UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Small-Scale DC Power Plants Supported by Blockchain, AI, and IoT Models: a Faster Transition to Sustainability

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under the supervision of

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, *Antonio Pereira dos Santos* declare that this thesis, is submitted in fulfilment of the requirements for the award of *[Doctor of Philosophy]*, in the *Faculty of Engineering and IT – FEIT* at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Abstract

The electricity industry has become the major greenhouse gas (GHG) emitter on Earth since every economic activity relies on it. Wealthy nations headquarter the largest transnational corporations, and to remain competitive, they are compelled to stimulate higher consumption levels, and higher productivity at lower costs. How can global GHG emissions be reduced when political economy and law keep rewarding institutions that directly or not, contributes to the release of emissions? How to reduce emissions when technology has mostly been used to magnify production, and boost indiscriminate consumption?

The transition to renewable energy sources and carbon offset have been the flagship strategies to lower emissions, sponsored by the United Nations, and eagerly adopted by affluent nations. Conversely, the assumption that an eventual transitioning to renewable sources in a localized region, could yield any substantial contribution to climate change in a global scale is rather weak-willed. It may provide a palliative comfort for the wealthy nations to mask environmental liabilities. However, it fails on addressing the emissions' root causes, allowing the perpetuation of the problem.

This research addresses the emissions dilemma within the electricity industry. It features an in-depth study on global emissions, covering causes, sources, drivers, root causes, and providing specifics why present mitigation strategies have failed. Then, it introduces the ADCx model, a small-scale autonomous DC power plant aiming to provide an alternative root for consumers to become sustainable, away from the large-centralised-polluted AC grid. It prioritises cleaner transformation methods and autonomy, irrespective of the type of power sources. Next, it proposes the BAIoT system, where Blockchain, Artificial Intelligence and IoT work together to provide additional features to the ADCx. While ADCx focuses on the network infrastructure, BAIoT builds upon user re-education, network intelligence, rationalising energy consumption, energy trading, and leveraging power demand and supply.

Next, it presents the BAIoTAG framework that establishes the 12 fundamental principles leading to sustainability. It has been strategically conceived to cause minimal impact on the existing AC system, reducing legal barriers, and facilitating cross-country replications. Rather waiting for an effective solution from government, this framework

enables citizens to spearhead a local solution, and the formation of off-grid communities.

Lastly, this study presents a comparative case study showing how AI/ML can support small-scale power plants in reaching sustainability. The greater the data granularity, the larger the opportunities for superior predictions, maximise network performance and increasing users' awareness on their local emissions.

Key Index Terms:
DC power plants, microgrid, nanogrid, picogrid, Blockchain, IoT, AI, sustainability

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Publications Associated with this Dissertation

(1) Blockchain: Status quo, enablers and inhibitors: IEEE, 2018, 26th International Conference on Systems Engineering, Sydney, Australia

(2) Greenhouse Gases (GHG) Emissions: Understanding Causes, Sources, Drivers, and Root Causes *(Paper ready to be published)*

(3) Autonomous DC Picogrids, Nanogrids and Microgrids (ADCx): A New Approach for Sustainability *(Paper ready to be published)*

(4) Reaching Sustainability Through Blockchain, AI & IoT: The BAIoT model *(Paper ready to be published)*

(5) BAIOTAG Framework: Enabling a Faster Transition to Sustainability *(Paper ready to be published)*

(6) A Comparative Case Study for the deployment of Machine Learning in Picogrid, Nanogrid & Microgrid *(Paper ready to be published)*

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