INSTITUTE FOR HOMELAND SECURITY

Sam Houston State University

Artificial Intelligence Governance

and Standards Guidance for the Texas Grid

Institute for Homeland Security

Sam Houston State University

Thomas Watson

Abstract

The Texas grid is going through tremendous changes as new digital technologies are added to the system such as grid modernization, renewable energy integration, advanced metering, distributed energy sources and electric vehicle integration. While still in the early stages of AI adoption, the Texas grid has the opportunity to enhance how these new digital technologies will impact future operations, safety and security of future generation, distribution, and consumption of electric power, while minimizing risk for the owners and operators. The Texas grid will require AI to be able to handle the exponential growth of data generated by the new digital technology. To manage this data, the Texas grid needs AI governance and standards to maximize AI decision support and predictive analytics. The effective use of AI has the potential to significantly enhance how these technology changes to the Texas grid will impact future generation, distribution, and consumption of electric power. This paper has the potential to contribute to AI-based operational solutions to the electric sector by generating actionable recommendations. The outcomes of this study may also be transferrable to other electric companies, government agencies, and stakeholders in other jurisdictions for implementation to their practices, leading to improved operations and security beyond the Texas grid.

Key Words: Artificial Intelligence, Texas Grid, Digitization, Governance, Standards

Table of Contents

Introduction

The electric sector is currently undergoing tremendous technology changes such as grid modernization and distributed energy sources. As a result of these changes, Artificial Intelligence (AI) is becoming an essential component of the electric sector for improving operational efficiency, effectiveness and resilience. With the use of AI, the Texas grid has the potential to significantly enhance how these technology changes will impact the operations, safety and security of future generation, distribution, and consumption of electric power, while minimizing risk for the owners and operators. To successfully implement and execute AI within Texas grid's operations, AI applications must be leveraged to enhance situational awareness, threat detection, and response capabilities. This paper will investigate the use of AI governance and standards to maximize AI applications for decision support and predictive analytics for situational awareness and the response capabilities of the Texas grid.

Background on Texas Interconnected System

The Texas Interconnected System is one of three large electric networks, along with the Eastern and Western Interconnects, that provide power for over 150 million customers in the continental United States (Cohn, 2022). The Texas Interconnected System supply's electric power to more than 26 million customers within the State of Texas (Electric Reliability Council of Texas, 2024). The physical infrastructure of the Texas Interconnected System is owned by individual power generators and transmission companies, while the Electric Reliability Council of Texas (ERCOT) serves as the independent system operator for the region (Cohn, 2022). ERCOT schedules electric power distribution over more than 54,100 miles of transmission lines and from 1,250 generation units (Electric Reliability Council of Texas, 2024). ERCOT also performs financial settlement for the competitive wholesale bulk-power market and administers

retail switching for 8 million customers who have a competitive choice of power providers (Electric Reliability Council of Texas, 2024). All of the components that make up the network controlled by ERCOT are commonly referred to as the Texas grid (Cohn, 2022). For the purpose of this paper, the collective parts of the Texas Interconnected System are referred to as the Texas grid.

Digitization

Electrical power grids have been operational unreliable, unstable, inflexible and inefficient for years, and the Texas grid is no exception (Alsaigh et al., 2023). The Texas grid has had its challenges monitoring the electrical systems and distribution lines, causing major electrical system failures, loss of human lives and economic impacts (Alsaigh et al., 2023). For example, Texas electric power crisis from February 6-19, 2021, resulted in over $195 billion in estimated property damage and 151 deaths due to extreme cold weather (Zhang et al., 2022). As the Texas grid continues to serve the daily needs of the its growing number of customers, it is also undergoing digitalization and data-enabled technologies upgrades for long-term efficiency, effectiveness and reliability of the Texas grid to help prevent the electrical outage of 2021 from happening, again, in the future (Bean & Davies, 2020).

A part of this change is new state-of-the-art technology to digitize texts, data, photographs and graphics to be processed, stored and transmitted to transform core business functions and improve efficiency across business lines (Bean & Davies, 2020). Some of the ongoing digital technological changes for the Texas grid are advanced smart metering, smart grid, integration of distributed renewable energy sources and electric vehicles (Andersen et al., 2021). The Texas grid smart energy systems are transforming the electric industry in Texas with emerging technologies, renewable energy sources and other trends (Alsaigh et al., 2023). To

enable the Texas grid to integrate these digital technology changes into the electric system requires additional digital options such as augmented and virtual reality, cloud computing distributed computing, robotics, Unmanned Aerial Vehicles (UAVs) and the Internet of Things (IoT) (Bean & Davies, 2020). The integrate of these new digital technologies will also add complexity to the Texas grid by producing massive amounts of data (Alsaigh et al., 2023). However, using this new data will allow Artificial Intelligence (AI) to potentially innovate products, optimize processes and increase productivity within the Texas grid (Alkhayat et al., 2022). The ability of AI to process massive amounts of complex data from the Texas grid will enable the owners and operators to make smarter and more timely decisions, while mitigating risks (Alsaigh et al., 2023). Simulation testing at the Department of Energy's Pacific Northwest National Laboratory suggests that AI flexible control of transactional energy alone could reduce peaks loads by 9 to 15 percent, resulting in savings of up to $5 billion per year for the Texas grid (Hede, 2022).

Texas deregulation of the retail electric market has provided the Texas grid with the opportunity to innovate (Bean & Davies, 2020). As user demands for electric power changes, the Texas grid can use technology to continuously adapt to customer demands with improved products and services (Li & Zhang, 2024). While the Texas grid invests billions of dollars in technologies to collect and harvest data on rising demand, changing demand, supply patterns, efficiency and energy storage, without AI capabilities to analyze the data the Texas grid will be unable to optimizing their future energy planning (Ahmad et al., 2022). AI analysis can enhance the Texas grid's power supply stability and dependability to satisfy future customer needs with the development of individualized products and services (Li & Zhang, 2024). By using AI, the Texas grid can enhance the benefits from its digital transformation by increased operational

effectiveness, more efficient management and greater reliability of services for consumers (Li & Zhang, 2024).

Artificial Intelligence (AI)

This paper uses the National Institute of Standards and Technology (NIST) AI 100-1 Artificial Intelligence Risk Management Framework (AI RMF 1.0) definition of an AI system. An AI system is either an engineered or machine-based system, with varying degrees of autonomy, that can generate prediction, recommendation, or decision outputs from a set of objectives to influence real or virtual environments (National Institute of Standards and Technology, 2023). This definition of AI was adapted by NIST from the Organization for Economic Cooperation and Development (OECD) in ISO/IEC 22989:2022 (National Institute of Standards and Technology, 2023). ISO/IEC 22989:2022 is a foundational international standard used to develop other AI standards and support communications standards for a large group of stakeholders, including the electric sector (International Organization for Standardization, 2022).

Advantages of AI

AI is enabling the electric sector to transform, changing the array of products and services available to customers through improvements in efficiency, effectiveness and resilience of processes (Raden, 2023). The use of AI by the electric sector has the potential to provide better demand forecasting, improve automation, create safer working environments, lower costs, quicker decision making, predictive maintenance and quality optimization (Ahmad et al., 2022). The Texas grid's digital electric system will also encounter major changes with the use of digital workflow tools, data visualization tools, quantum computing, robotics and a variety of safety enhancements through the integration of AI within the network (Bean & Davies, 2020). Cybersecurity can also be enhanced through AI data-driven solutions, enabling the Texas grid to

have greater confidentiality, integrity and availability of its information and systems (Danish, 2023). AI can optimize the electricity consumption within the State of Texas and reduce system waste, while enhancing the overall reliability of the Texas grid (Rueda et al., 2024).

Disadvantages of AI

However, as with the adoption of all new technologies, there are downsides from the use of AI within the Texas grid. AI technologies can produce results that negatively impact individuals, organizations and society (National Institute of Standards and Technology, 2023). The electric sector must still incorporate AI into aging legacy infrastructure, conduct AI training, integrate large quantities of new data into its operations and information technology and develop processes for distributing information across its enterprises (Danish, 2023). Like risks from other types of technology, AI risks will emerge in the form of short-or long-term, idiosyncratic or systemic, low-or high-probability and/or low-or high-impact (National Institute of Standards and Technology, 2023).

AI algorithms can act like black-boxes, but their outputs must still be interpretable and explainable so the AI decisions can be understood by all stakeholders (Alsaigh et al., 2023). AI algorithms are developed by people, use imperfect data and contain biases so the Texas grid must assume the outcomes have flaws (Alsaigh et al., 2023). For AI to successfully integrate into the Texas grid, it is dependent on algorithm selection, data accuracy, evaluation expertise and realistic expectations of the outcomes (Danish, 2023). In addition to the technical challenges of advancing AI in the Texas grid, there are legal and regulatory requirements, data standardization issues, limited capabilities for experimentation and lack of experienced AI personnel to successfully transform the electric sector (Bean & Davies, 2020). AI without proper governance

or standards will most likely maximize for efficiency, effectiveness and reliability variables over human values, legal mandates and other societal priorities (Alsaigh et al., 2023).

All stakeholders involved with AI outcomes must understand how AI works to ensure confidence in AI systems and cooperation with AI integration, this requires allowing the stakeholders opportunities to contribute throughout all stages of AI development (National Institute of Standards and Technology, 2023). For the Texas grid to be successful implementing AI into the electric system, stakeholder participation must be created to understand and address all interested parties' problems and expectations, including AI limitations (Ahmad et al., 2021). Stakeholders should also be able to provide their inputs on best practices for privacy, protection, and ensuring customer trust with data storage, use and access (Ahmad et al., 2021). Complex electric systems have AI risks associated with their large numbers of variables from associated social, national, environmental, and geopolitical issues that could cause severe consequences if they are not managed carefully (Alsaigh et al., 2023). To make the integration of AI possible requires AI governance and standards to ensure long-term use of AI in the electric sector (Ahmad et al., 2022). To successfully implement and execute AI, the Texas grid will need to incorporate AI governance and standards into its daily operations.

AI Governance

AI governance cuts across business functions and must be incorporated throughout an organization in order to effectively manage AI risk within the enterprise (National Institute of Standards and Technology, 2023). To fully realize the benefits of the AI technology, it is critical to exercise governance to manage AI risks, but currently the field of AI governance is an understudied area of scholarship (Taeilhagh, 2021). Without a good AI governance system, AI standards can produce biased, unethical and/or immoral results that undermine the value of the

AI analysis (Naidoo, 2021). What is known is that AI systems must work effectively to reduce risk, which means they must be considered trustworthy and responsive to a wide variety of concerns from all interested parties (Ahmad et al., 2022). How an organization approaches that enhanced level of trust among all AI stakeholders can result in the reduction of future AI risks (Alsaigh et al., 2023). The NIST Artificial Intelligence Risk Management Framework (AI RMF) provides the characteristics for AI trustworthiness and the guidance on how to address AI trustworthiness issues (National Institute of Standards and Technology, 2023). Creating trust requires the careful balancing of each of these characteristics within the context of the electric sector AI usage (Danish, 2023). While all of these characteristics are important to the overall success of gaining trust in the use of AI, two characteristics, accountability and transparency, are critical to establishing trust within AI processes and activities (National Institute of Standards and Technology, 2023). AI users in the electric sector that neglect these characteristics increase both the probability and magnitude of potential AI risks and negative consequences in the electric sector (National Institute of Standards and Technology, 2023). To ensure proper AI outcomes, AI systems must incorporating AI governance based on trust within an enterprise's organizational behavior (Alsaigh et al., 2023). Good AI governance requires engaging in ethical, responsible, trustworthy AI applications and a clear understanding of all appropriate policies, regulations and concerns over the use of AI data and AI decision outcomes (Alsaigh et al., 2023).

Governance and oversight of AI tasks must have the full participation from management with the appropriate budgetary and legal authority for designing, developing, and/or deploying AI systems within the organization (National Institute of

Standards and Technology, 2023). The key personnel responsible for AI governance include senior management, senior leadership and the Board of Directors who are concerned with the long-term impact and sustainability of the organization (National Institute of Standards and Technology, 2023). AI governance includes AI elements of organizational behavior, such as responsibility and accountability in regulations, fairness, consumer protections and ethics in electric sector (Alsaigh et al., 2023).

AI Standards

Few existing U.S. statutes or regulations directly apply to AI, but private standards have slowly begun to emerge (Walters & Wiseman, 2023). According to ISO/IEC 42001, AI international standards specify the requirements for establishing, implementing, maintaining and continually improving processes for producing and/or using AI-based products or services responsibly (International Organization for Standardization, 2024). For organizations, such as the Texas grid, standards establish a structured way to manage AI risks and opportunities, while balancing the competing interests of AI innovation and AI governance (International Organization for Standardization, 2024). Current AI standards cannot achieve all AI policy goals, but today's AI standards are a first step towards effective long-term AI solutions for the electric sector (Cihon, 2019).

There are currently only two international organizations that have created AI standards that have been successfully implemented (Naidoo, 2021). First is the International Organization for Standardization (ISO) which has published over 3000 standards, addressing everything from programming languages to data security procedures (International Organization for Standardization, 2024). The second international standards body developing AI standards is Institute of Electrical and Electronic Engineers (IEEE), which is an engineers' professional

organization that creates standards for technical products such as the Ethernet and WiFi (Institute of Electrical and Electronic Engineers, 2024). At the core of each standard is guidance for how an organizational should behavior and how to judge if the behavior is being achieved (Cihon, 2019). In practice, standards define technical processes and products of systems and how they impact society.

Current Landscape of ISO AI Standards

The ISO brings together subject matter experts from around the world to reach a consensus on the best way of making a product or to manage a process (Walters & Wiseman, 2023). ISO was established to enable trade and cooperation between people and companies around the world easier, safer and better through standards (International Organization for Standardization, 2024). The following are the international standards approved and/or published by ISO that have a direct or indirect impact on the governance of AI in the electric sector:

1. ISO/IEC AWI TS 7709: Information technology, Big data, security and privacy – Addresses security and privacy guidelines for multi-sourced data processing, including how to mitigate identified security and privacy risks (International Organization for Standardization, 2024)
2. ISO/IEC 19075-8:2021: Information technology, guidance for the use of database language SQL Part 8: Multidimensional arrays. This document describes the definition and use of multidimensional arrays in SQL, which are critical to the underlying structure of databases for information systems (International Organization for Standardization, 2021).
3. ISO/IEC 20546:2019: Information technology, big data, overview and vocabulary. This document provides the terminology and definitions for improved communication and

understanding of big data standards (International Organization for Standardization, 2019).

4. ISO/IEC 20546:2019: Information technology, big data, overview and vocabulary: Framework and application process describes the big data architecture framework and processes for users to apply this information to domain problems (International Organization for Standardization, 2019).
5. ISO/IEC TR 20547-2:2018: Information technology, big data reference architecture, Part 2: Use cases and derived requirements for big data with application domains and technical issues (International Organization for Standardization, 2018).
6. ISO/IEC 20547-3:2020: Information technology, big data reference architecture, Part 3: Reference architecture describes big data reference architecture (BDRA), including concepts and architectural perspectives for users and functions (International Organization for Standardization, 2020).
7. ISO/IEC 20547-4:2020: Information technology, big data reference architecture, Part 4: Security and privacy specifies the aspects of big data reference architecture (BDRA) for big data and functional components, including guidance on big data security and privacy operations (International Organization for Standardization, 2020).
8. ISO/IEC TR 20547-5:2018: Information technology, big data reference architecture, Part 5: Standards roadmap describes current and future big data standards priorities based on gap analysis (International Organization for Standardization, 2018).
9. ISO/IEC 24668:2022: Information technology, artificial intelligence, Process management framework for big data analytics provides a framework to leverage big data

analytics for process management across the enterprise (International Organization for Standardization, 2022).

10. ISO/IEC 22989:2022: Information technology, artificial intelligence, Artificial intelligence concepts and terminology for AI development of other standards and support communications among interested parties and/or stakeholders (International Organization for Standardization, 2022).
11. ISO/IEC 22989:2022/AWI Amd 1: Information technology, artificial intelligence, Artificial intelligence concepts and terminology, Amendment 1, to ISO/IEC 22989:2022 terminology for AI development of other standards and support communications among interested parties and/or stakeholders (International Organization for Standardization, 2022).
12. ISO/IEC 23053:2022: Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML) establishes a framework for a generic AI system using ML technology, including the system components and their functions (International Organization for Standardization, 2022).
13. ISO/IEC 23053:2022/AWI Amd 1: Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML), Amendment 1, to the ISO/IEC 23053:2022 Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML) listed above (International Organization for Standardization, 2022).
14. ISO/IEC 42001:2023: Information technology, artificial intelligence, Management system establishes, implements, maintains, and continually improves an Artificial Intelligence Management System (AIMS) that can provide or be use for AI-based

products or services, based on ethics, transparency, and continuous learning (International Organization for Standardization, 2023).

15. ISO/IEC DIS 42006: Information technology, Artificial intelligence, Requirements for organizations providing audit and certification of artificial intelligence management systems. (International Organization for Standardization, 2024).
16. ISO/IEC/IEEE 42030:2019: Software, systems and enterprise, Architecture evaluation framework specifies the organizational means and records for architecture evaluations of enterprise, systems and software application (International Organization for Standardization, 2019).
17. ISO/TS 50011:2023: Energy management systems-Assessing energy management using ISO 50001:2018 measures the status of energy management based on structure management score (SMS), operation management score (OMS) and target achievement score (TAS) (International Organization for Standardization, 2023).
18. ISO/PAS 50010:2023: Energy management and energy savings, Guidance for net zero energy in operations using an ISO 50001 energy management system enables the use of an energy management system (EnMS) to achieve sustainability goals (International Organization for Standardization, 2023).
19. ISO 50001:2018: Energy management systems, Requirements with guidance for establishing, implementing, maintaining and improving an energy management system (EnMS) organization (International Organization for Standardization, 2018).
20. ISO 50001:2018/Amd 1:2024: Energy management systems, Requirements with guidance, Amendment 1, amends ISO 50001:2018 to enable EnMS organizations to

continuously improve energy performance (International Organization for Standardization, 2024).

21. ISO 50005:2021: Energy management systems, Guidelines for a phased approach to energy management system (EnMS) implementation (International Organization for Standardization, 2021).
22. ISO 50004:2020: Energy management systems, Guidance for the implementation, maintenance and improvement of an ISO 50001 energy management system. (International Organization for Standardization, 2020).
23. ISO 50009:2021: Energy management systems, Guidance for implementing a common energy management system in multiple organizations in accordance with ISO 50001:2018 (International Organization for Standardization, 2021).

Current Landscape of IEEE AI Standards

IEEE, like ISO, is a consensus building organization that promotes global technologies (Institute of Electrical and Electronic Engineers, 2024). IEEE brings together subject matter experts from different disciplines and global organizations to further standards development and collaboration to promote innovation, create and expand international markets and protect health and safety (Institute of Electrical and Electronic Engineers, 2024). The following are the international standards produced by IEEE that have a direct or indirect impact on the governance of AI in the electric sector:

1. IEEE 7000-2021: Model Process for Addressing Ethical Concerns During System Design standard are processes that enable systems to management and engineer transparent communication processes include ethical values throughout exploration and development (Institute of Electrical and Electronic Engineers, 2021).

2. IEEE 7001-2021: Standards for Transparency of Autonomous Systems enables the measurement and testing for transparency to enable autonomous systems to be objectively assessed and evaluated for compliance (Institute of Electrical and Electronic Engineers, 2021).
3. IEEE 7002: Standards for Data Privacy Process are requirements for systems/software engineering processes to ensure privacy considerations are met for all products, services, and systems using Personal Identifiable Information (PII) data. (Institute of Electrical and Electronic Engineers, 2022).
4. IEEE 7003: Standards for Algorithmic Bias Considerations describes processes and methodologies to address issues of bias in algorithms using criteria to select valid data sets, establish algorithm boundaries, prevent unintended consequences and set expectation management for system outputs (Institute of Electrical and Electronic Engineers, 2024).
5. IEEE 7005: Standards for Transparent Employer Data Governance provides specific methodologies to access, collect, store, use, share and destroy employee data, including metrics and rules-based criteria for first and third parties (Institute of Electrical and Electronic Engineers, 2021).
6. IEEE 7005-2021: Ontological Standard for Ethically Driven Robotics and Automation Systems establishes concepts, definitions and axioms for the ethical design of robots and automation systems (Institute of Electrical and Electronic Engineers, 2021).
7. IEEE 7008: Standard for Ethically Driven Nudging for Robotic, Intelligent and Autonomous Systems applies nudging theory in robotic, intelligent or autonomous

systems to prevent influence from user bad behaviors (Institute of Electrical and Electronic Engineers, 2024).

8. IEEE 7009: Standard for Fail-Safe Design of Autonomous and Semi-Autonomous Systems establishes methodologies and tools for effective fail-safe mechanisms in autonomous and semi-autonomous systems (Institute of Electrical and Electronic Engineers, 2024).
9. IEEE 7010-2020: IEEE Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems (A/IS) on Human Well-Being measures the impact of A/IS on humans (Institute of Electrical and Electronic Engineers, 2020).
10. IEEE 7010.1: Recommended Practice for Environmental Social Governance (ESG) and Social Development (SDG) Action Implementation and Advancing Corporate Social Responsibility provides initiatives and targets for ESG and SDG (Institute of Electrical and Electronic Engineers, 2024).
11. IEEE 7011: Standard for the Process of Identifying and Rating the Trustworthiness of News Sources provides semi-autonomous processes to create and maintain news purveyor ratings for public awareness (Institute of Electrical and Electronic Engineers, 2024).
12. IEEE 7012: Standard for Machine Readable Personal Privacy Terms enables organizations to identify and address which personal privacy terms are read and agreed to by machines (Institute of Electrical and Electronic Engineers, 2024).
13. IEEE 7014: Standard for Ethical consideration in Emulated Empathy in Autonomous and Intelligent Systems defines ethical considerations and practices for empathetic

technology to incorporate the states of emotions and cognition (Institute of Electrical and Electronic Engineers, 2024).

14. IEEE 7015: Standard for Data and Artificial Intelligence (AI) Literacy, Skills, and Readiness to coordinate global data and AI literacy efforts for designing policy, tracking progress and evaluating outcomes (Institute of Electrical and Electronic Engineers, 2024).
15. IEEE 7016: Standard for Ethically Aligned Designed and Operation of Metaverse Systems defines a methodology for ethical assessments of Metaverse system design and operation (Institute of Electrical and Electronic Engineers, 2024).
16. IEEE 7016.1: Standard for Ethically Aligned Educational Metadata in Extended Reality (XR) & Metaverse provides an overview of a data schema concept for ethical learning in accordance with IEEE 7000 (Institute of Electrical and Electronic Engineers, 2024).
17. IEEE 7017: Recommended Practice for Design-Centered Human-Robot Interaction (HRI) and Governance addresses compliance methodology and application by design for human-robot interaction (HRI) with robots that socially assist humans (Institute of Electrical and Electronic Engineers, 2024).
18. IEEE 7018: Standard for Security and Trustworthiness Requirements in Generative Pretrained Artificial Intelligence (AI) Models to prevent privacy concerns from leaking into the development, deployment, and use of generative pretrained AI models (Institute of Electrical and Electronic Engineers, 2024).

The two international standards organizations of ISO and IEEE have, through a consensus of subject matter experts, approved and/or published 41 AI product and process standards that may be applicable to the Texas grid. For the Texas grid, these AI standards establish a structured way to incorporate AI within the system while managing both AI risks and

opportunities. The 41 AI standards presented here can serve as the initial building blocks for the long-term implementation and execution of AI within the Texas grid. Today's AI standards, however, are just a first step towards effective long-term AI solutions for the Texas grid.

Enforcement of AI Standards

In practice, standards address either products or processes (International Organization for Standardization, 2024). Product standards define characteristics such as terminology, measurements, testing methods and labeling criteria, while process standards can describe elements of organizations to achieve explicit goals (Cihon, 2019). Supporting collaboration on industry best practices for AI products and processes will aid individual institutions, such as the Texas grid, in reducing waste of limited resource through unnecessary duplication of effort (Naidoo, 2021). Adopting common best practices standards can also enable individual organizations, such as the Texas grid, to increase their competitiveness (Cihon, 2019).

Once AI standards have been developed, implemented and executed on a regular basis, AI standards must then be enforced. Standards enforcement is divided into two categories: self-enforcement and external enforcement (Cihon, 2019). The majority of standards for AI products and processes are self-enforced where all parties involved have a shared self-interest for a standard to be enforced and a shared risk if a standard is not enforced (Cihon, 2019). The use of self-enforcement often leads to self-regulatory initiatives and voluntary codes of conduct to guide future AI design (Taeihagh, 2021). The electric sector is an example of an industry producing a common product where all of the components of the system must work together to be successful, therefore ensuring that all involved parties have a common interest in enforcing the standards.

Figure 1. International AI Standards (Self-Governance)

Self-Governance - Product	Self-Governance - Process
• **ISO/IEC 22989:2022/AWI Amd 1:** Information technology, artificial intelligence, Artificial intelligence concepts and terminology, Amendment 1 • **ISO/IEC 23053:2022:** Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML) • **ISO/IEC 23053:2022/AWI Amd 1:** Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML), Amendment 1 (Under development) • **ISO/IEC 42001:2023:** Information technology, artificial intelligence, Management system • **ISO/IEC/IEEE 42030:2019:** Software, systems and enterprise, Architecture evaluation framework • **ISO 50001:2018:** Energy management systems, Requirements with guidance for use • **ISO 50001:2018/Amd 1:2024:** Energy management systems, Requirements with guidance for use Amendment 1 • **ISO 50005:2021:** Energy management systems, Guidelines for a phased implementation • **ISO 50009:2021:** Energy management systems, Guidance for implementing a common energy management system in multiple organizations • **ISO/PAS 50010:2023:** Energy management and energy savings, Guidance for net zero energy in operations using an ISO 50001 energy management system • **ISO/TS 50011:2023:** Energy management systems — Assessing energy management using ISO 50001:2018 • **IEEE 7001-2021**: Standards for Transparency of Autonomous Systems • **IEEE 7005-2021:** Ontological Standard for Ethically Driven Robotics and Automation Systems • **IEEE 7010-2020:** Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems (A/IS) on Human Well-Being • **IEEE 7010.1:** Recommended Practice for Environmental Social Governance (ESG) and Social Development (SDG) Action Implementation and Advancing Corporate Social Responsibility • **IEEE 7012:** Standard for Machine Readable Personal Privacy Terms • **IEEE 7016:** Standard for Ethically Aligned Designed and Operation of Metaverse Systems • **IEEE 7016.1:** Standard for Ethically Aligned Educational Metadata in Extended Reality (XR) & Metaverse • **IEEE 7017:** Recommended Practice for Design-Centered Human-Robot Interaction (HRI) and Governance • **IEEE 7018:** Standard for Security and Trustworthiness Requirements in Generative Pretrained Artificial Intelligence (AI) Models	• **ISO/IEC 19075-8:2021:** Information technology, guidance for the use of database language SQL Part 8: Multidimensional arrays • **ISO/IEC 20546:2019:** Information technology, big data, overview and vocabulary • **ISO/IEC 20546:2019:** Information technology, big data, overview and vocabulary: Framework and application process • **ISO/IEC TR 20547-2:2018:** Information technology, big data reference architecture, Part 2: Use cases and derived requirements • **ISO/IEC 20547-3:2020:** Information technology, big data reference architecture, Part 3: Reference architecture • **ISO/IEC 20547-4:2020:** Information technology, big data reference architecture, Part 4: Security and privacy • **ISO/IEC TR 20547-5:2018:** Information technology, big data reference architecture, Part 5: Standards roadmap • **ISO/IEC 24668:2022:** Information technology, artificial intelligence, Process management framework for big data analytics • **ISO/IEC 22989:2022**: Information technology, artificial intelligence, Artificial intelligence concepts and terminology • **IEEE 7000-2021**: Model Process for Addressing Ethical Concerns During System Design • **IEEE 7002:** Standards for Data Privacy Process • **IEEE 7011:** Standard for the Process of Identifying and Rating the Trustworthiness of News Sources • **IEEE 7014:** Standard for Ethical consideration in Emulated Empathy in Autonomous and Intelligent Systems • **IEEE 7015:** Standard for Data and Artificial Intelligence (AI) Literacy, Skills, and Readiness

Corporate AI governance can also be used to manage, operate, regulate and finance its enterprise including legal status, investor relationships, internal and external information flows and operational decisions (Cihon, 2019). While there are many benefits of self-regulation for AI

governance, there is concern that self-regulation can lack adequate enforcement mechanisms and, in some cases, self-regulatory mechanisms should be mandatory to meet the common good, such as ethics, biases, pollution, privacy and health and safety (Walters & Wiseman, 2023). As a result of these common interests, corporate AI governance can have a profound impact on society (Cihon et al., 2021). Standards designed for the common good often provide no direct benefit to the parties involved in producing the process or product, therefore the involved parties receive no immediate or direct benefit from enforcing the standards (Cihon, 2019). In this case, voluntary self-regulatory governance cannot assure that the standards will always be subject to uniform enforcement (Taeihagh, 2021). The external governance of standards results in the cooperation by all involved parties only when a third-party government, institution or organization creates penalties and an external enforcement mechanism (Cihon, 2019). Some forms of AI governance must be built around a broader societal consensus emphasizing AI ethical principles and accountability (Taeihagh, 2021).

Corporations can benefit from both internal and external stakeholder inputs for institutional standards enforcement so that all parties involved are sufficiently incentivized to meet those standards (Cihon et al., 2021). To achieve these standard enforcement goals flexibility is necessary to build a consensus in AI systems design and AI governance that is applicable across geographical areas, social norms and legal jurisdictions in alignment with individual rights (Taeihagh, 2021). In general, standards requiring external enforcement, need institutions to create the initial standardization and subsequent enforcement by multiple methods, from regulatory mandates to contractual monitoring (Cihon, 2019).

Figure 2. International AI standards for Enforcement (External Governance)

External Governance - Product	External Governance - Process
• **ISO/IEC DIS 42006:** Information technology, Artificial intelligence, Requirements for bodies providing audit and certification of artificial intelligence management systems • **IEEE 7009:** Standard for Fail-Safe Design of Autonomous and Semi-Autonomous Systems	• **ISO/IEC AWI TS 7709:** Information technology, Big data, security and privacy • **IEEE 7003:** Standards for Algorithmic Bias Considerations • **IEEE 7005:** Standards for Transparent Employer Data Governance • **IEEE 7008:** Standard for Ethically Driven Nudging for Robotic, Intelligent and Autonomous Systems

The current number of AI standards are 41 and focused on a small number of AI traits and electric sector issues. Of the 41 AI standards reviewed for this paper, 34 AI standards are for self-governing products or processes and 7 AI standards required external governance. However, the review of available literature did not find any references to the existence of any external AI standards governance for the Texas grid at this time.

The ERCOT Strategic Plan 2024-2028 acknowledges that the grid is rapidly changing due to advancements in digitalization in operational and information technologies, but no references were found regarding AI standards or AI governance (Electric Reliability Council of Texas, 2024). ERCOT is still in the early stages of investing in cloud-based technologies, data analytics, advanced computing, AI and machine learning to handle the exponential growth of data within the system (Electric Reliability Council of Texas, 2024). The language in the ERCOT Strategic Plan 2024-2028 suggests that the Texas grid is just at the start of implementing AI into the system.

Practical Applicability

The electric sector, including the Texas grid, is undergoing tremendous technology changes. As a result of these technological changes and digitization of the electric sector, AI is becoming an essential component for improved operational efficiency, effectiveness and

resilience. While still in the early stages of AI adoption, the Texas grid has opportunity to enhance how these new digital technologies will impact the operations, safety and security of future generation, distribution, and consumption of electric power, while minimizing risk for the owners and operators. In order for the Texas grid to successfully handle the exponential growth of data generated by the new digital technology, the Texas grid will require investments of time and resources into AI. However, to successfully implement and execute AI within Texas grid's operations, AI governance and standards are also necessary to maximize AI decision support and predictive analytics for situational awareness and the response capabilities of the Texas grid.

This paper creates a template for the Texas grid to begin implementing and executing AI starting with the NIST AI 100-1 AI RMF 1.0 (National Institute of Standards and Technology, 2023). Next, ISO/IEC 22989:2022 should be used as a foundational international standard to develop other AI standards and supporting communications standards needed for the Texas grid (International Organization for Standardization, 2022).

A review of AI standards applicable for the Texas grid was conducted from both ISO and IEEE. The review of AI standards found 41 approved and published standards from ISO and IEEE that may be applicable for the Texas grid for integration into their operations and information technologies. The 41 AI standards address either products or processes. Product standards define characteristics for the Texas grid such as terminology, measurements, testing methods and labeling criteria, while process standards describe organizational actions to achieve specific AI goals. These 41 ISO and IEEE standards provide recommendations to help the Texas grid begin its transition to an AI driven organization.

This was followed by a review of AI governance, its relationship to AI standards and how AI governance is incorporated throughout an organization to effectively manage AI risk. Without

good AI governance system, AI standards can produce biased, unethical and/or illegal results that can undermine the future value of the AI analysis generated by the Texas grid. To ensure proper AI outcomes, future AI systems must be based on incorporating AI governance into the Texas grid.

Once AI standards have been developed, implemented and executed on a regular basis, AI standards must then be enforced. Standards enforcement is divided into two categories: self-enforcement and external enforcement. A total of 34 ISO and IEEE standards for AI products and processes are self-enforcement governance where all parties are within the organizations that constitute the Texas grid. However, standards designed for the common good may not provide any direct benefit to the Texas grid, and, therefore, there is no immediate or direct incentive to enforce the standards. This category of standards favors cooperation by all involved parties only if a third-party government, institution or organization exists to create penalties and an enforcement mechanism (Cihon, 2019). A total of 7 standards for AI products and processes require external enforcement governance since all interested parties are not within the organizations that constitute the Texas grid. The components of the Texas grid will have to work with appropriate external stakeholders so that the parties that adopted the standards are sufficiently incentivized by external demands to enforce the new standards. For the 7 standards requiring external enforcement, there were no institutions found that currently exist to put in place AI enforcement mechanisms for the Texas grid.

Conclusion

This paper has the potential to contribute to AI adoption in the electric sector by generating actionable recommendations. The adoption of current AI standards as well as possible future standards can further serve to support operational solutions within and among the

components of the Texas grid. Outside of the Texas grid, standards can drive the adoption of best practices more widely across the electric industry. A culture change is not easy, but enforced standards can help move this effort forward. The use of these initial standards will serve as a model not only for today, but for future standards, policies and regulation as AI system capabilities increase within the Texas grid.

As the Texas grid matures in its use of AI standards, the Texas grid will be able to identify its own best practices. These best practices will result in additional related AI standards, as observed in other industries. New standards, in turn, will enable the electric sector's AI terminology, best practices, mitigating strategies, monitoring, safety and certification methodology to grow. This will enable the Texas grid to incorporate a continuous cycling of AI process and product standards improvement. This paper has deepened the understanding of the use of AI standards and AI governance in the Texas grid. This new understanding of AI standards and AI governance in the Texas grid should aid government, industry, academics and other stakeholders in developing future AI design, operations, usage and risk management improvements. The outcomes presented in this paper may also be transferrable to other electric companies, government agencies, and stakeholders in other states for implementation to their practices, leading to improved operations and security beyond of the Texas grid.

Disclosure Statement.

The author is an independent AI researcher and has no affiliated with any companies, organizations or agencies mentioned in this paper. The author has no financial interests in any of the companies, organizations or agencies, nor was the author compensated by any of the companies, organizations or agencies for his work on this paper. Therefore, author has no competing interests with regard to this paper to declare.

Biographical Note:

The author is Dr. Thomas F. Watson, DSc in Civil Security Leadership, Management and Policy, from New Jersey City University, who works in the field of cyber insurance and its impact on operational cyber risk management in banking. He has worked for over 20 years in various senior positions related to critical infrastructure issues for the Center for Climate and Security (CCS), the Department of Homeland Security (DHS) and on the faculty of the Industrial College of the Armed Forces at the National Defense University. Currently he is working as an independent senior researcher.

References

Ahmad, T., Zhang, D., Huang, C., Zhang, H., Dai, H., Song, Y., & Chen, H. (2021). Artificial intelligence in sustainable energy industry: Status Quo, challenges and opportunities. *Journal of Cleaner Production, Volume 289*, 2021, 125834, ISSN 0959-6526. https://doi.org/10.1016/j.jclepro.2021.125834.

Ahmad, T., Zhu, H., Zhang, D., Tariq, R., Bassam, A., Ullah, F., Al Ghamdi, A.S., & Alshamrani, S.S. (2022). Energetics Systems and artificial intelligence: Applications of industry 4.0, *Energy Reports, Volume 8, 2022, Pages 334-361*, ISSN 2352-4847, https://doi.org/10.1016/j.egyr.2021.11.256

Alkhayat, G., Hasan, S. H., & Mehmood, R. (2022). Senergy: A novel deep learning- based auto-selective approach and tool for solar energy forecasting. *Energies*, 2022; 15(18):6659. https://doi.org/10.3390/en15186659

Alsaigh R., Mehmood R., & Katib I. (2023). AI explainability and governance in smart energy systems: A review. *Front. Energy Res*, 11:1071291. DOI: 10.3389/fenrg.2023.1071291

Andersen, G., Cleveland, M., & Shea, D. (2021). Modernizing the Electric Grid: State Role and Policy Options, *National Conference of State Legislatures (NCSL) website.* https://www.ncsl.org/energy/modernizing-the-electric-grid

Bean, G., & Davies, C. (2020). Digitization of the Energy Industry. *University of Houston/UH Energy and the Gutierrez Energy Management Institute.* https://uh.edu/uh-energy-innovation/uh-energy/energy-research/white-papers/white-paper-files/digitization-of-energy-industry-web.pdf

Cihon, P. (2019). Standards for AI governance: international standards to enable global coordination in AI research & development. *Future of Humanity Institute, University of Oxford*, 340-342. https://www.fhi.ox.ac.uk/wp-content/uploads/Standards_-FHI-Technical-Report.pdf

Cihon P., Schuett J., & Baum S.D. (2021). Corporate Governance of Artificial Intelligence in the Public Interest. *Information*. 2021; 12(7):275. https://doi.org/10.3390/info12070275

Cohn, J.A. (2022). "Connecting Past and Future: A History of Texas' Isolated Power Grid", *Rice University's Baker Institute for Public Policy, December 1, 2022*. https://doi.org/10.25613/dpmy-r389.

Danish, M. S. S. (2023). "AI in Energy: Overcoming Unforeseen Obstacles", *AI* 4, no. 2: 406-425. https://doi.org/10.3390/ai4020022

Electric Reliability Council of Texas. (2024, April). *About ERCOT*. https://www.ercot.com/about

Electric Reliability Council of Texas. (2024, June). *ERCOT Strategic Plan, 2024-2028.* https://www.ercot.com/files/docs/2023/08/25/ERCOT-Strategic-Plan-2024-2028.pdf

Hede, K. (2022). How a Smart Electric Grid Will Power Our Future, Reimagining the United States power grid could save consumers $50 billion a year. *DOE Newswise.com,* 25 January 2022, 8:05 AM EST, by the Pacific Northwest National Laboratory (PNNL). https://www.newswise.com/doescience/how-a-smart-electric-grid-will-power-our-future/?article_id=764299

Institute of Electrical and Electronic Engineers (IEEE). (2024). *IEEE at a Glance*. https://www.ieee.org/about/at-a-glance.htm

Institute of Electrical and Electronic Engineers (IEEE). (2021). *IEEE 7000™-2021 - Model Process for Addressing Ethical Concerns During System Design.* https://standards.ieee.org/ieee/7000/6781/

Institute of Electrical and Electronic Engineers (IEEE). (2021). *IEEE 7001™-2021 - Standards for Transparency of Autonomous Systems.* https://standards.ieee.org/ieee/7001/6929/

Institute of Electrical and Electronic Engineers (IEEE). (2022). *IEEE P7002™-2022 - Standard for Data Privacy Process*. https://standards.ieee.org/ieee/7002/6898/

Institute of Electrical and Electronic Engineers (IEEE). (2024, June). *IEEE P7003™ - Standard for Algorithmic Bias Considerations*. https://standards.ieee.org/ieee/7003/11357/

Institute of Electrical and Electronic Engineers (IEEE). (2021). *IEEE 7005™-2021 - Standard for Transparent Employer Data Governance*. https://standards.ieee.org/ieee/7005/7014/

Institute of Electrical and Electronic Engineers (IEEE). (2021). *IEEE 7007™-2021 - Ontological Standard for Ethically Driven Robotics and Automation Systems*. https://standards.ieee.org/ieee/7007/7070/

Institute of Electrical and Electronic Engineers (IEEE). (2024, June). *IEEE P7008™ - Standard for Ethically Driven Nudging for Robotic, Intelligent and Autonomous Systems.* Retrieved June 9, 2024, from https://standards.ieee.org/ieee/7008/7095/

Institute of Electrical and Electronic Engineers (IEEE). (2024). *IEEE P7009™-2024 - Standard for Fail-Safe Design of Autonomous and Semi-Autonomous Systems.* https://standards.ieee.org/ieee/7009/7096/

Institute of Electrical and Electronic Engineers (IEEE). (2020). *IEEE 7010™-2020 - IEEE Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems on Human Well-being*. https://standards.ieee.org/ieee/7010/7718/

Institute of Electrical and Electronic Engineers (IEEE). (2024, June). *IEEE P7010.1™ - Recommended Practice for Environmental Social Governance (ESG) and Social Development*

Goal (SDG) Action Implementation and Advancing Corporate Social Responsibility. Retrieved June 9, 2024, from https://standards.ieee.org/ieee/7010.1/10756/

Institute of Electrical and Electronic Engineers (IEEE). (2024, June). *IEEE P7011™ - Standard for the Process of Identifying and Rating the Trustworthiness of News Sources*. Retrieved June 9, 2024, from https://standards.ieee.org/ieee/7011/7191/

Institute of Electrical and Electronic Engineers (IEEE). (2024, June). *IEEE P7012™ - Standard for Machine Readable Personal Privacy Terms*. Retrieved June 9, 2024, from https://standards.ieee.org/ieee/7012/7192/

Institute of Electrical and Electronic Engineers (IEEE). (2024). *IEEE P7014™-2024 - Standard for Ethical considerations in Emulated Empathy in Autonomous and Intelligent Systems*. https://standards.ieee.org/ieee/7014/7648/

Institute of Electrical and Electronic Engineers (IEEE). (2024, June). *IEEE P7015™ - Standard for Data and Artificial Intelligence (AI) Literacy, Skills, and Readiness*. https://standards.ieee.org/ieee/7015/10688/

Institute of Electrical and Electronic Engineers (IEEE). (2024, June). *IEEE P7016™ - Standard for Ethically Aligned Design and Operation of Metaverse Systems*. https://standards.ieee.org/ieee/7016/11178/

Institute of Electrical and Electronic Engineers (IEEE). (2024, June). *IEEE P7016.1™ - Standard for Ethically Aligned Educational Metadata in Extended Reality (XR) & Metaverse*. Retrieved June 9, 2024, from https://standards.ieee.org/ieee/7016.1/11237/

Institute of Electrical and Electronic Engineers (IEEE). (2024, June). *IEEE P7017™ - Recommended Practice for Design-Centered Human-Robot Interaction (HRI) and Governance*. Retrieved June 9, 2024, from https://standards.ieee.org/ieee/7017/11133/

Institute of Electrical and Electronic Engineers (IEEE). (2024, June). *IEEE P7018™ - Standard for Security and Trustworthiness Requirements in Generative Pretrained Artificial Intelligence (AI) Models*. Retrieved June 9, 2024, from https://standards.ieee.org/ieee/7018/11306/

International Organization for Standardization (ISO). (2024, June). *About ISO*. https://www.iso.org/about

International Organization for Standardization (ISO). (2024, June). *ISO/IEC AWI TS 7709: Information technology, Big data security and privacy - Security and privacy preserving guidelines for multi-sourced data processing*. Retrieved June 9, 2024, from https://www.iso.org/standard/82889.html

International Organization for Standardization (ISO). (2021). *ISO/IEC 19075-8:2021: Information technology, Guidance for the use of database language SQL Part 8: Multidimensional arrays*. https://www.iso.org/standard/78939.html

International Organization for Standardization (ISO). (2019). *ISO/IEC 20546:2019: Information technology, Big data, Overview and vocabulary.* https://www.iso.org/standard/68305.html

International Organization for Standardization (ISO). (2020). *ISO/IEC TR 20547-1:2020: Information technology, Big data reference architecture, Part 1: Framework and application process*. https://www.iso.org/standard/71275.html

International Organization for Standardization (ISO). (2018). *ISO/IEC TR 20547-2:2018: Information technology, Big data reference architecture, Part 2: Use cases and derived requirements*. https://www.iso.org/standard/71276.html

International Organization for Standardization (ISO). (2020). *ISO/IEC 20547-3:2020: Information technology, Big data reference architecture, Part 3: Reference architecture*. https://www.iso.org/standard/71277.html

International Organization for Standardization (ISO). (2020). *ISO/IEC 20547-4:2020: Information technology, Big data reference architecture, Part 4: Security and privacy*. https://www.iso.org/standard/71278.html

International Organization for Standardization (ISO). (2018). *ISO/IEC TR 20547-5:2018: Information technology, Big data reference architecture, Part 5: Standards roadmap*. https://www.iso.org/standard/72826.html

International Organization for Standardization (ISO). (2022). *ISO/IEC 24668:2022: Information technology, Artificial intelligence, Process management framework for big data analytics*. https://www.iso.org/standard/78368.html

International Organization for Standardization (ISO). (2022). *ISO/IEC 22989:2022: Information technology, Artificial intelligence, Artificial intelligence concepts and terminology*. https://www.iso.org/standard/74296.html

International Organization for Standardization (ISO). (2022). *ISO/IEC 22989:2022/AWI Amd 1: Information technology, Artificial intelligence, Artificial intelligence concepts and terminology, Amendment 1*. https://www.iso.org/standard/88145.html

International Organization for Standardization (ISO). (2022). *ISO/IEC 23053:2022: Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML)*. https://www.iso.org/standard/74438.html

International Organization for Standardization (ISO). (2022). *ISO/IEC 23053:2022/AWI Amd 1: Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML), Amendment 1 (Under development)*. https://www.iso.org/standard/88149.html

International Organization for Standardization (ISO). (2023). *ISO/IEC 42001:2023: Information technology, Artificial intelligence, Management system*. https://www.iso.org/standard/81230.html

International Organization for Standardization (ISO). (2024, June). *ISO/IEC DIS 42006: Information technology, Artificial intelligence, Requirements for bodies providing audit and certification of artificial intelligence management systems*. Retrieved June 9, 2024, from https://www.iso.org/standard/44546.html

International Organization for Standardization (ISO). (2019). *ISO/IEC/IEEE 42030:2019: Software, systems and enterprise, Architecture evaluation framework*. https://www.iso.org/standard/73436.html

International Organization for Standardization (ISO). (2023). *ISO/TS 50011:2023: Energy management systems — Assessing energy management using ISO 50001:2018*. https://www.iso.org/standard/81286.html

International Organization for Standardization (ISO). (2023). *ISO/PAS 50010:2023: Energy management and energy savings, Guidance for net zero energy in operations using an ISO 50001 energy management system*. https://www.iso.org/standard/51873.html

International Organization for Standardization (ISO). (2018). *ISO 50001:2018: Energy management systems, Requirements with guidance for use*. https://www.iso.org/standard/69426.html

International Organization for Standardization (ISO). (2024). *ISO 50001:2018/Amd 1:2024: Energy management systems, Requirements with guidance for use Amendment 1: Climate action changes*. https://www.iso.org/standard/88430.html

International Organization for Standardization (ISO). (2021). *ISO 50005:2021: Energy management systems, Guidelines for a phased implementation*. https://www.iso.org/standard/76428.html

International Organization for Standardization (ISO). (2021). *ISO 50009:2021: Energy management systems, Guidance for implementing a common energy management system in multiple organizations*. https://www.iso.org/standard/51872.html

International Organization for Standardization (ISO). (2020). *ISO 50004:2020: Energy management systems, Guidance for the implementation, maintenance and improvement of an ISO 50001 energy management system*. https://www.iso.org/standard/74863.html

Li, X., & Zhang, S. (2024). Management mode and path of digital transformation of power grid enterprises based on artificial intelligence algorithm, *International Journal of Thermofluids, Volume 21, 2024, 100552, ISSN 2666-2027.* https://doi.org/10.1016/j.ijft.2023.100552.

Naidoo, M. (2021). "Artificial Intelligence and Global Governance: How AI Ethics and Standards Should Be Addressed at the Global Level", *The IJournal: Student Journal of the*

Faculty of Information 7 (1). Toronto, Canada:1–12. https://doi.org/10.33137/ijournal.v7i1.37894

National Institute of Standards and Technology (NIST), US Department of Commerce. (2023). Artificial Intelligence Risk Management Framework (AI RMF 1.0). https://nvlpubs.nist.gov/nistpubs/ai/NIST.AI.100-1.pdf

Raden, N. (2023). AI Revolutionizes the Energy Industry: From Grid Optimization to Data Management. *Media.com*. https://nraden.medium.com/ai-revolutionizes-the-energy-industry-from-grid-optimization-to-data-management-a8e15c79853b

Rueda, I.A., van Soest, H., & Park, H.M. (2024). The Promise and Peril of AI in the Power Grid. *The National Interest.* https://nationalinterest.org/blog/techland/promise-and-peril-ai-power-grid-208858

Taeihagh, A. (2021). Governance of artificial intelligence, *Policy and Society,* Volume 40, Issue 2, June 2021, Pages 137–157. https://doi.org/10.1080/14494035.2021.1928377

Walters, D.E., & Wiseman, H.J. (2023). "Self-regulation in Emerging and Innovative Industries". *Law & Economics Center at George Mason University Scalia Law School* Research Paper Series No. 22-033. https://ssrn.com/abstract=4226081or http://dx.doi.org/10.2139/ssrn.4226081

Zhang, G., Zhong, H., Tan, Z., Cheng, T., Q. Xia, Q., & Kang, C. (2022). "Texas electric power crisis of 2021 warns of a new blackout mechanism," in *CSEE Journal of Power and Energy Systems*, vol. 8, no. 1, pp. 1-9, Jan. 2022. doi: 10.17775/CSEEJPES.2021.07720.

Appendix A

International Standards Organization (ISO) Artificial Intelligence (AI) Related Standards for the Electric Sector

1. **ISO/IEC AWI TS 7709:** Information technology, Big data security and privacy - Security and privacy preserving guidelines for multi-sourced data processing; https://www.iso.org/standard/82889.html

2. **ISO/IEC 19075-8:2021:** Information technology, Guidance for the use of database language SQL Part 8: Multidimensional arrays; https://www.iso.org/standard/78939.html

3. **ISO/IEC 20546:2019:** Information technology, Big data, Overview and vocabulary; https://www.iso.org/standard/68305.html

4. **ISO/IEC TR 20547-1:2020:** Information technology, Big data reference architecture, Part 1: Framework and application process; https://www.iso.org/standard/71275.html

5. **ISO/IEC TR 20547-2:2018:** Information technology, Big data reference architecture, Part 2: Use cases and derived requirements; https://www.iso.org/standard/71276.html

6. **ISO/IEC 20547-3:2020:** Information technology, Big data reference architecture, Part 3: Reference architecture; https://www.iso.org/standard/71277.html

7. **ISO/IEC 20547-4:2020:** Information technology, Big data reference architecture, Part 4: Security and privacy; https://www.iso.org/standard/71278.html

8. **ISO/IEC TR 20547-5:2018:** Information technology, Big data reference architecture, Part 5: Standards roadmap; https://www.iso.org/standard/72826.html

9. **ISO/IEC 24668:2022:** Information technology, Artificial intelligence, Process management framework for big data analytics; https://www.iso.org/standard/78368.html

10. **ISO/IEC 22989:2022:** Information technology, Artificial intelligence, Artificial intelligence concepts and terminology; https://www.iso.org/standard/74296.html

11. **ISO/IEC 22989:2022/AWI Amd 1:** Information technology, Artificial intelligence, Artificial intelligence concepts and terminology, Amendment 1; https://www.iso.org/standard/88145.html

12. **ISO/IEC 23053:2022:** Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML); https://www.iso.org/standard/74438.html

13. **ISO/IEC 23053:2022/AWI Amd 1:** Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML), Amendment 1 (Under development); https://www.iso.org/standard/88149.html

14. **ISO/IEC 42001:2023:** Information technology, Artificial intelligence, Management system; https://www.iso.org/standard/81230.html

15. **ISO/IEC DIS 42006:** Information technology, Artificial intelligence, Requirements for bodies providing audit and certification of artificial intelligence management systems; https://www.iso.org/standard/44546.html

16. **ISO/IEC/IEEE 42030:2019:** Software, systems and enterprise, Architecture evaluation framework; https://www.iso.org/standard/73436.html

17. **ISO/TS 50011:2023:** Energy management systems — Assessing energy management using ISO 50001:2018; https://www.iso.org/standard/81286.html

18. **ISO/PAS 50010:2023:** Energy management and energy savings, Guidance for net zero energy in operations using an ISO 50001 energy management system; https://www.iso.org/standard/51873.html

19. **ISO 50001:2018/Amd 1:2024:** Energy management systems, Requirements with guidance for use Amendment 1: Climate action changes; https://www.iso.org/standard/88430.html

20. **ISO 50001:2018:** Energy management systems, Requirements with guidance for use; https://www.iso.org/standard/69426.html

21. **ISO 50005:2021:** Energy management systems, Guidelines for a phased implementation; https://www.iso.org/standard/76428.html

22. **ISO 50009:2021:** Energy management systems, Guidance for implementing a common energy management system in multiple organizations; https://www.iso.org/standard/51872.html

23. ISO 50004:2020: Energy management systems, Guidance for the implementation, maintenance and improvement of an ISO 50001 energy management system; https://www.iso.org/standard/74863.html

Appendix B

Institute of Electrical and Electronic Engineers (IEEE) AI Related Standards for the Electric Sector

1. **IEEE 7000™-2021 - Model Process for Addressing Ethical Concerns During System Design:** This standard outlines an approach for identifying and analyzing potential ethical issues in a system or software program from the onset of the effort.
2. **IEEE 7001™-2021 - Standards for Transparency of Autonomous Systems:** This standard describes measurable, testable levels of transparency, so that autonomous systems can be objectively assessed and levels of compliance determined
3. **IEEE P7002™ - Standard for Data Privacy Process:** This standard specifies how to manage privacy issues for systems or software that collect personal data.
4. **IEEE P7003™ - Standard for Algorithmic Bias Considerations:** This standard describes specific methodologies to help users certify how they worked to address and eliminate issues of negative bias in the creation of their algorithms, where "negative bias" infers the usage of overly subjective or uniformed data sets or information known to be inconsistent with legislation concerning certain protected characteristics; or with instances of bias against groups not necessarily protected explicitly by legislation, but otherwise diminishing stakeholder or user well-being and for which there are good reasons to be considered inappropriate.
5. **IEEE 7005™-2021 - Standard for Transparent Employer Data Governance:** The standard defines specific methodologies to help employers to certify how they approach accessing, collecting, storing, utilizing, sharing, and destroying employee data.
6. **IEEE 7007™-2021 - Ontological Standard for Ethically Driven Robotics and Automation Systems:** The standard establishes a set of ontologies with different abstraction levels that contain concepts, definitions and axioms which are necessary to establish ethically driven methodologies for the design of Robots and Automation Systems.
7. **IEEE P7008™ - Standard for Ethically Driven Nudging for Robotic, Intelligent and Autonomous Systems:** "Nudges" as exhibited by robotic, intelligent or autonomous systems are defined as overt or hidden suggestions or manipulations designed to influence the behavior or emotions of a user.
8. **IEEE P7009™ - Standard for Fail-Safe Design of Autonomous and Semi-Autonomous Systems:** This standard establishes a practical, technical baseline of specific methodologies and tools for the development, implementation, and use of effective fail-safe mechanisms in autonomous and semi-autonomous systems.
9. **IEEE 7010™-2020 - IEEE Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems on Human Well-being:** Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems (A/IS) on Human Well-being is a recommended practice for measuring the impact of A/IS on humans.
10. **IEEE P7010.1™ - Recommended Practice for Environmental Social Governance (ESG) and Social Development Goal (SDG) Action Implementation and Advancing Corporate Social Responsibility:** IEEE Standards Project to provide recommendations for next steps in the application of IEEE Std 7010, applied to meeting Environmental Social Governance (ESG) and Social Development Goal (SDG) initiatives and targets.

11. **IEEE P7011™ - Standard for the Process of Identifying and Rating the Trustworthiness of News Sources:** This standard provides semi-autonomous processes using standards to create and maintain news purveyor ratings for purposes of public awareness.
12. **IEEE P7012™ - Standard for Machine Readable Personal Privacy Terms:** The standard identifies/addresses the manner in which personal privacy terms are proffered and how they can be read and agreed to by machines.
13. **IEEE P7014™ - Standard for Ethical considerations in Emulated Empathy in Autonomous and Intelligent Systems:** This standard defines a model for ethical considerations and practices in the design, creation and use of empathic technology, incorporating systems that have the capacity to identify, quantify, respond to, or simulate affective states, such as emotions and cognitive states.
14. **IEEE P7015™ - Standard for Data and Artificial Intelligence (AI) Literacy, Skills, and Readiness:** IEEE Standards Project to coordinate global data and AI literacy building efforts, this standard establishes an operational framework and associated capabilities for designing policy interventions, tracking their progress, and empirically evaluating their outcomes.
15. **IEEE P7016™ - Standard for Ethically Aligned Design and Operation of Metaverse Systems:** This standard defines a methodology for creating possible Metaverse systems.
16. **IEEE P7016.1™ - Standard for Ethically Aligned Educational Metadata in Extended Reality (XR) & Metaverse:** This standard defines a high-level overview of a conceptual data schema for a metadata instance based on ethics concepts for a learning object utilized within XR systems and Metaverse applications.
17. **IEEE P7017™ - Recommended Practice for Design-Centered Human-Robot Interaction (HRI) and Governance:** This recommended practice describes the methodology and application of 'compliance by design' in the area of human-robot interaction (HRI) with regard to socially assistive robots.
18. **IEEE P7018™ - Standard for Security and Trustworthiness Requirements in Generative Pretrained Artificial Intelligence (AI) Models:** This standard establishes a comprehensive framework for mitigating security risks, privacy leaking in the development, deployment, and use of generative pretrained AI models.

INSTITUTE FOR HOMELAND SECURITY

Sam Houston State University

The Institute for Homeland Security at Sam Houston State University is focused on building strategic partnerships between public and private organizations through education and applied research ventures in the critical infrastructure sectors of Transportation, Energy, Chemical, Healthcare, and Public Health.

The Institute is a center for strategic thought with the goal of contributing to the security, resilience, and business continuity of these sectors from a Texas Homeland Security perspective. This is accomplished by facilitating collaboration activities, offering education programs, and conducting research to enhance the skills of practitioners specific to natural and human caused Homeland Security events.

Institute for Homeland Security
Sam Houston State University

Watson, Thomas F. (2024) Artificial Intelligence Governance and Standards Guidance for the Texas Grid. (Report No. IHS/CR-2024-1019). The Sam Houston State University Institute for Homeland Security.
https://doi.org/10.17605/OSF.IO/F7VH8