

Genre Unit Project:

The switch to clean power, and the infrastructure needed to make it happen.

Over the recent few decades, the switch to clean power, whether nuclear, solar, wind, geothermal, or other sources, has seen significant development within the generation methods. The infrastructure needed to sustain such power resources needs significant improvement, and fast. As Oil is starting to dwindle, and coal is killing our environment, the need for alternative power generation is growing, and in order to do so, many laws and regulations need to be passed for a net-zero emission world to be a reality.

Research Log Entry [1]

Source Title:

Smart Grid Integration of Renewable Energy Systems

Source Authors:

Ahsan Shahid EIC IEEE TVCG, University of Maryland at College Park

Source type and location:

Scholarly journal article

Citation:

A. Shahid, "Smart Grid Integration of Renewable Energy Systems," 2018 7th International Conference on Renewable Energy Research and Applications (ICRERA), Paris, France, 2018, pp. 944-948, doi: 10.1109/ICRERA.2018.8566827. keywords: {Renewable energy sources;Smart grids;Inverters;Power system reliability;Reliability;Voltage control;Reactive power;Integration;Renewable Energy;Resilient;Scalable;Smart Grid},

Key Findings:

- Improved technology enhances renewable energy usage and conserves energy.
- Smart Grids rely on real-time monitoring and automated control to integrate renewables properly due to the inconsistency of some alternative energy sources, such as wind and solar.

- Communication systems that can send a lot of data quickly are essential for balancing variable energy demand.
- Microgrids improve reliability and resilience within a power grid when paired with data-driven control and automation.

Relevance to clean power infrastructure:

This Journal demonstrates the importance of automated control and more localized power grids, as opposed to the large-scale grids we currently have in place. These small grids allow for more precise control and integration with renewable energy types that vary in power production. It also provides information about how crucial communication is between the stages of power generation and storage.

Research Log Entry [2]

Source Title:

From digitalization to renewable energy: How the tech-energy connection drives the green energy in Belt and Road countries

Source Authors:

Wang Bingxin, Ghulam Muhammad Qamri, Guo Hui, Waqar Ameer, Muhammad Ansar Majeed

Source type and location:

Scholarly journal article

Citation:

[1]W. Bingxin, G. M. Qamri, G. Hui, W. Ameer, and M. A. Majeed, "From digitalization to renewable energy: How the tech-energy connection drives the green energy in Belt and road countries," *Energy Economics*, p. 108324, Mar. 2025, doi: <https://doi.org/10.1016/j.eneco.2025.108324>.

Key Findings:

- High renewable energy production requires a lot of advanced forecasting and data analytics for proper introduction to the current grid system.
- Digital infrastructure is just as crucial as the physical infrastructure needed to integrate renewable power, such as the use of physical transmission lines and more direct information transmission.

Relevance to clean power infrastructure:

This journal shows that the clean energy transition will fail without strong support from the digital front, having the correct digital systems in place so that renewable energy can be transitioned to is only possible with the coordination of supply and demand.

Research Log Entry [3]

Source Title:

Grid Modernization: Metrics Analysis (GMLC1.1) - Sustainability; Reference Document, Volume 5

Source Authors:

Garvin Heath, Jordan Macknick, Annika Eberle, Monisha Shah, Rob Bickhart, Ariel Miara, Maninder Thind

Source type and location:

Trade/government research report

Citation:

Heath, G., Macknick, J., Eberle, A., Shah, M., Bickhart, R., Miara, A., & Thind, M. (2020). Grid Modernization: Metrics Analysis (GMLC1.1) - Sustainability; Reference Document, Volume 5. <https://gmlc.doe.gov/resources/grid-modernization-metrics-analysis-gmlc1.1-sustainability>

Key Findings:

- Modern grid structure depends on data visibility across all voltage levels, even the smallest to manage power consumption and production to meet requirements set by the usage.
- Advanced metering infrastructure (AMI) enables real-time decision-making for power plants, allowing for better efficiency and better visibility.
- Cybersecurity is a core concern for modern power infrastructure; keeping the data transmitted to the various parts of the power generation process encrypted is crucial to prevent malicious attempts, but encrypting the data can limit the speed of data transmission between the processes.

Relevance to clean power infrastructure:

The report connects clean power generation to the need for more secure data systems and grid-wide information flow, showing problems that could arise with everything being digital, such as cybersecurity and other unwelcome aspects.

Research Log Entry [4]

Source Title:

Smart Grid Management of Renewable Energy

Source Authors:

N/A

Source type and location:

Trade / popular sources.

Citation:

B. Pilkington, "The role of semiconductors in clean energy," AZO CleanTech, Sep. 4, 2019. [5] R. Castagna, "How smart grid technology is driving renewable energy," IoT World Today, Aug. 29, 2019. [6] A. Clemens, "New York power grid challenge is part of larger state energy goals," The Daily Orange, Sep. 12, 2019. [7] M. Basu, "Thailand will use smart grid to predict outages," GovInsider, Aug. 19, 2019. [8] M. Basu, "How Thailand will integrate renewables and EVs into the grid," GovInsider, Sep. 16, 2019.

Key Findings:

- Semiconductors enable efficient power conversion and grid-scale electronics to be used
- Smart grid utilization improves renewable integration and outage prediction.
- Utilizing government led grids monetization aligns clean energy goals with digital infrastructure, allowing for proper usage.

Relevance to clean power infrastructure:

These sources illustrate how digital control systems, power generation-specific electronics, and data-driven grid management can support large-scale clean energy transitions.

Summary:

In short, these articles show the potential for digital driven infrastructure to be used to guide the current power generation system into a sustainable process, allowing for proper integration of clean energy, while taking into account that some alternative power sources require different approaches to properly introduce and rely on for large-scale usage and storage through automated grid systems. Automated decision-making is an absolute must for safe usage and safe introduction into our current grid systems.