Abstract

Modern economy relies heavily on steady production of energy. Traditional energy sources mostly include non-renewable energy like coal, natural gas and fossil fuel-based power plants. They are highly reliable and predictable in nature as the output can be moderated according to the consumers' requirements. However, they are increasingly undesirable due to their adverse environmental impacts.

Germany's Renewable Energy Sources Act or EEG (German: *Erneuerbare-Energien-Gesetz*) is a series of legislations introduced in 2014 aimed at encouraging development of renewable energy sources (RES) such as wind and solar energy. As of 2016, RES constitute nearly 34% of net electricity production and the target is to meet over 50% of the production by 2030. The inclination towards RES is due to their non-existent or low toxic emissions and inexhaustibility. However, inclusion of RES into the national power grid for energy production adds to grid's volatility as such sources' outputs cannot be controlled and depend on the location's meteorological conditions at any given time. Therefore, this increased dynamicity of the grid mandates a higher monitoring resolution for safe operation.

State Estimation (SE) in power grids acts as the first filter for extracting information from noisy measurement data obtained from sensors and measuring devices placed throughout the grid. This information is necessary for the rest of the energy management system (EMS) components. Considering Germany's ambitious renewable energy targets and the state of existing RES infrastructure's dynamic nature, SE is increasingly indispensable to readily respond to grid voltage fluctuations. However, the common hurdles against obtaining a higher monitoring resolution through SE over a vast nationwide power grid are the required large computational power and long execution times.

General Purpose Computation on Graphics Processing Unit (GPGPU) refers to the use of a graphics processor for calculations beyond its original scope of tasks. GPGPU are 'massively parallel' in nature because of their ability to launch and run a vast number of threads concurrently. GPGPU are a fit to the problem of SE due to the presence of various large matrix-matrix and matrix-vector operations that can be efficiently implemented with higher throughput on a GPGPU compared to the CPU implementation. Through porting the existing SE algorithm to the GPGPUs to exploit its high degree of parallelism, a higher monitoring resolution can be obtained.

Similarly, through decentralization of SE, the complete power grid is split into smaller sectors and independent parallel SE computations can be run for the individual sectors. The obtained results can then be merged to obtain the final global information.

In this master thesis, the possibility of a performance gain and accuracy analysis of the results of decentralized SE using GPGPUs is explored.