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## Renewable Energy Optimisation

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The devastating impact of climate change, based primarily on the overuse of fossil fuels, has increased awareness of and interest in renewable energy. This awareness is increased by recent problems in South Africa, among other nations. Renewable energy sources face the “energy trilemma” of energy supply, economics, and environmental concerns that must be addressed through an optimal configuration of a hybrid renewable energy system (HRES) to meet these concerns. In this talk, we will first outline how the use of renewable energy resources may mitigate climate change. Then, we will discuss how bio-inspired algorithms may play a role in smart energy management of both these renewable energy resources (the production side) and smart energy consumption (the load side) through dynamic optimization of load shifting and through optimal utilization of available renewable energy resources respectively. Load-shifting is accomplished, via a bio-inspired algorithm, to shift peak load demand to off-peak hours using agent negotiation of appliance operational times and thus, reduce the peak load demand. In terms of production, an optimal configuration of renewable energy components is needed in terms of optimal cost and sizing to meet this load demand via a “check-reduce-improve” framework using the newly-developed bio-inspired algorithm of Spider-Prey. The first step of this cost and sizing is through a feasibility study where streaming IOT data of environmental data at a specified locale is pre-processed and then reviewed and mapped to a preliminary system design (the “check” phase). Based on this mapping, a performance analysis of the system configuration parameters is conducted (the “reduce” phase). Finally, using the Spider-Prey algorithm, an improved solution to the optimisation problem of the “energy trilemma” is evaluated (the “improve” phase). To validate this optimised system design, extrapolated sensor data, supplemented with historical data, of environmental conditions at that locale is applied to different scenarios, utilising different arrangements of renewable energy components, along with known costing and sizing models in order to find the best HRES configuration. From our work, it was determined that a composite of a select number of solar panels, wind turbines, a biomass gasifier, and a collection of batteries was able to provide an optimal combination of the least system cost with the highest reliability in terms of meeting load demand.

Although bio-inspired algorithms have been applied in many domains, such as in this case of an optimal hybrid renewable system, the swarm-based nature of the algorithms used in this domain consist of many independent agents using collective intelligence to achieve a goal. The independence of actions leads naturally to parallelism and the potential slow convergence of these algorithms leads to the need for high-performance computing in order to assist the algorithms to attain their goals faster and, thus, make them a more viable option in many domains. This area will be touched on in the final stage of the talk.

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