



10-30-2023

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### Recommended Citation

Rahman, Farishta and Ranganathan, Prakash, "Empowering Resilience: Insights from ChatGPT on the Texas 2021 Power Outage" (2023). *Electrical Engineering Posters and Presentations*. 3.  
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# Empowering Resilience: Insights from ChatGPT on the Texas 2021 Power Outage

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## Abstract

This poster explores the symbiosis of energy resilience and AI support, using the Texas blackout of 2021 as a lens. Delving into causes, constraints, and financial impacts, it uncovers vulnerabilities in energy systems. Introducing ChatGPT, the poster emphasizes the synergy of cutting-edge AI in crisis response. Bridging technology, resilience strategies, and policy implications, it offers a succinct narrative on fortifying energy grids amidst growing demands and extreme weather events.

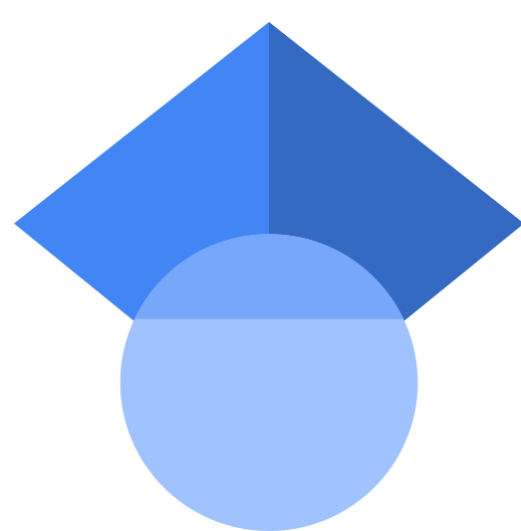
## Scholarly articles and Government Websites

### Causes:

1. Lack of Winterization of Power Equipment [1]
2. Extreme Cold [1]
3. Natural Gas Pipelines Freezing [1]
4. No Storage of Renewable Energy [1]
5. Inadequate Planning [2]

### Impacts:

- Impact on Health [1]
- Impact on Economy [3]
- Impact on Social Life [4]



## Technical Recommendations:

Recommendations	Benefits	Feasibility of Implementation	Cost
<b>Combined Heat and Power (CHP)</b>	It will protect the facility from freezing due to extreme cold and reduce waste of heat	CHP technology may be implemented rapidly and affordably	Low [5, 6]
<b>Battery Energy Storage System (BESS)</b>	Creating backup during blackouts	Does not require much implementation	Low [7, 8]
<b>Distributed Energy Resources Management System (DERMS)</b>	Active monitoring of grid conditions and real-time intervention for periods of instability	Requires necessary infrastructure in place (DGs, DERs)	High [9]
<b>Advanced Distribution Management System (ADMS)</b>	Getting beforehand notifications from the problematic equipment in order to avoid any possible failures	Requires pre-installation and field surveys	Medium [10]
<b>Reducing vegetation around transmission lines</b>	This will prevent trees from falling on the transmission lines during any storms	Requires pre-planning of positioning the transmission lines in accordance with the surroundings	Low [11, 12]
<b>Conservation of energy</b>	Powering down unused equipment and reducing the use of high-power equipment will help in conserving the energy by saving for the rainy day	Requires planning of how to minimize the use of unnecessary electric equipment	Low [13]

## Recommendations given by FERC and NERC [14]:

- Generator Cold Weather Reliability
- Natural Gas Infrastructure Cold Weather Reliability
- Gas-Electric Coordination Cold Weather Reliability
- Electric Grid Operations Cold Weather Reliability

## Introduction

This poster synthesizes interdisciplinary research on utilizing artificial intelligence, specifically models like ChatGPT, to learn about the preventive measures during weather emergencies, using the February 2021 Texas power grid disaster as a case study. The review consolidates key findings regarding proposed applications of such AI systems for grid operations, including weather emergency preparation, outage prediction, and crisis response coordination. Insights gained aim to formally delineate the capabilities and limitations of ChatGPT-like AI technologies to inform strategies for judicious adoption that maximizes utility for disaster prevention while minimizing hazards of misuse [1].

## ChatGPT

### Causes:

1. Extreme Weather
2. Power Generation Failures
3. Natural Gas Shortages
4. Renewable Energy Challenges
5. Grid Unpreparedness
6. Inadequate Planning
7. Limited Interconnectivity
8. Communication Issues



### Impacts:

- What were the impacts of the blackout?
- The 2021 Texas power blackout had widespread and significant impacts, affecting various aspects of life and infrastructure:
- Loss of Power:** Millions of households and businesses experienced power outages, leaving them without heating, lighting, and essential services during extremely cold temperatures.
  - Water Supply Disruptions:** Water treatment plants and pumping stations were affected, leading to disruptions in water supply. Many residents faced challenges accessing clean water for drinking and sanitation.
  - Transportation Issues:** Roads became hazardous due to icy conditions, limiting transportation. Public transit services were disrupted, and travel was challenging for emergency responders.
  - Health and Safety Concerns:** The lack of power and heating posed health risks, especially for vulnerable populations. Medical facilities faced challenges, and individuals struggled to stay warm and safe.
  - Economic Losses:** Businesses, particularly those in the energy sector, suffered economic losses. The outage disrupted production and supply chains, leading to financial setbacks.
  - Energy Price Surge:** Electricity prices surged during the crisis, resulting in high bills for consumers. The financial burden added to the challenges faced by individuals and businesses.
  - Impact on Agriculture:** Livestock and crops were affected by the extreme cold, leading to losses in the agricultural sector.
  - Communication Breakdowns:** Communication networks faced disruptions, hindering emergency response efforts and public communication.
  - Social Disruptions:** Schools, workplaces, and community services were disrupted, impacting daily life and social activities.
  - Loss of Life:** Tragically, there were reports of fatalities related to the extreme weather conditions and challenges posed by the power outage.

### Technical Recommendations:

- What are the technical recommendations to prevent such blackouts in the future? Give bullet points with cost comparison
- Winterization Measures:**
    - Cost: Varies based on facility size and technology.
    - Consideration: Initial investment offset by potential savings from prevented outages.
  - Diversify Energy Sources:**
    - Cost: Initial investment in new infrastructure.
    - Consideration: Long-term benefits in resilience, reduced dependence.
  - Grid Modernization:**
    - Cost: Significant upfront investment.
    - Consideration: Long-term benefits in efficiency, reduced downtime.
  - Interconnectivity:**
    - Cost: Infrastructure investment.
    - Consideration: Enhanced reliability and shared resource benefits.
  - Advanced Weather Forecasting:**
    - Cost: Investment in technology and data analysis.
    - Consideration: Improved preparedness and proactive response.
  - Demand Response Programs:**
    - Cost: Implementation and promotion expenses.
    - Consideration: Potential cost savings during peak demand.
  - Smart Grid Technologies:**
    - Cost: Upfront investment in technology.
    - Consideration: Long-term benefits in efficiency and adaptability.
  - Energy Storage Solutions:**
    - Cost: Significant upfront investment.
    - Consideration: Long-term benefits in stability and flexibility.
  - Critical Infrastructure Protection:**
    - Cost: Investment in cybersecurity measures.
    - Consideration: Protection against potential costly cyber threats.
  - Research and Development:**
    - Cost: Ongoing investment in innovation.
    - Consideration: Addresses emerging challenges, long-term benefits.
  - Regular Maintenance:**
    - Cost: Ongoing operational expenses.
    - Consideration: Prevents unexpected failures, potential cost savings.

## Recommendations given by FERC and NERC:

What are the recommendations given by FERC and NERC for these blackouts?

- As of my last knowledge update in September 2021, the Federal Energy Regulatory Commission (FERC) and the North American Electric Reliability Corporation (NERC) continuously provide recommendations and guidelines for enhancing the reliability and resilience of the electric grid. However, specific recommendations may evolve, and it's crucial to check their latest publications or updates for the most current information.
- As of my last update, some general recommendations and areas of focus from FERC and NERC include:
- Grid Modernization:**
    - Invest in modernizing the electric grid to improve its efficiency, reliability, and ability to handle evolving challenges.
  - Resilience Planning:**
    - Develop comprehensive resilience plans that account for various threats, including extreme weather events, cyber threats, and physical attacks.
  - Interconnection and Coordination:**
    - Enhance interconnection between different regions and entities to facilitate the sharing of resources and improve overall grid reliability.
  - Critical Infrastructure Protection:**
    - Implement robust cybersecurity measures to protect critical infrastructure from cyber threats and attacks.
  - Weatherization and Preparedness:**
    - Encourage utilities and power plants to implement weatherization measures, especially in regions prone to extreme weather events.
  - Information Sharing:**
    - Facilitate improved information sharing between grid operators, utilities, and relevant stakeholders to enhance situational awareness and response capabilities.
  - Reliability Standards Compliance:**
    - Ensure compliance with reliability standards set by NERC to maintain the reliability and security of the bulk power system.
  - Investment in Research and Development:**
    - Support research and development initiatives to advance technologies and strategies that enhance grid resilience and address emerging challenges.
- It's essential to regularly check the official websites of FERC and NERC for the latest recommendations, guidelines, and regulatory updates related to grid reliability and resilience. Additionally, specific recommendations may be provided in response to investigations following major grid events, such as the Texas power outage in 2021.

Provide the references of the recommendations you gave

- I don't have specific references for the recommendations I provided earlier, as they are based on general knowledge and common strategies for enhancing grid resilience. However, I can guide you on where to find more detailed and specific information:
- Federal Energy Regulatory Commission (FERC):**
    - FERC regularly releases reports, guidelines, and recommendations related to grid reliability and resilience. You can find these on their official website: [FERC Website](#)
  - North American Electric Reliability Corporation (NERC):**
    - NERC publishes reliability standards, assessments, and reports on their website: [NERC Website](#)
  - Academic Journals:**
    - Scholarly articles on grid resilience, energy infrastructure, and recommendations can be found in academic journals. Utilize databases like PubMed, IEEE Xplore, JSTOR, or Google Scholar to search for specific research articles.
  - Energy Research Organizations:**
    - Explore reports and publications from energy research organizations such as the Electric Power Research Institute (EPRI) or research centers at universities focusing on energy studies.
  - Government Reports:**
    - Check for reports from government agencies involved in energy and grid management, such as the Department of Energy (DOE).
- Remember to use specific keywords related to your topic of interest when searching these sources. Access to some publications may require a subscription or institutional access. If you have access to a university or academic institution, their library services can be valuable in obtaining scholarly articles and reports.

## Conclusions

In summary, this poster highlights the vital link between technology and resilience in addressing energy crises, using the Texas 2021 Power Outage as a revealing case. ChatGPT, as a real-time insights provider, showcases AI's potential in grid fortification. The convergence of advanced tech, policy, and proactive measures is key. In the face of increasing demands and climate uncertainties, the poster prompts reflection on ChatGPT's pivotal role in bolstering preparedness, response, and recovery for a resilient energy future.

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## Acknowledgements

I would like to acknowledge my supervisor, Dr. Prakash Ranganathan for his invaluable guidance, encouragement, and support throughout the course of this research.

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