Publisher

ADSRS EDUCATION AND RESEARCH

www.adsrs.net

E-ISSN:2583-4487

Global Journal of Novel Research in Applied Sciences

2022 Volume 1 Number 1 Jan-Jun

Research Article

Quantum Computing

Utilization of Renewable energy for Industrial Applications using Quantum Computing

Singh Rajawat A.[1*], Pant P.[2], B Goyal S.[3]

DOI: https://doi.org/10.58260/j.nras.2202.0102

[1*] Anand Singh Rajawat, School of Computer Science and Engineering, Sandip University, Nashik , Maharashtra, India.

[2] Piyush Pant, School of Computer Science and Engineering, Sandip University, Nashik , Maharashtra, India.

[3] S B Goyal, City University, Malaysia.

Even though the energy and utilities industry have trouble integrating new technologies for a long time, the benefits of quantum computing make it worth the trouble. In the past, it has been hard for the utilities industry to use new technology to drive strategic initiatives. But those who do see big improvements in how well they run their businesses. For example, utilities that put a lot of money into digital transformation have the chance to cut their operating costs by about 25%. Quantum computing is a new field of technology that is not as well developed as digital projects, but it is still something that modern renewable energy and utility companies should look into. Quantum computing will give utilities a lot more computing power, which will let them solve business problems that were too hard to try before.

Keywords: Quantum Computing, Industrial Applications, Renewable energy

Corresponding Author	How to Cite this Article	To Browse
Anand Singh Rajawat, , School of Computer Science and Engineering, Sandip University, Nashik , Maharashtra, India. Email: anandrajawatds@gmail.com	Anand Singh Rajawat, Piyush Pant, S B Goyal, Utilization of Renewable energy for Industrial Applications using Quantum Computing. Glo.Jou.Nov.Res.App.Sci. 2022;1(1):5-10. Available From http://nras.adsrs.net/index.php/nras/article/view/3	

Manuscript Received	Review Round 1	Review Round 2	Review Round 3	Accepted
2022-06-04	2022-06-06	2022-06-11	2022-06-23	2022-06-30
Conflict of Interest	**Funding**	**Ethical Approval**	**Plagiarism X-checker**	**Note**
Nil	Nil	Yes	17%	

Introduction

In order to meet the increasing demand for renewable energy, energy management systems will need to become more effective. In spite of the fact that renewable energy sources are "free," it is challenging to plan for their use because of variables such as the amount of sunlight, the temperature, and the rate at which the wind blows. In recent years, hybrid power systems that incorporate a variety of renewable energy sources, such as solar, wind, and hydro, have been put into operation in order to improve their dependability. A single residence can be powered by a smaller unit, while a whole community or island can be powered by a larger unit. After that, optimization techniques are utilised in order to locate the most cost-effective mix of all power generators (both conventional and renewable) and storage capacity [1] that is able to satisfy anticipated demand with the lowest possible degree of risk. The models are required to incorporate not only information about the weather, but also systems for solar power, hydropower, wind power, and battery storage. In addition, the use of renewable energy can result in the development of distributed energy resources (DERs), such as solar photovoltaic systems installed on rooftops. DERs are able to include non-renewable energy sources, electric vehicles, battery storage, and other home energy management devices that utilise the internet of things. Methods of optimization are required in order to strike the optimal balance between reliability, availability, efficiency, and cost in order for the network or "smart grid" to function properly.

Quantum Computing Optimization of the grid encompasses all aspect of the process, from the generation of power to ensuring that it reaches everyone who requires it. To carry out this kind of optimization on a broad scale requires a significant amount of computational power. For instance, even determining the optimal number of power-generating units for a specified demand requires a significant amount of computer time, the amount of which increases by a factor of 10 for each variable included in the model. This indicates that if there is an addition of a new node to the network, there will be a requirement for twice as much processing power in order to determine the most effective method by which the smart grid can function. In the real world, it's likely that you'll have to make do with solutions that aren't The ideal option for everyone. It may be challenging to achieve optimal performance on a big scale in other areas of the energy business as well. For instance, optimizing [2] a shale-gas supply chain network that has a square coverage area of around 10,000 kilometres may entail more than 50,000 variables and 50,000 constraints. It is possible that a supercomputer that is always up to date will need more than 15 hours or even days to get a satisfactory response in some situations.

Due to the high expense associated with performing the necessary calculations, this makes it more difficult to optimise energy systems on a national or global scale. We have a role to play in the development of Renewable energy. Over the next few decades, the electrical system will face new issues as renewable resources are adopted and scaled up. These problems include the need to manage more spread resources and to consider weather-dependent power trends. These issues will arise as a result of the necessity to maintain control over these resources. Here are several ways that quantum computing could exacerbate the current problems with renewable energy. Quantum computing may be able to tackle issues that current technologies will encounter in the opportunity. Afterwards, we'll offer some ideas for interdisciplinary research that could help further quantum computing and renewable energy development. To utilization of renewable energy for industrial applications using quantum computing.

Related Work: Giani et al[3] Some activities that need quantum computing cannot be completed by conventional or "classical" computers. Quantum physics can be used to achieve tasks in quantum computing. Quantum computers are capable of solving problems that conventional computers cannot. Quantum computing research has been mostly confined to physics and theoretical computer science, leading to a disconnect between researchers and the realities of quantum computing's challenges and potential uses. To illustrate quantum computing's ability to solve real-world problems, look for topics that will be significant in the future.

A., Becquin, G. et al[4] The Quantum Technology and Application Consortium, or QUTAC, was established with the intention of providing assistance to the ambitious quantum computing aims of the German government as well

As various research programmes. The ten individuals that make up QUTAC have diverse professional experiences, some of which include working in the automotive, chemical, pharmaceutical, insurance, and technology industries. The contributions that QUTAC has made to this ecosystem are analysed in this paper, which investigates the use of quantum computing in a variety of industries, including the aerospace sector. An approach to industrialization that is application-centric and is based on the proven value to the business is suggested here.

Koronen, C., et al[5] According to the study's conclusions, demand response and energy system integration have a lot of promise. So, new policies and coordination of policies, as well as reforms in regulation, taxes, and the design of electrical markets are needed to deal with this issue.

Emad, D., et al[6] The components of a hybrid microgrid are broken down and explained in this document. In this research mathematical modelling and optimization approaches, as well as adaptive goal functions, equality and inequality constraints, and other related topics, are investigated (HMGs). Both conventional and cutting-edge approaches to optimization can produce desirable results. Wind, solar, and battery storage should be given precedence over other energy sources. This page includes a discussion of forecasting models for solar and wind energy, as well as their uses. Evaluation of the planning and design strategies employed by HMGs is carried out with reference to the aforementioned comparisons and criticisms.

Maheshwari, S., et al.[7] In this article, we are going to take a more in-depth look at some of the research that focuses on the technology of hydrogen and carbon. These studies make use of a variety of different methodologies, including atomic and multi-scale continuum methods, as well as machine learning methods guided by physics. The discovery of novel materials and innovative production methods might be used to generate environmentally benign technologies that are also financially viable and emit minimal or no emissions at all. These technologies could be created.

Aaryashree, Sahoo, et al[8] In this study, investigate the recent developments and potential benefits of smart chemical sensors that are both wearable and self-powered. Investigate the mechanisms that allow self-powered gadgets to store and transform their own energy. list is going to be about these chemical sensors that are self-powered (SPCS). Thermal energy can be stored in a variety of ways, including PV, triboelectric, piezoelectric, and piezoelectric devices. These are all examples of SPCS.

Chinde, V., et al.[9] This article presents a discussion on the modelling of the operation of the electric grid through the utilisation of a simulation that replicates the provision of utility services by buildings. Specifically, the study focuses on the modelling of the operation of the electric grid. These services are beneficial to the operation of both systems.

Proposed methodology Quantum computing:

The resolution of challenging optimization problems can be accomplished in a novel way through the utilisation of quantum computing. The way in which information is processed on a quantum computer is fundamentally dissimilar from that of a conventional computer, sometimes known as a "classical" computer, in two crucial characteristics. To begin, in contrast to a classical processing unit, also known as a bit, which can only have the value 0 or 1, a quantum processing unit, also known as a qubit, can have both the value 0 and the value 1 at the same time. In other words, qubits have the ability to take on both values simultaneously.

The final permits a quantum computer to simultaneously study a multitude of alternative solutions to a problem before settling on the most effective one when it is subjected to measurement. This paves the way for the development of practical applications for quantum computing. Second, even if they are not sending out any signals, two or more qubits can instantly 'feel' what is going on with the other qubits, even if they are physically separated by a considerable distance. This is true even if they are not communicating with each other in any way. This phenomenon is referred to be quantum entanglement [10], which is the name given to characterise it. This final component is absolutely necessary in order to achieve the desired quantum speedup. On the other hand, the building of a full-scale quantum computer is not a straightforward endeavour.

The equipment used for quantum computing is particularly vulnerable to the damaging

Effects of noise. The vast majority of quantum hardware architectures demand for the qubits to be cooled down to temperatures that are sub-millielvin, which is far lower than the temperature of outer space. In the course of the most recent few years, governments from all over the world, in addition to enormous technology businesses such as Google, IBM, Microsoft, Alibaba, and many more of their peers, have been making considerable investments in quantum computing.

A. Quantum computing for Utilization of Renewable energy for Industrial Applications

[11] Due to the promise that quantum computing holds for enhancing the efficiency of energy systems, the energy industry is devoting a significant amount of attention to the field of quantum computing. These subfields include things like facility-location allocation for the building of energy systems infrastructure [12], part commitment for the operations of electric power systems, and heat exchanger network synthesis. This proof of concept is being carried out with the intention of demonstrating that cloud quantum computing is a viable option. The objective of the facility-location allocation problem is to find the optimal locations of facilities like solar or wind power farms so as to minimise the cost of facility opening as well as the cost of transportation, considering the quantity of energy that is required and the resources that are available. This can be accomplished by finding the optimal locations of facilities like solar or wind power farms. In order for this problem to be addressed, a quadratic assignment problem is mapped to this problem. The latter is famously difficult to optimise using a conventional computer.

The table that follows presents a comparison between the execution times required by a single CPU core and the processor utilised by D-quantum wave for a number of different facilities counts. It shows that the amount of time required to compute the former increases in a manner that is exponential with the number of facilities. On the other hand, this is not the case with the alternative that I will discuss next. However, the researchers have found that other applications do not benefit from using the D-wave quantum processor in any way that could be considered quantum. This is due to the fact that the available quantum technology has a high level of background noise and a restricted number of connections.

Quantum computers are still in the very early stages of development, as was just mentioned, as was just mentioned. One may draw parallels between this period and the time when modern computers relied on vacuum tubes, which was in the 1950s. In spite of this, the terrain is evolving rapidly, and there is a tremendous amount of promise. Because of this, in order for organisations and professionals to be able to make strategic decisions, they should ensure that they are keeping track of all the relevant information. Within the realm of the energy industry, a wide variety of businesses and organisations are contributing monetary resources to the cause of research and development in the field of quantum computing.

B. Managing the Resources of Renewable Energy

Wind, solar, and hydropower are all renewable sources of energy; yet they are susceptible to variations in the weather. As a result of this, hybrid models that combine the dependability, availability, efficacy, and cost of renewable sources are gaining a lot of traction in the market. This kind of model calls for complex computations that are beyond the capabilities of standard computers. As a result of the improved processing capacity offered by quantum, optimization models for renewable energy [13] can now deal with problems involving thousands of variables and restrictions.

C. Locating the Best Places to Put a Generator

Facility opening costs and transportation [14] costs should also be taken into consideration when selecting new location locations for solar [15] and wind power farms because these farms are often located in remote areas. IBM and Dwave teamed up to use quantum technology to locate generators in the best possible places [16]. It would take more than 11 hours to look at just 14 different websites on a regular computer to tackle this problem. However, using a Dwave quantum processor reduced the computation time to 16 minutes.

D. Computational Chemistry

Computational chemistry stands to benefit greatly from the introduction of quantum computing due to the large amount of calculations that go into it. The discovery of new materials with improved carbon capture efficiency may be aided by the enormous computational power [17] of quantum computers [18] being unlocked.

E. Addressing the Possible Risks

On the other hand, computing based on quantum mechanics [19] is not risk-free. In particular, quantum computing will have a significant effect on the encryption strategies that we currently employ. It is possible that headlines about quantum may become more commonplace sooner rather than later, much as we have witnessed [20] with other developing technologies such as social media and artificial intelligence (AI).

Conclusion

Quantum computing could be used in the future to help even more traditional industries, such as the energy and utilities business. The vastly improved computing power of quantum will help this industry in many ways, such as making renewable energy sources more efficient, finding the best places for facilities, and coming up with new ways to capture carbon. Quantum computing has the potential to have a big positive effect, even though it comes with some risks, especially in the areas of security and encryption. Even though there are risks involved, this is the case. Because of this, business organisations, academic institutions, are already looking into this new technology.

Reference

1. Anand Singh Rajawat, kanishk Barhanpurkar , Rabindra Nath Shaw Ankush Ghosh, Chapter five - IoT in renewable energy generation for conservation of energy using artificial intelligence, Applications of AI and IOT in Renewable Energy 2022, Pages 89-105

2. Upadhyay, S.N., Satrughna, J.A.K. & Pakhira, S. Recent advancements of two-dimensional transition metal dichalcogenides and their applications in electrocatalysis and energy storage. emergent mater. 4, 951–970 (2021). https://doi.org/10.1007/s42247-021-00241-2.

3. G, Ramya, Suresh, Arthi, Murugesanet al. “Renewable Energy Enhanced Smart Energy Management System Using Internet of Things.” ECS Transactions, vol. 107, no. 1, 24 Apr. 2022, pp. 5335–5342, 10.1149/10701.5335ecst.

4. Giani, A. Quantum computing opportunities in renewable energy. Nat Comput Sci 1, 90–91 (2021). https://doi.org/10.1038/s43588-021-00032-z.

5. A., Becquin, G. et al ,Quantum Technology and Application Consortium – QUTAC., Bayerstadler,. Industry quantum computing applications. EPJ Quantum Technol. 8, 25 (2021). https://doi.org/10.1140/epjqt/s40507-021-00114-x

6. Koronen, C., Åhman, M. & Nilsson, L.J. Data centres in future European energy systems—energy efficiency, integration and policy. Energy Efficiency 13, 129–144 (2020). https://doi.org/10.1007/s12053-019-09833-8.

7. Emad, D., El-Hameed, M.A., Yousef, M.T. et al. Computational Methods for Optimal Planning of Hybrid Renewable Microgrids: A Comprehensive Review and Challenges. Arch Computat Methods Eng 27, 1297–1319 (2020). https://doi.org/10.1007/s11831-019-09353-9

8. Maheshwari, S., Shetty, S., Ratnakar, R. et al. Role of Computational Science in Materials and Systems Design for Sustainable Energy Applications: An Industry Perspective. J Indian Inst Sci 102, 11–37 (2022). https://doi.org/10.1007/s41745-021-00275-9

9. Aaryashree, Sahoo, S., Walke, P. et al. Recent developments in self-powered smart chemical sensors for wearable electronics. Nano Res. 14, 3669–3689 (2021). https://doi.org/10.1007/s12274-021-3330-8

10. Chinde, V., Hirsch, A., Livingood, W. et al. Simulating dispatchable grid services provided by flexible building loads: State of the art and needed building energy modeling improvements. Build. Simul. 14, 441–462 (2021). https://doi.org/10.1007/s12273-020-0687-1.

11. Ahmed, F., Naeem, M., Ejaz, W. et al. Renewable Energy Assisted Sustainable and Environment Friendly Energy Cooperation in Cellular Networks. Wireless Pers Commun 108, 2585–2607 (2019). https://doi.org/10.1007/s11277-019-06539-z

12. Srinivasan, S. Power Relationships: Marginal Cost Pricing of Electricity and Social Sustainability of Renewable Energy Projects. Technol Econ Smart Grids Sustain Energy 4, 13 (2019). https://doi.org/10.1007/s40866-019-0070-4

13. Subramanian, S., Mohan, R., Shanmugam, S.K. et al. Speed control and quantum vibration reduction of Brushless DC Motor using FPGA based Dynamic Power Containment Technique.

J Ambient Intell Human Comput (2021). https://doi.org/10.1007/s12652-021-02969-5

14. Ning, H., Liu, H. Cyber-physical-social-thinking space based science and technology framework for the Internet of Things. Sci. China Inf. Sci. 58, 1–19 (2015). https://doi.org/10.1007/s11432-014-5209-2

15. Das, R.N., Roy, K. Advances in QSPR/QSTR models of ionic liquids for the design of greener solvents of the future. Mol Divers 17, 151–196 (2013). https://doi.org/10.1007/s11030-012-9413-y

16. Bibri, S.E., Krogstie, J. The core enabling technologies of big data analytics and context-aware computing for smart sustainable cities: a review and synthesis. J Big Data 4, 38 (2017). https://doi.org/10.1186/s40537-017-0091-6

17. Singla, P., Duhan, M. & Saroha, S. A comprehensive review and analysis of solar forecasting techniques. Front. Energy 16, 187–223 (2022). https://doi.org/10.1007/s11708-021-0722-7.

18. Sharifi, A., Ahmadi, M. & Ala, A. The impact of artificial intelligence and digital style on industry and energy post-COVID-19 pandemic. Environ Sci Pollut Res 28, 46964–46984 (2021). https://doi.org/10.1007/s11356-021-15292-5.

19. Bedi, P., Goyal, S.B., Rajawat, A.S., Shaw, R.N., Ghosh, A. (2022). Application of AI/IoT for Smart Renewable Energy Management in Smart Cities. In: Piuri, V., Shaw, R.N., Ghosh, A., Islam, R. (eds) AI and IoT for Smart City Applications. Studies in Computational Intelligence, vol 1002. Springer, Singapore. https://doi.org/10.1007/978-981-16-7498-3_8.

20. Rajawat, A.S., Bedi, P., Goyal, S.B., Shaw, R.N., Ghosh, A., Aggarwal, S. (2022). AI and Blockchain for Healthcare Data Security in Smart Cities. In: Piuri, V., Shaw, R.N., Ghosh, A., Islam, R. (eds) AI and IoT for Smart City Applications. Studies in Computational Intelligence, vol 1002. Springer, Singapore. https://doi.org/10.1007/978-981-16-7498-3_12