

Chapter 21

Realizing Sustainable Energy Quantum Computing Applications in Power Grids

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ABSTRACT

Climate change and the desire to cut carbon emissions have increased demand for renewable energy. Quantum computing's revolutionary potential and unmatched processing capability could benefit capacity grids and other businesses. This research examines how quantum computing could improve power network efficiency to achieve sustainable energy goals. Quantum computing can solve complex power grid optimization problems. Current conventional approaches to power grid improvement have limits, but quantum computing can assist overcome them. Power grid optimization incorporates quantum methods like Grover's algorithm and the quantum approximate optimization algorithm. Quantum-resistant cryptographic techniques and quantum key distribution could secure power grid communication and data transfer. Given that quantum computing is still developing, the research examines the present obstacles to implementing quantum power grid solutions. Finally, quantum computing could improve power grid operations, security, and renewable energy consumption, helping accomplish sustainable energy goals.

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INTRODUCTION

Kurt, M. N 2020, Nelson 2020 In light of the fact that climate change is occurring and the demand for electricity is increasing, it is becoming increasingly important for people all over the world to look for sustainable energy alternatives. Traditional power grids are having difficulty fulfilling the demands of an energy landscape that is continuously expanding, and as a result, there is an urgent need for novel technologies that can improve efficiency, dependability, and sustainability. With its unrivalled processing power and capacity to find solutions to difficult problems, quantum computing is emerging as a possible frontier for the transformation of power grids into systems that are more intelligent and sustainable.

Jia Y. W 2020, 4. Arute, F 2019 Through the use of the laws of quantum physics, quantum computing is able to do calculations at speeds that are significantly faster than those of classical computers. This opens up new options for optimizing different aspects of power grids, such as the distribution of electricity, the stability of the grid, and the management of resources.

Roushan, P. 2020, Nielsen 2010 Throughout the course of this investigation, we will investigate the various ways in which quantum computing may be utilized in the field of power grids, as well as the ways in which it may contribute to the development of sustainable energy systems.

P.S. Ranjit 2022 We need to engage in extremely complicated computations in order to handle a number of significant difficulties that are associated with the climate of the Earth and to enhance the generation and utilization of energy [7]. This area of study involves the simulation of the complex impacts that clouds that are continually shifting have on the environmental conditions. In a similar vein, the evaluation of a wide variety of materials such that solar energy output is maximized or the retention of energy is also included in this group.

William DeGroat 2023 as the complexity of computations increases, it is becoming increasingly difficult to solve problems of this nature using traditional computers that run programmes based on binary codes.

Wiseman 2009, Lara 2019 This is because binary codes are the basis for conventional computer programming. As a result, these problems are solved by adopting models that are dependent on approximations.

Feng F., 2021 For example, such models include climate parameterizations-processes that impact the production of clouds and climate-related phenomena like hurricanes. This action is made to lower the quantity of computational labour. On the other hand, fact that these models do not possess the requisite level of accuracy is an unavoidable trade-off for their potential. Nevertheless, in spite of these estimations, supercomputers are gradually getting closer and closer to the boundaries of the ordinary processing capacity.

RELATED WORKS

Zhang P 2022 There is a universal pursuit for innovative electrolytes and compounds that can facilitate carbon capture at a reduced expense or improve the quality of electric batteries. The assessment of millions of chemical combinations necessitates protracted and exorbitantly priced laboratory experiments based on trial and error, often culminating in unsatisfactory, incremental progress. In the realm of materials and chemistry, even the most robust supercomputers are limited to approximative functionality and will perpetually be unable to effectively handle the intricacy involved.

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