability (RAM) of Power Plants		
	Safety Codes and Standards: Controls & Safety Devices for Automatically Fired Boilers		
	Energy and Environmental Standards Advisory Board		
Conferences	International Mechanical Engineering Congress & Exposition (IMECE)		
	International Conference on Energy Sustainability		
	International Heat Transfer Conference		
	Annual Fuel Cell Science, Engineering & Technology International Conference		
	Annual Electric Power Conference & Exposition		
	Pressure Vessels & Piping Conference		
	ASME Power	Energy Nanotechnology International Conference	
	International Conference on Nuclear Engineering (ICONE)	International Pipeline Conference and Exposition	
Turbo Expo			
Training	Alternative Energy 101: Introduction to Manufacturing Fuel Cells and Advanced Batteries		
	QA Considerations for New Nuclear Facility Construction		
	Power Plant Training Simulation for Manager & Engineers		
	Operation, Maintenance and Repair of Plant Piping Systems		
	Basics of Combustion for Conventional and Alternative Fuels		
	Numerous courses on the Boiler and Pressure Vessel Code and B31 Pressure Piping Code		



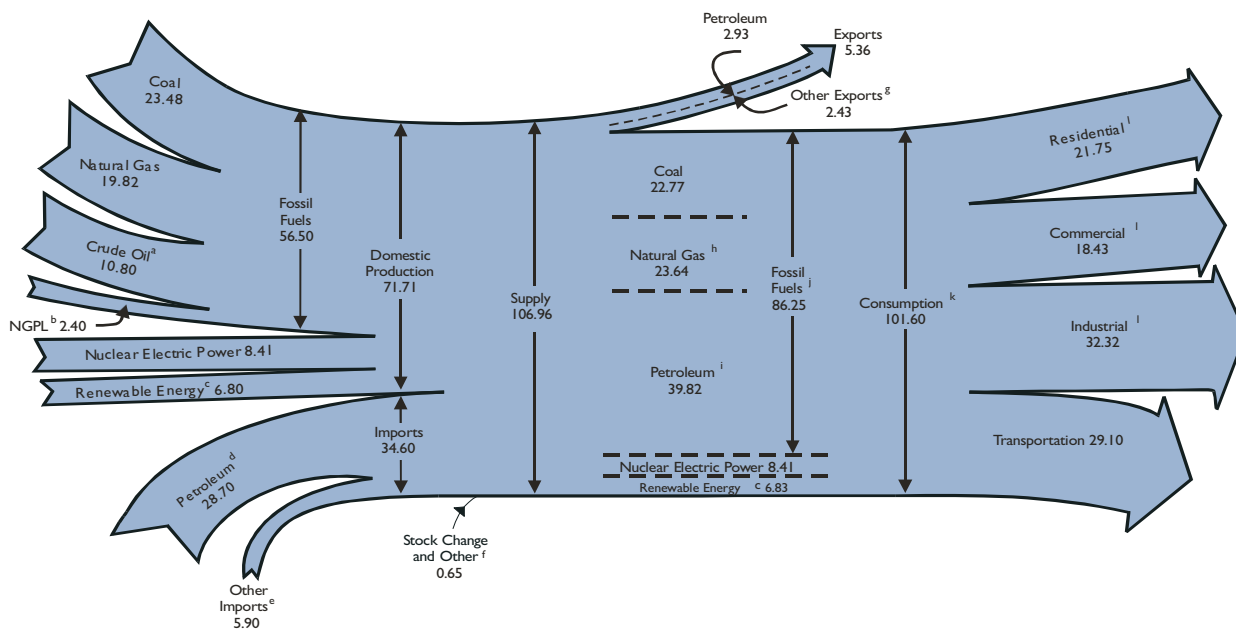
3. Trends and Drivers in the Energy Sector

Energy is a global commodity that is integrally tied to nearly every aspect of society. The energy sector contains some of the oldest functional mechanical equipment and technology in the nation and is currently undergoing major changes in all aspects of the value chain ranging from the diversification of fuel sources to the implementation of end-use energy efficiency programs. As ASME seeks to address the critical, complex and inter-related energy issues, it must consider the major trends and drivers that are shaping the energy industry in the United States over the next five years.

Increased Emphasis on Climate Change and Sustainability Creates the Need for Holistic Approaches

Driven by renewed interest in environmental issues and concern over climate change, sustainable development is being widely acknowledged as an essential component of industrial growth. As countries, corporations, and the general public gain greater understanding of the risks and effects of a significant, potentially global change in climate, this shift in thinking has particular significance for the energy sector. This is due to energy's integral role

Figure 3. U.S. Energy Flow, 2007 (Quadrillion Btus)



a Includes lease condensate.
 b Natural gas plant liquids.
 c Conventional hydroelectric power, biomass, geothermal, solar/photovoltaic, and wind.
 d Crude oil and petroleum products. Includes imports into the Strategic Petroleum Reserve.
 e Natural gas, coal, coal coke, fuel ethanol, and electricity.
 f Adjustments, losses, and unaccounted for.
 g Coal, natural gas, coal coke, and electricity.
 h Natural gas only; excludes supplemental gaseous fuels.
 i Petroleum products, including natural gas plant liquids, and crude oil burned as fuel.
 j Includes 0.03 quadrillion Btu of coal coke net imports.

k Includes 0.11 quadrillion Btu of electricity net imports.
 l Primary consumption, electricity retail sales, and electrical system energy losses, which are allocated to the end-use sectors in proportion to each sector's share of total electricity retail sales. See Note, "Electrical Systems Energy Losses," at end of Section 2.
 Notes:
 • Data are preliminary.
 • Values are derived from source data prior to rounding for publication.
 • Totals may not equal sum of components due to independent rounding.

Sources: Tables 1.1, 1.2, 1.3, 1.4, and 2.1a.

Source: Energy Information Administration, Annual Energy Review 2007.

as a global commodity in nearly all aspects of economic development. This shift is also significant because of the energy sector's heavy reliance on limited natural resources, such as water and fossil fuels, for its inputs and the resulting emissions and waste products that are generated along its value chain, including CO₂. Lifecycle analyses are subsequently becoming the norm when evaluating alternative fuels and energy technologies in order to ensure there are real net improvements in environmental impacts. Thinking globally is now the only way to meaningfully address some of the more complex energy challenges, such as mitigating climate change in the face of the soaring energy demand expected to occur in the next few decades in the developing world. There are concerns that much of this demand will be met with high carbon intensity fuels such as coal, which will place increasing pressure on countries like the United States to more expediently transition to carbon-free energy sources and to export clean energy technologies. It is clear that meeting future energy requirements in an environmentally and economically sustainable way is an incredibly complex task requiring a holistic approach to fully understand the underlying energy issues and to appropriately guide policy and technology developments.

Growing Recognition of the Need for a National Energy Policy

Earlier this year, ASME joined with the presidents from 21 engineering societies, representing more than 1.4 million engineers, in endorsing a “National Energy Policy Goals Proclamation.” The Proclamation urges the administration and Congress to act quickly in establishing guiding principles and goals to help ensure the nation’s economic and national security and to guide the development of energy technology for the twenty-first century.

There is a growing recognition that our nation must develop a comprehensive national energy policy with clear guiding principles and goals. Past energy crises and challenges have often been dealt with in a piecemeal approach representing short-term thinking and polarized political interests. A national energy policy that solidifies the nation’s long-term strategy and goals and that can adapt to future circumstances will help to create consistency among federal energy programs, standards, and incentives, and to harmonize U.S. policy with those of other nations. It will also allow industry to make long-term investments in technologies that can reach their full potential.

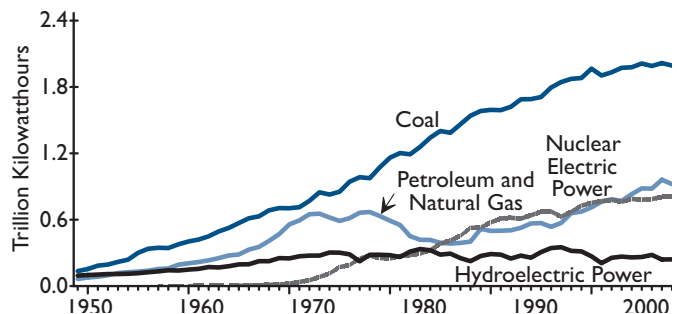
A national energy policy will also help to clear up public misperceptions about energy stemming from publicized debates that are often based on highly visible information—accurate or not—instead of the important technical knowledge required for intelligent discussions and informed decisions. A national energy policy, therefore,

must be informed by objective, scientific information and a holistic understanding of energy issues that recognizes the complex interactions that take place across the energy value chain.

Increased Energy Diversification and Use of Renewables Creates Challenges for Grid Reliability and Drives the Need for Smart Grid and Energy Storage

The trend toward energy diversification and increased use of alternative and renewable energy sources for electricity generation will drive major changes in electricity transmission and distribution systems and infrastructure. The dispersed and intermittent nature of alternative energy sources (including point-of-use, such as solar panels and on-site generators, as well as non-centralized generation systems, such as wind) pose new challenges to grid reliability. Addressing these challenges will require technological advances in energy storage and smart grid technologies, changes in system operations by independent systems operators (ISOs) and regional transmission organizations (RTOs), and intelligent feedback systems that help users better monitor energy consumption. It will also require the development of new metrics and standards that allow for disparate energy resources to be meaningfully compared and integrated into the bulk power supply system.

Figure 4. Major Sources of Total Electricity Net Generation within the United States



Source: Energy Information Administration, Annual Energy Review 2008.

Increasing Need for Codes and Standards to Facilitate Greater Commercialization of Renewables and Other Innovative Energy Technologies in the United States and Globally

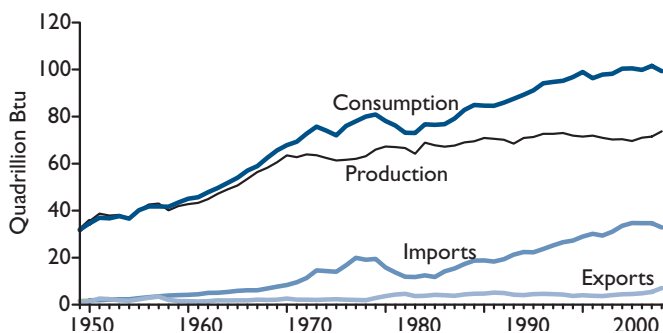
The adoption of technically relevant, consensus-based standards for new energy technology helps overcome barriers to commercialization, establishes public confidence, provides rapid and transportable workforce development, and facilitates business and trade. As solar, wind, geothermal, biofuels, and other renewable energy sources continue their rapid growth and begin to form

a significant portion of total electricity generation, new content that focuses on engineering practices and codes and standards will be increasingly needed to facilitate and streamline the integration of renewable with existing energy infrastructures. Globally, codes and standards will be needed more broadly as developing nations seek to greatly expand their energy infrastructures to meet the growing energy demands that fuel economic development.

Increasing Concerns about Energy Security and Resilience Drive the Need for New Metrics

Energy security encompasses several areas, including the operational safety of energy systems, the protection and resilience of critical energy infrastructure, and the need for the nation to be more self-sufficient with respect to energy production. Increasing international political tensions have heightened security concerns, particularly in regards to infrastructure protection and energy independence. Energy security is a complex and interrelated issue that has major implications for energy reliability and economic stability. These concerns are subsequently driving advances in physical and cyber security as well as innovations in alternative energy sources, creating the need for new engineering content; codes and standards and certification programs; and metrics.

Figure 5. Primary Energy Overview Shows Growing U.S. Reliance on Imported Energy



Source: Energy Information Administration, *Annual Energy Review 2008*.

Aging Infrastructure Requires New Materials and Standards

An aging energy infrastructure further complicates the challenges of accommodating increasingly diverse energy sources, rising energy demand, and efficiency needs. As transmission systems, pipeline infrastructures, and existing power plants and petroleum refineries are upgraded, new design requirements, codes and standards and certification programs will need to be first identified and then created for the new materials and technologies.

Aging Workforce Drives Need to Attract New Talent

As the current skilled energy workforce reaches retirement age, it is essential to both attract and train new talent and to transfer the skills and retain the knowledge of the current retiring workforce. The presence of young engineers is crucial to the success of the energy sector in overcoming the challenges of upcoming decades, driving an increased need for outreach and education to attract young professionals to the field. Engineering workforce development is one of ASME's three strategic priorities.

Shifting Economic Landscape Leads to Insufficient Investment in Energy

Fluctuations in the economy have had a pronounced effect on the energy sector. Volatile prices for energy sources have severely limited the willingness of financiers to take risks and as a result have crippled many fledgling and maturing energy projects. Organizations within the sector remain wary, looking to minimize risk while achieving inexpensive and cost-effective energy. This mindset often leads to short-term, narrowly focused solutions. Advances in particular fields of energy will lead to increasingly complex energy systems that serve primary constituents well but make attempts to maintain a holistic view of the energy sector more and more difficult. In addition to a cohesive national energy policy, having integrated and centralized educational information regarding changing economic trends and new energy resources may assist in encouraging entrepreneurial investments in capital-intensive energy projects. This issue further emphasizes the need for collaboration in research between industry, government, and academic organizations to both define and then complete the energy research that will benefit the entire nation.

Increasing Recognition of the Link Between Energy and Water Stimulates Need for Innovative Approaches to the Energy-Water Nexus

Energy and water resources are inextricably and reciprocally linked; the production of energy requires large volumes of water while the treatment and distribution of water is equally dependent upon readily available, low-cost energy. A focused effort to build on the base of knowledge and understanding of this linkage, developed by the DOE Energy-Water Nexus Project led by Sandia National Laboratory, is a critical activity for ASME. The DOE Energy-Water Nexus Project states that the continued security and economic health of the United States depends on a sustainable supply of both energy and water. Ensuring adequate supplies of clean, affordable, reliable energy and water will be increasingly challenging in the coming decade as continued economic development strains existing water and energy resources.



4. ASME's Energy Grand Challenge Strategy

The ASME Energy Grand Challenge embodies ASME's commitment to making meaningful contributions to energy challenges facing the nation and the world. The ASME Board of Governors established the Energy Grand Challenge in 2008 as one of three ASME strategic priorities, along with globalization and engineering workforce development. The strategy for the Energy Grand Challenge is bold:

ASME will serve as an essential energy technology resource for business, government, academia, practicing engineers, and the general public and as a leading energy policy advocate. As a credible, unbiased voice, ASME will be a key source of energy technology information and standards. We will achieve this by leveraging our knowledge-based communities, expanding our energy portfolio, building a more effective energy workforce, and supporting balanced energy policies in the United States and other areas of the world.

ASME will implement this strategy by internally aligning its energy-related capabilities and resources and leveraging these resources with those of its many partners.

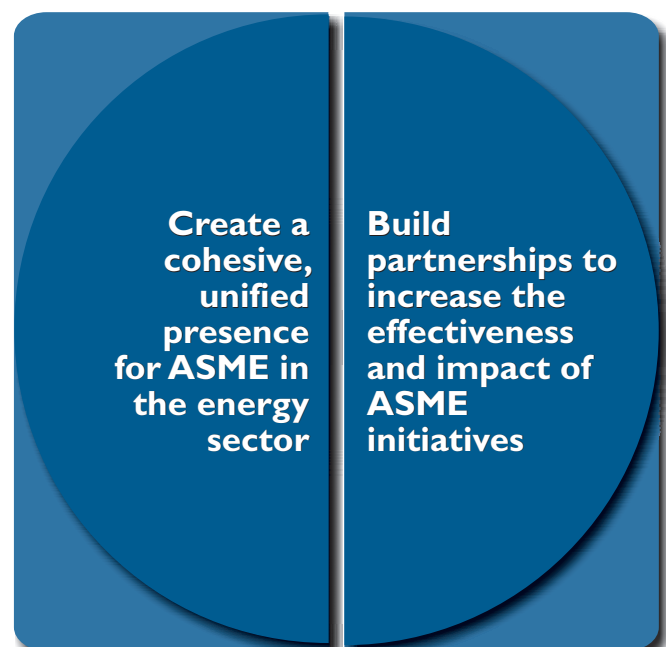
ASME Priorities for Energy

ASME recognizes that, as a professional engineering society, it can make the most meaningful contributions to energy by optimizing its volunteer and staff resources and by partnering with other organizations. These two approaches enable ASME to achieve a much greater impact than it could alone and form the foundation of the successful ASME approach to energy (Figure 6).

- **Create a cohesive, unified presence for ASME in the energy sector.** ASME is deeply involved in many aspects of the energy sector, a broad presence resulting from the critical role engineers play in the energy workforce. To date, ASME's efforts in energy have evolved throughout the organization, with seven ASME technical divisions and two technical institutes

serving as major players in the energy sector and with many other ASME technical divisions serving in supporting roles. ASME's energy efforts also include numerous codes and standards, certification, training, conferences and workshops, and technical publications. To optimize ASME's resources and present itself to the world as an important contributor to energy challenges, ASME will align its internal resources to create a cohesive, unified presence in the energy sector. This approach better positions ASME to address energy issues holistically along the energy value chain, ensure consistency in public policy and public outreach messages, and help partners and other interested parties understand ASME's diverse energy activities. Ultimately, improved internal alignment will enhance ASME's authority, credibility, and value-added contributions within the energy sector, and better leverage experts within ASME to meet the

Figure 6. ASME's Organizational Approach to the Energy Grand Challenge



energy information and technology needs of industry, government, and academia. This will allow ASME to build on and leverage its vast energy capabilities to make increased contributions to addressing major energy challenges.

- **Build partnerships to increase the effectiveness and impact of ASME initiatives.** Despite ASME’s broad energy presence, the energy sector extends well beyond its reach. To fully address the energy challenges facing the nation, ASME must leverage its capabilities with those of partner organizations. Strong partnerships with leading companies, government agencies, academic institutions, and other professional societies bring different perspectives, skill sets, and resources to help ASME address the most complex energy issues and achieve far more than it could alone.

These two organizational priorities—focused internally and externally, respectively—anchor ASME’s overall approach to the Energy Grand Challenge. Optimized internal organization and external partnerships will allow ASME to pursue four priorities as the core contributions ASME will make in the energy sector. These priorities are shown in Figure 7 and are further described below.

- **Serve as an impartial, authoritative, rational voice in energy matters by offering technical expertise to regulators and policymakers.** To assist in the development, evaluation, and integration of current and future energy technologies, ASME must maintain its reputation as an unbiased and authoritative voice. With an objective stance, ASME can become the “go-to” organization for energy technical expertise that can help develop policies, codes and standards, and certification programs to support existing and emerging energy technologies.

- **Develop and promote codes and standards and related products and services to support energy technology innovation and commercialization.** The energy industry already extensively uses consensus-based codes and standards, but these codes and standards need to expand to support the commercialization of the new energy technologies needed to overcome national energy and environmental challenges. The development of the first ASME codes and standards answered a need for an informed, impartial determination and standardization of equipment, consistent across an industry and, eventually, the world. The first ASME standard, “Code for the Conduct of Trials of Steam Boilers,” was developed in 1884. This need for codes and standards remains in many parts of the rapidly changing energy sector, particularly around renewable and emerging energy technologies. Standards for energy lifecycle analysis that support a holistic view of energy will inform policy and business decisions and encourage energy technology innovation. The development of ASME codes and standards is a transparent, consensus-driven process that involves code committees who represent a balance of interested, engaged individuals with the necessary technical expertise.
- **Support the expansion and development of a more effective energy workforce.** A significant portion of ASME’s 127,000 members work in energy industries or teach mechanical engineering to undergraduate and graduate students. ASME will leverage this great member resource through its workforce development initiative to bolster the size and technical ability of the energy sector workforce to meet the quickly changing needs of the sector globally. This strategic objective complements ASME’s

Figure 7. Four Priorities Form ASME’s Core Contributions to the Energy Sector



ongoing advocacy to improve science, technology, engineering, and mathematics (STEM) education initiatives nationwide.

- **Increase public awareness and knowledge of the energy sector.** As an organization representing those who envision, design, build, operate, and maintain modern energy technology, ASME is positioned to offer an experienced, informed, and unbiased voice to a public in need of credible information. By working with the public, ASME can promote understanding of basic scientific and energy realities, leading to increased interest in engineering and greater public acceptance of effective and responsible energy solutions.

Potential ASME Activities

Within each of the four strategic priorities and two organizational approaches of ASME’s strategy for energy, ASME has identified high-priority activities that represent the top opportunities it can undertake to implement its plan for energy. Together these activities provide an array of options for specific action initiatives that also serve to enhance ASME’s expertise and offerings in energy. The following tables offer actionable opportunities that have the greatest potential impact within and outside of ASME. The activities in red type represent the nine top action opportunities that were identified as such at the Energy Grand Challenge Workshop and for which action plans have been created. These action plans are presented in the next chapter of this roadmap. By working internally and partnering with other organizations to pursue these activities, ASME can better address the array of energy challenges the nation and the world face today.

Create a cohesive, unified presence for ASME in the energy sector

Table 2 presents potential ASME activities to create a cohesive, unified presence in the energy sector. These primarily inward-focused activities are organized into three categories:

Communication – Integrated communication from a centralized focal point within ASME is essential to create a cohesive and unified presence. An internal infrastructure can be developed to support ASME energy communication and strategically deploy multiple communication methods to reach the broadest audience and create the greatest impact.

ASME actions – ASME’s members have a wealth of energy knowledge and experience. Internal collaboration and dialogue opportunities can serve to integrate this knowledge and experience into cohesive energy capabilities. The effective deployment of these capabilities can be achieved by unified ASME actions (e.g., taking a portfolio approach to product and content development focused on specific market segments) aligned with the Energy Grand Challenge strategy.

Developing a position – ASME’s presence in the energy sector is a function of the authority and persuasiveness of its positions on energy issues. ASME needs to continue to disseminate a series of energy positions that are based on the objective facts and impartial analyses that are the basis of ASME’s value proposition. ASME’s National Energy Policy Goals Proclamation, developed jointly with IEEE-USA in 2009 and in partnership with 21 other organizations, is an important example of this ASME capability.

Table 2. Potential ASME Activities—Create a Cohesive, Unified Presence for ASME in the Energy Sector (highest priorities in red)

Communication	<ul style="list-style-type: none"> • Form a self-sustaining energy focal point within ASME to maintain a holistic approach to internal and external communications. • Develop an ASME energy communication plan • Create an energy focal point on ASME website • Develop a cache of web 2.0 products (wikis, blogs, etc.) to facilitate collaboration • Create a series of ASME-produced energy podcasts • Put concerted, consistent emphasis on energy across ASME events and outreach efforts
ASME actions	<ul style="list-style-type: none"> • Create a new kind of conference for practitioners, presenting energy best management practices case studies and implementation challenges • Bring in new people; express the openness of ASME; increase its appeal to a broader energy audience • Increase internal energy collaboration and commitment—promote inter-ASME Sector understanding • Take a portfolio approach to product development focused on specific market segments
Developing a position	<ul style="list-style-type: none"> • Develop a position on energy efficiency; consider developing: <ul style="list-style-type: none"> ▪ a methodology for energy management and labeling ▪ positions on fuel sources ▪ codes/standards/definitions regarding efficiency • Position ASME as a technology/knowledge organization/resource <ul style="list-style-type: none"> ▪ Determine ASME value proposition regarding energy • Create an ASME Energy Speaker’s Bureau

Build partnerships to increase the effectiveness and impact of ASME initiatives

Table 3 presents potential ASME activities to establish partnerships and connections externally across industry, academia, and government in order to create a cohesive, unified presence in the energy sector. These primarily externally focused activities are organized into the following three categories:

ASME partnerships with others – ASME’s internal energy capability can be leveraged to have a more significant impact through strategic alliances with other engineering societies, as well as the broader science, engineering, and technology (SET) community and through various coalitions. The National Energy Policy Goals Proclamation, which was initiated by ASME and IEEE-USA in 2009 and endorsed by 21 other organizations, is an important example of this capability. ASME frequently collaborates with engineering societies such as IEEE-USA, ASCE, AIChE, AIME, and SWE, among others, on issues identified as priorities for all of these societies, such as energy, carbon mitigation, workforce and education, and strengthening federal investments in research and

development. Continuing to form partnerships like these requires a focused effort to establish connections and to identify opportunities for meaningful partnerships and collaboration in areas of high potential impact.

Facilitate partnerships – Facilitating partnerships between key energy stakeholders extends ASME’s impact and leverages its core capabilities as an impartial convener and community builder. This impact is also enhanced by creating forums using ASME’s neutral convener role to bring diverse interest together and by matching needs and resources around energy-related issues.

Advancing ASME’s outreach capabilities – ASME’s ability to stay in touch with both local and global energy issues provides an important foundation for advancing ASME activities in the energy arena. ASME needs to seek and create opportunities to exercise and develop its outreach capabilities, particularly to federal, state, and local governments. Effective outreach is an important capability for enabling the partnership building that enhances ASME’s influence and impact on energy technology development and energy policy.

Table 3. Potential ASME Activities—Build Partnerships to Increase the Effectiveness and Impact of ASME Initiatives (highest priorities in red)

<p>ASME partnership with others</p>	<ul style="list-style-type: none"> • Strengthen alliances with other Societies and international organizations to address energy issues and challenges • Increase ASME’s profile in renewable and emerging technologies • Create council between ASME, IEEE-USA, and other societies—one award per year for top innovative product for renewable energy <ul style="list-style-type: none"> ▪ i.e., for wind, biomass, and solar • Build strategic partnership with energy-saving organizations—support efforts and coordinate (American Council for an Energy Efficient Economy, Natural Resources Defense Council, Alliance to Save Energy, etc.) • Improve building efficiency—opportunity for coalition
<p>Facilitate partnerships</p>	<ul style="list-style-type: none"> • Facilitate the matchmaking/convening of partnerships that lead to innovations and technology commercialization • Develop a business model where small companies can come to ASME and where ASME can facilitate contact with potentially interested parties • Establish a global energy forum • Facilitate materials, technology, and knowledge transfer between industries • Form user groups for technologies and other energy areas to bring people together (without competing with existing ones) • Provide a forum in which innovators can review their ideas with experts for feedback
<p>Advancing ASME’s outreach capabilities</p>	<ul style="list-style-type: none"> • Hold the Energy Grand Challenge workshop in key global locations and compare results <ul style="list-style-type: none"> ▪ Make the whole ASME website available in Chinese and Spanish • Create an energy advisory board for ASME • Set up an inter-society workgroup on electricity transmission grid issues <ul style="list-style-type: none"> ▪ Work with IEEE-USA on electricity transmission grid issues • Double the size of the (now highly effective) ASME Washington office • Increase outreach to state and local governments • Increase ASME Washington fellows (there are two) by a factor of five to ten fellows • Add resiliency and security to the risk analysis work ASME does • Encourage a five- to tenfold increase in R&D investment regarding energy technology challenges

ASME Priority: Serve as an impartial, authoritative, rational voice in energy matters by offering technical expertise to regulators and policymakers

Table 4 presents potential ASME activities to offer impartial and authoritative technical expertise to regulators and energy policy decision makers to ensure an effective and holistic national energy policy. These activities are organized into the following three categories:

Educating policymakers/regulators – ASME can make a significant value-added contribution to energy policy by undertaking focused initiatives to inform legislators and policymakers. These initiatives can range from the general dissemination of technical information to organizing educational events, such as congressional briefings, to convening meetings with government representatives.

Developing briefings and information resources – ASME can expand its influence and impact on government by developing and disseminating focused energy information documents and resources. These include briefing documents, speaker forums, and dialogue opportunities as well as objective assessments of energy technology, energy policy, and energy use with appropriate recommendations.

ASME proactivity – ASME can enhance its influence by proactively identifying, analyzing, and developing its product and service portfolio regarding emerging energy issues and key energy topics. ASME can also identify a group of energy experts willing to serve as a technical resource for policymakers who would not only be well versed in the energy technology, but would also be able to convey the information in a manner understandable to a nontechnical audience.

Table 4. Potential ASME Activities—Serve as an Impartial, Authoritative, Rational Voice in Energy Matters by Offering Technical Expertise to Regulators and Policymakers (highest priorities in red)

<p>Educating policy-makers/regulators</p>	<ul style="list-style-type: none"> • Provide a rational, informed voice for political engagement • Convene congressional briefings on energy technologies and related issues and identify speakers with energy expertise who can provide information on a specific technology, while still emphasizing the importance of a balanced energy portfolio • Identify a group of ASME energy experts willing to serve as a technical resource for policymakers (e.g., identify an ASME expert on the smart grid who would be available to interact with policymakers, speak at congressional briefings, or be interviewed by the news/media when needed); this group of experts would not only be well versed in the energy technology, but would also be able to convey the information in a manner understandable to a nontechnical audience • Identify and initiate opportunities for ASME energy experts to communicate with policymakers and the media
<p>Developing briefings and information resources</p>	<ul style="list-style-type: none"> • Prepare position statements assessing what other countries are doing regarding production, generation, and end use and where the United States stands, since global competition is a strong motivator • Revive ASME Distinguished Lecturers Series with an emphasis on energy • Convene an annual State of Energy Technology briefing or workshop for the White House, policymakers, and press for establishing energy facts • React to the Obama administration’s energy plan to assess what is achievable, as well as the short- and long-term requirements • Assess needs for workforce, training, education, codes and standards, certification programs, and laws and regulations • Assign groups and members within ASME to issue position statements that assess investments in energy R&D, describe efficiencies at existing facilities, and provide energy policy and technology recommendations; these efforts should be coordinated with similar ongoing activities of the ASME Energy Committee
<p>ASME proactivity</p>	<ul style="list-style-type: none"> • Increase ASME’s understanding, profile, and contributions regarding the energy-water nexus • Frame legislative and executive discussions within a balance of affordability, cleanliness, and reliability • Become proponents for transportation solutions that are aligned with those proposed in the ASME- and IEEE-USA-led National Energy Policy Goals Proclamation • Serve as an independent, rational voice in national energy debates • Advocate a balanced energy policy

ASME Priority: Develop and promote codes and standards and related products and services to support energy technology innovation and commercialization

Table 5 contains several of the highest priority activities ASME has identified to help it develop codes and standards and processes in wide-ranging areas of energy that will encourage innovation. Activities are organized into the following categories:

Identify standards needs – ASME should perform standards gap analyses and develop comprehensive standards development plans for creating new standards promoting the commercialization of new energy technologies. As gaps are identified, ASME will engage key stakeholders and initiate appropriate standards actions, and identify and prioritize necessary prerequisite technology development and research activities. High-priority energy technology areas include wind, solar, hydrokinetics, geothermal, biofuels, hydrogen, energy efficiency, carbon capture and storage, and energy storage. Such standards development activities will be conducted in a manner that complements public-private R&D, technology demonstration, and infrastructure construction programs.

Nuclear codes and standards – ASME should build on its existing capabilities and expertise in the nuclear area to address nuclear and other energy technology issues. In particular, ASME should leverage its 125-year history of codes and standards, which began in 1884 with the “Code for the Conduct of Trials of Steam Boilers,” to build on ASME’s Nuclear Codes and Standards Board’s and other nuclear-related boards’ expertise as well as that of the new ASME Energy and Environmental Standards Advisory Board. Efforts should focus on further addressing codes and standards needs in the nuclear sector and exploring opportunities to address codes and standards needs in renewable and emerging energy technologies.

Transmission, distribution, transportation, and storage – As emerging technologies continue to greatly impact these four areas of energy, ASME should consider the development of a roadmap for current and emerging technology, identify gaps in standards, and work to develop standards in these areas, particularly large energy storage. ASME can also leverage its resources and expertise to develop models of lifecycle costs and impacts for these technologies.

Support renewable and sustainable energy development and implementation – As renewable and sustainable energy technologies—including wind, solar, thermal energy, heat transfer, carbon capture and storage, and others—continue to emerge and gain further acceptance, these industries could benefit from codes and standards and certification programs to ensure consistent development and to help expand implementation. By developing a combination of codes and standards, processes and principles for renewable energy technologies, ASME can help promote sustainable energy development.

Increasing efficiency – ASME’s experience in energy efficiency improvements can be leveraged to develop codes, standards, and methodologies to demonstrate potential energy savings for the existing energy infrastructure. Performance test codes and standards to define or increase energy efficiency can also be developed for new technologies. Identifying areas for efficiency improvements can encourage innovation in energy management for new and existing technologies.

Opportunities for ASME – ASME has identified several opportunities to develop new products and services that will increase the impact of ASME work in the energy sector, including new best practices products, innovative business models, and the application of work done in other sectors to the energy sector. These new specific products and processes can help support efforts in other areas under this objective .

Table 5. Potential ASME Activities—Develop and Promote Codes and Standards and Related Products and Services to Support Energy Technology Innovation and Commercialization (highest priorities in red)

<p>Identify standards needs</p>	<ul style="list-style-type: none"> • Perform standards gap analyses leading to new standards promoting the commercialization of new energy technology • Investigate key energy technology areas including wind, solar, hydrokinetics, geothermal, biofuels, hydrogen, energy efficiency, carbon capture and storage, and energy storage
<p>Nuclear codes and standards</p>	<ul style="list-style-type: none"> • Build on existing ASME capabilities and expertise in the nuclear area • Build on the expertise of the ASME’s Nuclear Codes and Standards Board and other nuclear-related Boards as well as that of the new Energy and Environmental Standards Advisory Board to address codes and standards needs in nuclear sector and to explore opportunities to address codes and standards needs in renewable and emerging energy technologies
<p>Transmission, distribution, transportation, and storage</p>	<ul style="list-style-type: none"> • Identify gaps in current and emerging technologies and related standards for energy generation, production, electricity transmission (including smart grid and energy storage), distribution, transportation, and efficiency • Conceptualize, design, develop codes and standards, and train for massive energy storage <ul style="list-style-type: none"> ▪ Solicit and promote expert information regarding energy storage (two ASME LLCs exist for innovation) • Develop models that provide lifecycle costs of source, risks, and environmental impacts for generation, transmission, transportation, distribution, and storage
<p>Support renewable and sustainable energy development and implementation</p>	<ul style="list-style-type: none"> • Define the ASME concept of “green” • Work with existing codes and standards and DOE to extend codes and standards to efficiency and renewables areas • Consider developing ASME codes and standards and certification programs in renewables, testing for concentrating solar power (CSP), concentrating PV, thermal energy heat transfer, and other renewables • Look at developing CO₂ capture and storage technology standards • Develop technologies for how to approach carbon capture and sequestration • Promote wind/solar/thermal for base load storage and CO₂ reduction • Create a set of umbrella principles on how to engineer for sustainability (e.g., lifecycle accounting of emissions, incorporating recycling) <ul style="list-style-type: none"> ▪ Use cradle-to-cradle systems-level thinking • Collaborate with other standard-making bodies to develop standards <ul style="list-style-type: none"> ▪ Helps build efficiency worldwide
<p>Increasing efficiency</p>	<ul style="list-style-type: none"> • Use ASME Performance Test Codes to show how existing energy infrastructure can be made more efficient • Use ASME Performance Test Codes and Energy Assessment Standards to provide additional codes and standards and to define/increase the efficiencies of existing and new production and exploration, such as for new and existing energy technologies <ul style="list-style-type: none"> ▪ Integrate across generation/production, transmission/distribution, and usage/efficiency ▪ Emphasize a systems approach while offering expertise ▪ Train people to think at a systems level ▪ Develop a methodology for an energy management and labeling tool
<p>Opportunities for ASME</p>	<ul style="list-style-type: none"> • Apply the ASME Water Management Technology Roadmap Workshop report to other ASME energy efforts (e.g., petroleum) • Offer new products to bring knowledge to bear on best practices • Establish user groups to identify and promote best practices • Develop codes and standards to encourage the uniform adoption of standards to solve regulatory differences between jurisdictions <ul style="list-style-type: none"> ▪ Reduces cost and enhances trade by reducing regulation uncertainty • Match engineers/scientists with business problems, like the NASA Space Alliance Technology Outreach Program • Support research in new and emerging areas of energy technology

ASME Priority: Support the expansion and development of a more effective energy workforce

Table 6 contains several of the highest priority activities ASME has identified to help it cultivate a knowledgeable, expansive workforce. Activities are organized into the following categories:

K–12, college, and continuing education – Engaging the next generation in energy issues early and encouraging interest in the engineering field at all levels of education will build a generation of students primed to tackle engineering in college and beyond. ASME can partner with colleges and universities to develop and improve

energy and engineering curricula and also sponsor games or competitions, such as the FIRST Robotics Competition, that promote excitement and innovation among K–12 and college students. Improving continuing education courses and promoting job opportunities will continue to grow ASME’s already broad workforce development activities.

Professional development and outreach – ASME can encourage the continued professional development of its members by developing energy-management and other certification programs that encourage engineers to increase their capabilities and elevate the status of energy expertise. ASME can also expand efforts to engage its volunteers in its energy activities in the ASME technical divisions and in the ASME standards and certification programs.

Table 6. Potential ASME Activities—Support the Expansion and Development of a More Effective Energy Workforce (highest priorities in red)

<p>K–12, college, and continuing education</p>	<ul style="list-style-type: none"> • Develop a new generation of engineering workforce • Partner with other engineering societies to improve education activities • Develop courses and training materials for continuing education, mechanical engineering groups, and K–12 <ul style="list-style-type: none"> ▪ Educate students on energy presence in mechanical engineering ▪ Educate students on energy job availability • Sponsor student design competitions for undergraduates and high school students on efficiency to promote innovation <ul style="list-style-type: none"> ▪ Identify a critical class of problems to be solved ▪ Specify design constraints • Adjust/improve the college engineering curriculum—improve the link to energy topics and concerns <ul style="list-style-type: none"> ▪ Consider curriculum changes through ABET • Create an energy prize with other engineering organizations • Improve teacher education (e.g., develop a packaged energy module for each grade) <ul style="list-style-type: none"> ▪ Further educate teachers about energy issues during teacher institutes ▪ Conduct outreach in support of workshops for middle school teachers and Engineers’ Week ▪ Support teacher in-service programs ▪ Offer, at every ASME event, a free one-day session for every science teacher (K–12) in the region • Expose students to exciting problems and challenges in energy • Adjust/improve the college engineering curriculum—improve the link to energy topics and concerns <ul style="list-style-type: none"> ▪ Maintain/improve ASME’s relevance to the new generation of students and to (new) energy topics ▪ Partner with educational systems to improve the environment in which engineering is advanced • Develop games and contests on energy topics for middle schools and high schools • Create opportunities to enhance early career engineers’ experience working in the energy space
<p>Professional development & outreach</p>	<ul style="list-style-type: none"> • Increase engineering expertise among executives/management <ul style="list-style-type: none"> ▪ Task the existing ASME Centers Sector with these kinds of activities • Offer energy management certification programs • Illustrate the importance of reliance on engineers in everyday life • Hire ASME IT staff who are familiar with web 2.0 networking capabilities

ASME Priority: Increase public awareness and knowledge of the energy sector

Table 7 contains several of the highest priority activities ASME has identified to help the society better educate the public on important energy issues. Activities are organized into the following categories:

Tools the public can use – ASME can use its collective expertise and resources to develop several interactive tools that will improve the public’s access to credible energy information and encourage self-education. By providing comprehensive information on the web that is searchable and in a user-friendly format, citizens will be able to better understand—and respond to—leading energy issues.

Media attention – As energy issues and technologies continue to gain public attention, citizens often rely on news reports or social media to explain energy challenges and the national and global efforts to address them. By engaging the media in its efforts to better educate the public, ASME can provide accurate and actionable energy information, promote the idea of responsible energy use, and improve public perception of key energy issues.

Awareness campaign – Tools and media attention are aspects of a greater public outreach and awareness campaign that aims to generate a positive perception of responsible energy solutions. By approaching energy topics in simple, straightforward terms and expanding initiatives to include K–12 education, ASME can more effectively reach a broader audience.

Table 7. Potential ASME Activities—Increase Public Awareness and Knowledge of the Energy Sector (highest priorities in red)

Tools the public can use	<ul style="list-style-type: none"> • Develop a comprehensive web-based clearinghouse of energy information and a search engine to facilitate efficient retrieval of relevant information • Produce an interesting and exciting energy game (e.g., SimCity) with sufficient detail to educate players • Further develop a searchable energy fact book with one-page summaries of key energy sources <ul style="list-style-type: none"> ▪ ASME is an expert publisher ▪ ASME is an information expert ▪ Link to appropriate pages—clearinghouse—by references ▪ Make it public a la Wikipedia
Media attention	<ul style="list-style-type: none"> • Work with the media to conduct interviews that provide ASME energy perspectives • Create contests (on YouTube or something similar)—e.g., spend a day with 50% or 100% less energy, greatest increased efficiency for a set amount of money, etc.
Awareness campaign	<ul style="list-style-type: none"> • Lead effort to talk about energy in simple terms • Offer a high-profile energy public awareness campaign to help educate the public • Develop K–12 education initiatives—choices that help society • Illustrate the importance of reliance on engineers in everyday life • Re-establish ASME Distinguished Lecture Series with an energy focus



5. Top-Priority Opportunities for ASME Action

ASME has established a bold strategy for its Energy Grand Challenge and has identified priorities to implement that strategy. Effective implementation will require the active development and deployment of ASME's energy capabilities. ASME has identified nine top-priority opportunities to focus its efforts in achieving its Energy Grand Challenge. These opportunities cut across the full spectrum of ASME's strategy and serve to expand ASME's professional offerings as an energy technology resource.

The top-priority opportunities for ASME's Energy Grand Challenge are listed in Figure 8 and a series of one-page action plans for each are provided on the following pages. Each action plan provides a more detailed description of the priority; identifies the key challenges addressed by the activity and the desired outcomes of ASME's efforts; and presents a preliminary list of tasks, potential partners, key milestones, and immediate next steps. These one-page plans are intended to jump-start the implementation of ASME's energy strategy.

Figure 8. Priority Opportunities for the ASME Energy Grand Challenge

- Form a self-sustaining energy focal point within ASME to maintain a holistic approach to internal and external communications
- Strengthen alliances with other societies and international organizations to address energy issues and challenges
- Increase ASME's profile in renewable and emerging technologies
- Provide a rational, informed voice for political engagement
- Increase ASME's understanding, profile, and contributions regarding the energy-water nexus
- Build on existing ASME capabilities and expertise in the nuclear area
- Identify gaps in current and emerging technologies and related standards for energy generation, production, electricity transmission (including smart grid and energy storage), distribution, transportation, and efficiency
- Develop a new generation of engineering workforce
- Develop a comprehensive web-based clearinghouse of energy information and a search engine to facilitate the efficient retrieval of relevant information

Priority Activity I: Form a self-sustaining energy focal point within a ASME to maintain a holistic approach to internal and external communications.

Description

A wide range of energy-related initiatives, activities, and resources contribute to ASME’s strong energy capability. To optimally leverage, develop, and deploy this asset, ASME must create an internal infrastructure that aggregates the strengths of the ASME sectors, technical divisions, and standards and certification into a cohesive and holistic energy center within ASME. This internal energy center would enlist volunteer and staff participation and establish clear roles and responsibilities for creating and carrying out the energy center’s strategic, operational, and financial plans. The internal energy center would serve as a focal point for ASME’s energy capability and provide a centralized source for energy-related information and communication. Ultimately, the center would become self-sustaining through the creation and marketing of products and services based on ASME’s energy capability.

Time Frame = Near-term (0–1 years)

Key Challenges or Gaps Addressed

- Effective integration of strengths and content of ASME sectors and technical divisions
- Effective articulation to stakeholders of the value of the interaction
- Expedited implementation of the initiative
- Coordination of the initiative internally and externally

Desired Outcomes

- Infrastructure support for a forum for the discussion and debate of energy-related information
- Creation of products and services that effectively deploy ASME’s energy capability to meet the energy needs of society
- Facilitation of internal and external energy-related collaboration and networking; minimization of duplicated efforts
- Increased ASME energy brand recognition
- Integrated programs, expert panels, and a Speakers’ Bureau
- Congressional invitations
- Corporate communications strategy

Tasks

1. Conduct SWOT (strengths, weakness, opportunities, and threats) analysis of ASME’s energy initiatives, activities, and resources across ASME sectors, technical divisions, and standards and certification in order to determine the potential for the further development of each of ASME’s energy capabilities
2. Identify energy market needs and compare to SWOT analysis to determine the most effective way to deploy each energy capability
3. Identify a volunteer/staff partnership infrastructure for the ASME Energy Center, and establish accountability and ownership for the center’s activities and function
4. Identify steering committee members to engage in planning for the ASME Energy Center
5. Develop strategic, operational, and financial plans
6. Develop revenue model

Potential Partnerships

- ASME technical divisions, institutes, sectors, standards, and certification
- Domestic and international energy-focused organizations (societies, government agencies)
- Academic alliances

Key Milestones

- Meeting of key stakeholders, including government, universities, societies, national labs, and industry
- Develop business plan for Energy Center
- Energy Grand Challenge Advisory Board

Immediate Next Steps

- Buy-in from volunteer and staff leaders
- Identification of ASME existing energy capability
- Stakeholder workshop

Priority Activity 2: Strengthen alliances with other societies and international organizations to address energy issues and challenges.

Description

Building on existing collaboration among Engineering Founder Societies (Institute of Electrical and Electronic Engineers [IEEE-USA]; American Society of Civil Engineers [ASCE]; American Institute of Chemical Engineers [AIChE]; and American Institute of Mining, Metallurgical, and Petroleum Engineers [AIME]), ASME can expand and strengthen its partnerships and connections with other societies, academia, government, and industry. These alliances will provide ASME with a wider range of opportunities to deploy its energy capability and will allow ASME to promote collaboration on a broader spectrum of energy issues and challenges. The partnerships also create a platform for exercising leadership in addressing increasingly complex energy issues and increasing technology and knowledge transfer between industries.

Time Frame = Mid-term (1–3 years)

Key Challenges or Gaps Addressed

- Better leverage ASME’s energy resources
- Increasing complexity and inter-relatedness of energy issues
- Knowledge and information sharing across sector and industry boundaries
- Sub-optimization in energy policies, strategies, and actions by both government and industry

Desired Outcomes

- Increased level of collaboration on energy activities (technical and public policy) among Founder Societies and their international partners
- More holistic and systemic approaches to energy issues
- Improved dissemination of new knowledge and technology
- Greater consensus and common understanding of energy issues
- Buy-in and support across a broader range of stakeholders

Tasks

1. Identify current energy technical activities of the Founder Societies
2. Identify current energy public policy activities of the Founder Societies as well as other engineering societies
3. Examine energy activities suggested in Energy Grand Challenge (EGC) Roadmap to identify new energy areas for collaboration
4. Pick top five new energy activity opportunities
5. Draft one-page action plan for each activity
6. Run ASME-led technical conference working with other societies and trade groups (e.g., high-pressure pipelines, piping systems, boilers-solar-coal multi-fuel)

Potential Partnerships

- Institute of Electrical and Electronic Engineers (IEEE-USA)
- American Institute of Chemical Engineers (AIChE)
- American Society of Civil Engineers (ASCE)
- American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME)
- American Institute of Aeronautics and Astronautics (AIAA)
- Society of Automotive Engineers (SAE)
- U.S. Department of Energy (DOE)
- U.S. Department of Defense (DOD)
- Defense Advanced Research Projects Agency (DARPA)
- Advanced Research Projects Agency-Energy (ARPA-E)
- Industry

Key Milestones

- Winning grant funding from the United Engineering Foundation
- Establishment of an energy-water nexus partnership

Immediate Next Steps

- Form Steering Committee
- Identify possible partnership areas with Founder Societies
- Identify best practices of existing partnerships

Priority Activity 3: Increase ASME's profile in renewable and emerging technologies.

Description

ASME's credibility and leadership in energy will require ASME to increase its profile in renewable energy technologies. ASME will make a deliberate effort to expand its focus on renewable-energy-related knowledge, information, technologies, codes and standards, and will leverage its existing base of knowledge and understanding in this area.

Time Frame = Near-term (0–1 years)

Key Challenges or Gaps Addressed

- Integrating increasing amounts of renewable energy sources into existing infrastructure

Desired Outcomes

- Additional ASME products, services, and activities in renewables and emerging technology areas
- Recognition of current ASME activities in renewable and emerging technologies
- ASME viewed as a significant player in the renewable and emerging technologies area

Tasks

1. Leverage existing ASME programs, including the following:
 - Advanced Energy Systems Technical Division
 - Solar Energy Technical Division
 - Wind Energy Technical Committee
 - Power Technical Division (including the Fuels and Combustion Technology Technical Committee)
 - Annual Sustainable Energy Conference
 - Emerging Technologies Program in Knowledge and Community Sector
 - Standards and Certification's current and planned renewable energy standards
 - Existing ASME energy conferences with significant attendance by ASME members
 - Solid Waste Processing Technical Division (Waste-to-Energy)
 - Bio-X Customer Segment Team
 - Bioengineering Technical Division
2. Conduct targeted outreach to renewable energy professionals to explain their role and fit within ASME
3. Seek partner opportunities with established renewables societies or associations
4. Integrate ASME members into DOE renewable and emerging technology programs (via a mechanism similar to Federal Fellows program)

Potential Partnerships

- Institute of Electrical and Electronic Engineers (IEEE-USA)
- American Institute of Chemical Engineers (AIChE) Institute for Sustainability
- American Society of Civil Engineers (ASCE)
- U.S. Department of Energy (DOE) Energy Efficiency and Renewable Energy (EERE)
- National Renewable Energy Laboratory (NREL)
- Renewable source-specific industry associations such as the American Wind Energy Association and the Solar Energy Industries Association

Key Milestones

- At least one new ASME offering in renewables by 2011
- ASME renewable and emerging technologies exhibit

Immediate Next Steps

- Reach out to partner organizations to identify possible areas for near-term collaboration
- Develop outreach materials communicating ASME products and services for the renewables sector

Priority Activity 4: Provide a rational, informed voice for political engagement.

Description

ASME should build on its credibility as a nonpartisan, neutral voice of reason, objectivity, and information in the eyes of legislators and regulators in local, state, and federal governments. ASME aims to become a go-to resource for policymakers on technical issues associated with energy policy, which will allow ASME to exercise positive leadership and influence to contribute to a holistic and cohesive national energy strategy.

Time Frame = Mid-term (1–3 years)

Key Challenges or Gaps Addressed

- Enhance database of core group of ASME energy experts
- More resources needed for state and local outreach

Desired Outcomes

- Increase in ASME's influence and visibility with legislators, regulators, and the general public
- More informed, objective, and fact-based public dialogue on energy issues

Tasks

1. Identify and engage a core group of ASME volunteers who are well informed and actively working in the energy industry and academia to serve as ASME's energy experts
2. Continue to work with the ASME Knowledge and Community Sector's Energy Committee to issue position papers providing objective and fact-based information and ensure relevant position statements are updated within a specified time
3. Continue to convene congressional briefings and identify opportunities for ASME involvement in other energy policy activities
4. Build the Engineering Energy Policy Alliance through continued outreach and collaborative activities
5. Develop strategies to use partnerships for expanding reach and impact of ASME's nonpartisan voice of reason.
6. Build on ASME's capacity for outreach to policymakers and federal officials
7. Work closely with ASME Knowledge and Community Sector to involve ASME members in outreach at the local and state level through Town Hall Meetings or other events and/or policy-related activities
8. Place federal fellows in assignments dealing with energy

Potential Partnerships

- Engineering societies
- Other non-governmental organizations (NGOs)
- National Conference of State Legislatures

Key Milestones

- Number of energy position statements issued
- Number of energy related Congressional briefings and Town Hall meetings convened

Immediate Next Steps

- Identify topics for Congressional briefings and position papers

Priority Activity 5: Increase ASME’s understanding, profile, and contributions regarding the energy-water nexus.

Description

ASME’s credibility and leadership in energy depend on cutting edge knowledge of emerging challenges and complexities of the energy issue, one of which is the energy-water nexus. The energy-water nexus is becoming increasingly relevant since energy is required for the production and use of water, and water is required for the production and use of energy. A focused effort to build on the base of knowledge and understanding of this issue, developed by the DOE Energy-Water Nexus Project led by Sandia National Laboratory, is a critical activity for ASME.

Time Frame = Mid-term (1–3 years)

Key Challenges or Gaps Addressed

- Efficient and comprehensive data gathering
- Effective and clear public communication regarding the energy-water nexus

Desired Outcomes

- Knowledge of the energy content of water and the water content of energy
- “Energy-Water Star” rating system and label

Tasks

1. Clearly communicate the importance of the energy-water nexus (1–3 years)
2. Gather data detailing the status of energy and water use for such sectors as buildings, industry, power, and utilities at regional, national, and global levels (0–1 years)
3. Set goals for achieving efficiency improvements in water and energy and develop methodologies to enable such improvements (1–3 years)
4. Establish an energy-water content evaluation system for appropriate sectors

Potential Partnerships

- American Society of Civil Engineers (ASCE)
- Institute of Electrical and Electronic Engineers (IEEE-USA)
- American Water Works Association (AWWA)
- WaterReuse Foundation
- Water Environment Federation (WEF)
- Community water boards
- Electric Power Research Institute (EPRI)
- U.S. Nuclear Regulatory Commission (NRC)
- Federal agencies (U.S. Department of Energy [DOE], U.S. Army Corps of Engineers, Bureau of Reclamation, U.S. Environmental Protection Agency [EPA])
- Industry (General Electric [GE], power companies)
- Local power and water utilities

Key Milestones

- Gather data by region for the development of a metric that determines the energy content of water and the water content of energy

Immediate Next Steps

- Initiate efforts with DOE, national labs, and other societies to build alliances
- Determine data requirements and initiate gathering
- Work with DOE/EPA to develop an “Energy-Water Star” evaluation system

Priority Activity 6: Build on existing ASME capabilities and expertise in the nuclear area.

Description

ASME has recently established a cross sector nuclear customer segment team to identify and support all of ASME's products and services in the nuclear area. Several hundred nuclear products and services have been identified including the boiler and pressure vessel code. The nuclear customer segment team has identified in its first year of operation eight new cross sector projects in the nuclear area to be completed in Fiscal Year 2010. This builds on ASME's existing credibility and expertise and has identified additional ASME products and services that are needed.

Time Frame = Mid-term (1–3 years)

Key Challenges or Gaps Addressed

- Defining scope of new nuclear products and services needed
- Obtaining information on emerging nuclear technology areas
- Differences in global standards

Desired Outcomes

- Development of scope and need statements for new standards
- Global acceptance of results by industry and government stakeholders
- ASME equipment manufacturer certifications helps ensure globally consistent quality in key nuclear components
- Consistency of global regulators to foster investment

Tasks

1. Form task team of experts with knowledge of standards and energy technologies
2. Formulate a gap analysis plan to identify standards and best practices needed to support current or emerging nuclear technologies
3. Seek and assemble relevant data and information
4. Build the gap analysis plan
5. Determine and communicate the results

Potential Partnerships

- Experts from other societies
- Foreign standards organizations
- Foreign governments
- U.S. Nuclear Regulatory Commission (NRC)

Key Milestones

- Gap analysis plan: 6 months
- Data assembled: 12–18 months
- Gap analysis established: 18 months
- Identification of new and existing standards and revised scope: 2 years

Immediate Next Steps

- Identify and engage experts in standards and nuclear infrastructure
- Contact foreign nuclear standards bodies

Priority Activity 7: Identify gaps in current and emerging technologies and related standards for energy generation, production, electricity transmission (including smart grid and energy storage), distribution, transportation, and efficiency.

Description

As energy technology continues to grow, ASME’s standards and certification initiatives will need to be more strategic. ASME will need to efficiently monitor and evaluate current and new technologies for energy generation, production, electricity transmission (including smart grid and energy storage), distribution, transportation, and efficiency in order to identify needed consensus standards and revisions to existing standards. This effort will be accomplished by identifying gaps in codes and standards and certification programs for both current and emerging energy technologies.

Time Frame = Mid-term (1–3 years)

Key Challenges or Gaps Addressed

- Efficient and comprehensive data gathering
- Defining the scope of needed standards
- Obtaining information on emerging technologies
- Producing timely standards
- Compatibility of emerging technologies

Desired Outcomes

- Development of scope and need statements for new standards
- Worldwide acceptance of results by industry and government stakeholders
- Development of standards in a timely manner to enable emerging technology, maximize flexibility, and prevent incompatibilities
- Effective, evolving standards which guide the release of significant energy technologies

Tasks

1. Form task team of experts with knowledge of standards and energy technologies
2. Formulate a gap analysis plan to identify standards needed to support significant current or emerging energy technologies
3. Seek and assemble relevant data and information
4. Build the gap analysis plan
5. Determine results
6. Initiate development of standards in identified areas
7. Monitor, evaluate, and improve standard effectiveness

Potential Partnerships

- Experts from sister societies and other societies worldwide
- Electric Power Research Institute
- National Institute of Standards and Technology

Key Milestones

- Gap analysis plan: 6 months
- Data assembled: 12–18 months
- Gap analysis established: 18 months
- Identification of new and existing standards and revised scope: 2 years

Immediate Next Steps

- Meet with major stakeholders to determine extent of existing efforts and how ASME may contribute

Priority Activity 8: Develop a new generation of engineering workforce.

Description

The continued development and effective deployment of new energy technology requires a highly trained engineering workforce. Maintaining a highly trained workforce is a core of ASME’s energy strategy, as well as part of ASME’s ongoing advocacy of the engineering profession. The development of a new generation of the engineering workforce requires courses, training, and materials for continuing education, university education, and STEM (science, technology, engineering, and mathematics). ASME can use its resources, capabilities, and partnerships to foster the creation of education programs and materials.

Time Frame = Mid-term (1–3 years)

Key Challenges or Gaps Addressed

- Interesting students in engineering careers
- Students leaving engineering
- Stagnant engineering career
- Eroding energy infrastructure
- Need for further training of new engineering graduates who are immediately put on the job

Desired Outcomes

- Increase in engineering degrees
- Addition of a more agile workforce
- Job re-training once a specialty becomes obsolete
- Interdisciplinary and international training and experience

Tasks

1. Gather information to understand and analyze the current status of the workforce and workforce education (Rising Above the Gathering Storm—NAS Report)
2. Identify strongest needs in K–12, universities, continuing education, and interdisciplinary training programs
3. Identify key stakeholders in meeting needs
4. Form joint ventures with industries and schools; create government-industry-university roundtable to facilitate discussion
5. Leverage existing ASME early career forums
6. Increase fellowships related to energy
7. Develop messages for ASME public voice (President, Executive Director, conference speakers, etc.) regarding workforce and energy issues
8. Expand training on new ASME energy initiatives including standards

Potential Partnerships

- Industry
- Technical organizations
- ASME operating units
- Government
- Non-profits
- Non-governmental organizations (NGOs)

Key Milestones

- Form a task force consisting of ASME members who are in industry and education
- Develop preliminary plan and secure funding
- Develop, produce, and distribute educational materials
- Develop student role-playing exercises; publicize and distribute them
- Develop and organize a student competition

Immediate Next Steps

- Identify the players in ASME
- Identify an effective delivery system involving students and teachers
- Identify low-hanging fruits that can be implemented immediately: ASME fellowship, energy competitions, ASME “mentorship”

Priority Activity 9: Develop a comprehensive web-based clearinghouse of energy information (e.g., wiki web page) and a search engine to facilitate efficient retrieval of relevant information.

Description

ASME can provide concrete information tools that leverage its capabilities and promote its role as an objective, informed resource for energy information. Information tools can also minimize misinformation and help create a more informed national energy dialogue. A web-based clearinghouse and search engine would allow policymakers, engineers and the general public to access the most up-to-date relevant information on any energy issue and challenge.

Time Frame = Mid-term (1–3 years)

Key Challenges or Gaps Addressed

- Determining the accuracy of the energy information found
- Liability and intellectual property (IP) issues
- Developing a business plan for energy information

Desired Outcomes

- An easy-to-use energy search web page
- A reliable energy wiki and teaching tool
- A “one-stop” energy web site (e.g., WebMD) for the public and technology community
- Use of web sources by engineering talent to improve project synergy
- Generate interest in engineering

Tasks

1. Form a task group to determine the boundaries of the information that will be obtained as part of the search results, determine the nature of and audience for the project
2. Explore the development of an ASME wiki that would provide information about energy issues, allow posting of technologies and solutions, and enable users to have their questions answered by experts.
3. Develop a business case and value-proposition for the project.
4. Contact potential/suitable partners for the creation of the search engine.
5. Create an oversight group to seek contributors to the wiki.
6. Conduct beta testing and fact checking.

Potential Partnerships

- Google/Yahoo
- Professional societies and trade organizations
- Industry
- U.S. Department of Energy (DOE)
- U.S. Environmental Protection Agency (EPA)
- Non-governmental organizations (NGOs)

Key Milestones

- Definition of energy search parameters: within first 6 months
- Resolution of legal and liability issues: within first 6 months
- Contract with developer: 8 months–1 year
- Completion of prototype site: 1–1.5 years
- Beta test: 1.5–2 years, run for 6 months
- Rollout of web site(s): 2.5–3 years

Immediate Next Steps

- Form a task force
- Consult legal
- Determine where activity would reside within ASME
- Engage ASME staff and the ASME Board of Governors



Appendix A. Steering Committee Members

ASME greatly appreciates the efforts of the Energy Grand Challenge Vision and Roadmap Steering Committee, whose guidance has been instrumental in helping to define an appropriate role for ASME in the energy arena. Steering Committee members include:

Dilip Ballal
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Earnest F. Gloyna Regents Chair in Engineering
The University of Texas at Austin

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Phil Hamilton
Associate Executive Director, Strategy and Outreach
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Entergy Nuclear

Michael Tinkleman
Director, Research
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Mel Torre
Director, Communications
ASME



Appendix B. Workshop Participants

The following workshop participants made valuable contributions to this *ASME Energy Grand Challenge Roadmap*:

Philip Abold
Vice President
Defense Group Inc

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University of Texas at Austin

Sam Baldwin
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Energy Efficiency & Renewable Energy
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Ken Balkey
Consulting Engineer, Nuclear Services
Westinghouse Electric Company LLC

Dilip Ballal
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University of Dayton

Thomas Barlow
President
ASME

John Bendo
Nuclear Engineering Business Manager
ASME

Thomas Bergman
Deputy Director for Licensing Operations
U.S. Nuclear Regulatory Commission

Gil Bindewald
Program Manager, Transmission & Distribution
Integration
U.S. DOE

Peter Blair
Executive Director, Engineering and Physical Sciences
National Academy of Sciences

Chris Blazek
Vice President, Marketing
Benetech

David Bodde
Senior Fellow of the Spiro Institute
Clemson University

Jerry Brashear
Program Director
ASME Innovative Technologies Institute, LLC

Shawn Burns
Committee on Energy & Natural Resources
U.S. Senate

Philip Carpentier
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Shell Oil Products

Shekhar Chandrashekhar
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Gene Whitney
Research Manager, Energy and Minerals
Congressional Research Service

Bill Worek
Director, Energy Resources Center
University of Illinois at Chicago



Appendix C. Overview of ASME



ASME helps the global engineering community develop solutions to real world challenges. Founded in 1880 as the American Society of Mechanical Engineers, ASME is a not-for-profit professional organization that enables collaboration, knowledge sharing and skill development across all engineering disciplines, while promoting the vital role of the engineer in society. ASME codes and standards, publications, conferences, continuing education and professional development

programs provide a foundation for advancing technical knowledge and a safer world.

ASME strives to promote and enhance the technical competency and professional well-being of its members, and through quality programs and activities in mechanical engineering, better enable its practitioners to contribute to the well-being of humankind.

Vision: "ASME will be the essential resource for mechanical engineers and other professionals throughout the world for solutions that benefit humankind"

ASME prides itself in setting the standard...

... in engineering excellence
 ... in knowledge, community, and advocacy
 ... for the benefit of humanity

Meeting the Needs of the Global Technological Community

To efficiently and effectively serve the needs of the engineering profession, ASME has established five specialized sectors. By working together, these sectors provide engineers and technical professionals along with those in academia and government with a combination of products and services tailored for today's rapidly changing global technological environment. The sectors include:

- **Standards and Certification**—Establishes a set of technical definitions, instructions, rules, and guidelines for designers, manufacturers, and users to promote the safety, reliability, uniformity, productivity, and efficiency of engineering components and equipment.
- **Knowledge and Community**—Serves as a communications platform for connecting students, engineers, government officials, and industry practitioners to facilitate technology transfer, share best practices, and discuss common issues.
- **Centers**—Advances the engineering profession by increasing public awareness of engineering contributions to society, promoting professional and ethical engineering practices, advocating excellence in engineering education, and cultivating leadership and diversity among all engineering fields.
- **Institutes**—Provides a focused arena for business activities relevant to identified technical and technology endeavors including networking and information exchange opportunities.
- **Strategic Management**—Identifies key opportunities to impact public policy relevant to engineering and sets priorities for ASME initiatives to effectively meet industry needs.

Serving...

- Academia
- Early career engineers
- Government agencies
- Industry
 - Bio-pharmaceutical
 - Energy
 - Manufacturing
 - Nanotechnology
 - Pressure technology
 - Sustainability
 - Water management technology

For more information, visit www.asme.org.

Who We Are

What We Do

<p>Standards and Certification</p>	<p>Supervisory and advisory boards managing over 700 technical committees with 4,000 volunteer members, including expert engineers, users, manufacturers, consultants, universities, testing laboratories, insurance interests, and government regulatory agencies</p>	<ul style="list-style-type: none"> • Maintain approximately 500 codes and standards covering areas such as boiler and pressure vessel components, piping and pipelines, elevators, fasteners, geometric dimensioning & tolerancing, and machine tools. Develop the preeminent, universally applicable codes, standards, conformity assessment programs, and related products and services for the benefit of humanity • The Engineering Management Certification Institute (EMCT) offers certification and accreditation courses, management training, licensure assistance (including webinars, short courses, on-site training, books, and videos) • The Continuing Education Institute
<p>Knowledge and Community</p>	<p>Volunteer members serving in over 800 resource platforms, including 37 technical divisions, 220 geographical sections, 500+ student sections, 215 online communities of practice, and the Center for Research and Technology Development (CRTD)</p>	<ul style="list-style-type: none"> • Form collaborative efforts • Share best practices • Support communities of practice • Provide forums for outreach • Focus programs on critical issues that impact early career engineers, government agencies, and industry • Publish 21 technical journals • Conduct 15 technical conferences • CRTD coordinates a member-driven, pre-competitive, collaborative research program • The Emerging Technologies area offers an expanded portfolio of available products and services in emerging fields of new technology, such as nanotechnology, fuel cells, and nanoengineering for medicine and biology
<p>Centers</p>	<p>Volunteer members serving in 24 committees, including three in public awareness; five in professional practice, development, and ethics; 11 in education; and five in leadership and diversity</p>	<ul style="list-style-type: none"> • Sponsor competitions and awards to inspire future innovations and celebrate past achievements • Supervise student/professional development activities • Support development of ethics standards and reviews • Provide resources for the support, development, and recognition of excellence among mechanical engineering education community worldwide • Lead, facilitate, coordinate, and support leadership development, mentoring, and diversity and outreach activities
<p>Institutes</p>	<p>ASME staff serve in two institutes focused on specific technology areas. Volunteers have the opportunity to participate in the technical committees and technical communities of the two institutes</p>	<ul style="list-style-type: none"> • International Gas Turbine Institute (IGTI) • International Petroleum Technology Institute (IPTI)
<p>Strategic Management</p>	<p>Two boards, comprised of industry executives, engineering academics, and ASME staff, supervising interactions with government and industry, and providing internal and external insight on trends and opportunities that impact the engineering community</p>	<ul style="list-style-type: none"> • The Board on Government Relations provides guidance and aid in developing strategies, testimony, and position papers to ensure issues of importance to the practice of mechanical engineering are made in the best interest of the public • The Industry Advisory Board provides a voice for industry within ASME to ensure ASME programs are relevant and effective • Strategic Initiatives and Innovation supports ASME strategic initiatives and innovation products for industry, early career engineers, and globalization • Strategic Issues conducts annual environmental scans and produces bimonthly Issue Briefs on emerging trends affecting engineering

Serving the Engineering Community



Appendix D. Acronyms

ABET	Accreditation Board for Engineering and Technology	GE	General Electric
AIAA	American Institute of Aeronautics and Astronautics	IEEE-USA	Institute of Electrical and Electronics Engineers-USA
AIChE	American Institute of Chemical Engineers	IMECE	International Mechanical Engineering Congress and Exposition
AIME	American Institute of Mining, Metallurgical, and Petroleum Engineers	IP	Intellectual Property
ARPA-E	Advanced Research Projects Agency - Energy	ISO	independent system operator
ASCE	American Society of Civil Engineers	IT	information technology
ASME	American Society of Mechanical Engineers	NASA	National Aeronautics and Space Administration
AWWA	American Water Works Association	NGO	non-governmental organization
CO ₂	carbon dioxide	NO _x	nitrous oxide
CSP	concentrated solar power	NRC	U.S. Nuclear Regulatory Commission
DARPA	Defense Advanced Research Project Agency	R&D	Research and Development
DOD	U.S. Department of Defense	RTO	regional transmission organization
DOE	U.S. Department of Energy	SAE	Society of Automotive Engineers
DOE EERE	Department of Energy Efficiency and Renewable Energy	STEM	science, technology, engineering, and mathematics
EGC	Energy Grand Challenge	SWE	Society of Women Engineers
EPA	U.S. Environmental Protection Agency	SWOT	strengths, weaknesses, opportunities, and threats
EPRI	Electric Power Research Institute		



Appendix E. ASME Energy Grand Challenge Roadmap Workshop Agenda

Grand Hyatt Hotel • March 12-13, 2009 • Washington DC

Thursday, March 12, 2009	
8:30 – 10:30	Opening Remarks and Introductions <ul style="list-style-type: none"> • Welcome and Overview of ASME’s Energy Grand Challenge – Thomas Barlow, ASME President • Panel Discussion: Congressional Priorities for Energy • Industry’s Perspective: Energy Challenges – John Voeller, Chief Technology Officer, Black & Veatch • ASME Energy Grand Challenge Roadmap – Michael Tinkleman, ASME Director of Research • Workshop Process and Logistics – Ross Brindle, Energetics
10:30 – 10:45	Break
10:45 – 12:30	Group Discussion: Major Trends Shaping Energy’s Future Major trends that will shape the energy sector over the next five years.
12:30 – 1:30	Lunch Proceed to three parallel breakout sessions after lunch: <ul style="list-style-type: none"> • Energy Generation and Production • Energy Transmission, Transportation, and Distribution • Energy Use and Efficiency
1:30 – 3:30	Breakout Session #1: Identify Critical Energy Challenges Major challenges that must be overcome in the next five years.
3:30 – 3:45	Break
3:45 – 5:00	Breakout Session #2: Identify Potential Solutions Potential solutions that hold promise for overcoming key challenges in energy.
5:00 – 5:30	Recap and Instructions for Day 2
5:30	Networking Reception
Friday, March 13, 2009	
8:30 – 10:00	Breakout Session #3: Identify Priorities for ASME Select the most promising opportunities for ASME action.
10:00 – 10:15	Break
10:15 – 11:30	Breakout Session #4: Develop Preliminary Implementation Plans Preliminary implementation plans for the highest-priority activities
11:30 – 12:00	Prepare Breakout Session Report-Out
12:00 – 12:45	Lunch – <i>proceed to closing session after lunch</i>
12:45 – 1:45	Closing Session <ul style="list-style-type: none"> • Breakout Session Reports • Next Steps and Closing Remarks
3:30	Adjourn

