ASME Energy Grand Challenge Roadmap

Executive Summary

ASME
SETTING THE STANDARD

September 2009

Prepared by:

ENERGETICS
A Subsidiary of VSE Corporation

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Acknowledgements

The ASME Energy Grand Challenge Roadmap was prepared by Ross Brindle, Fred Hansen, Amanda Greene, Matt Munderville, and Julie Chappell of Energetics Incorporated under the guidance of Dr. Michael Tinkleman, Director, Research at ASME, and the Energy Grand Challenge Vision and Roadmap Steering Committee (roster on page 8). On behalf of ASME, we would like to express our appreciation to the Energy Grand Challenge Roadmap Workshop participants and the Steering Committee for their input and recommendations (Participants List on page 9).

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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

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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'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.

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 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

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

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

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 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 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 opportunities for ASME's Energy Grand Challenge are listed in Figure ES-1. Chapter 5 in the full roadmap report presents a series of one-page action plans for each top-priority opportunity. Each action plan provides a more detailed description of the opportunity; 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.

Table ES-1. Top Opportunities for ASME Action

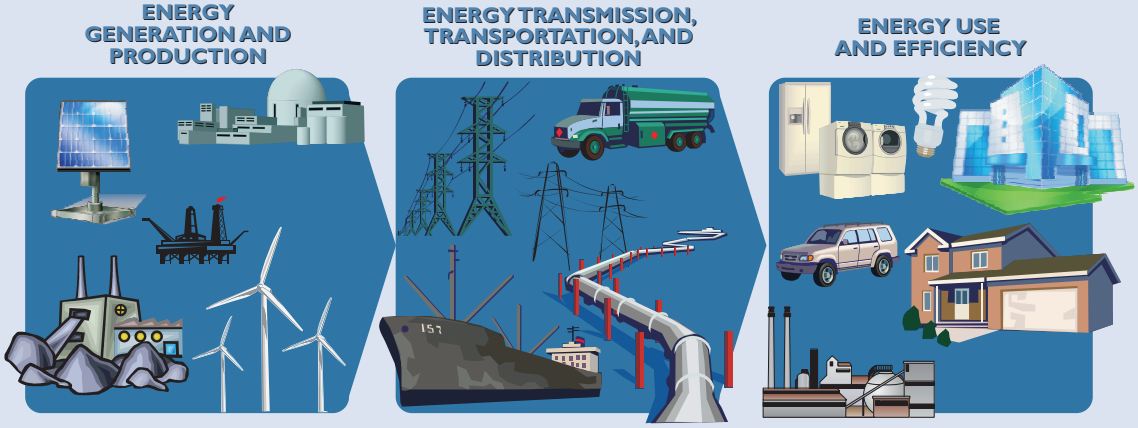
Priority Activity 1	Form a self-sustaining energy focal point within a ASME to maintain a holistic approach to internal and external communications.	A wide range of energy-related initiatives, activities, and resources contribute to ASME's strong energy capability. To optimally leverage, develop, and 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.
Priority Activity 2	Strengthen alliances with other societies and international organizations to address energy issues and challenges.	Building on existing collaboration among the Engineering Founder Societies, ASME can expand and strengthen its partnerships and connections with other engineering 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.
Priority Activity 3	Increase ASME's profile in renewable and emerging 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.
Priority Activity 4	Provide a rational, informed voice for political engagement.	ASME will 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.
Priority Activity 5	Increase ASME's understanding, profile, and contributions regarding the energy-water nexus.	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.
Priority Activity 6	Build on existing ASME capabilities and expertise in the nuclear area.	ASME has recently established a cross sector nuclear customer segment team to identify, support, and grow all of ASME's products and services in the nuclear area. Almost 60 ASME nuclear products and services have been identified including the boiler and pressure vessel code.
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.	As energy technology continues to grow, ASME's standards and certification initiatives 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.
Priority Activity 8	Develop a new generation of engineering workforce.	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 Engineering Workforce Development initiative.
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.	ASME will provide information resources and tools online that leverage its capabilities and promote its role as an objective, informed resource for energy information. These information resources and tools can also help create a more informed national energy dialogue.

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

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

- Serve as an impartial, authoritative, rational voice in energy matters by offering technical expertise to regulators and policymakers
- Develop and promote codes and standards and related products and services to support energy technology innovation and commercialization
- Support the expansion and development of a more effective energy workforce
- Increase public awareness and knowledge of the energy sector

Build partnerships to increase the effectiveness and impact of ASME initiatives

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**

Table ES-2. 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		
	Plant Engineering & Maintenance Division		
Energy-Related Divisions	Dynamic Systems and Control Division		
	Design Engineering Division		
	Safety Engineering and Risk Analysis 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	
			Manufacturing 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)	

	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		

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:

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