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Automated Verification of Stand-alone Solar Photovoltaic Systems

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Abstract

With declining costs and increasing performance, the deployment of renewable

energy systems is growing faster. Particular attention is given to stand-alone

solar photovoltaic systems in rural areas or where grid extension is unfeasible.

Tools to evaluate electrification projects are available, but they are based on

simulations that do not cover all aspects of the design space. Automated verification using model checking has proven to be an effective technique to program

verification. This paper marks the first application of software model checking

to formally verify the design of a stand-alone solar photovoltaic system including

solar panel, charge controller, battery, inverter, and electric load. Case studies, from real photovoltaic systems deployed in five different sites, ranging from

700W to 1,200W, were used to evaluate this proposed approach and to compare

that with specialized simulation tools. Data from practical applications show

the effectiveness of our approach, where specific conditions that lead to failures

in a photovoltaic solar system are only detected by our automated verification

method.

Keywords: Formal verification, model checking, photovoltaic power systems,

power system modeling, solar power generation

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