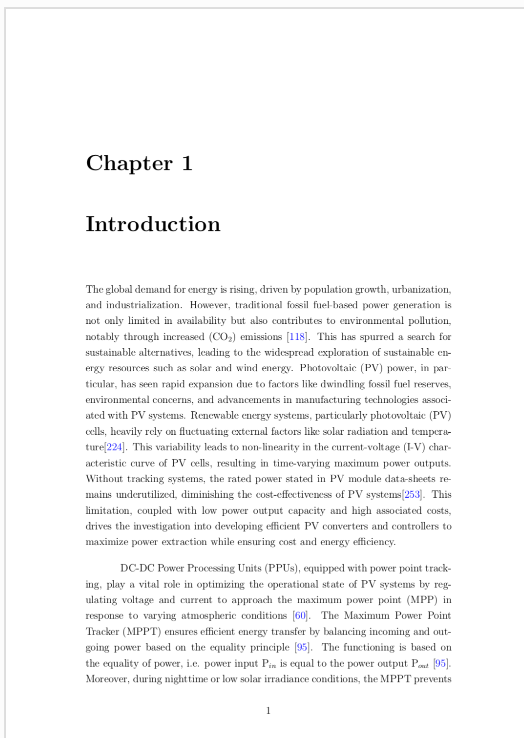

Chapter 1

Introduction

The global demand for energy is rising, driven by population growth, urbanization, and industrialization. However, traditional fossil fuel-based power generation is not only limited in availability but also contributes to environmental pollution, notably through increased (CO_2) emissions [118]. This has spurred a search for sustainable alternatives, leading to the widespread exploration of sustainable energy resources such as solar and wind energy. Photovoltaic (PV) power, in particular, has seen rapid expansion due to factors like dwindling fossil fuel reserves, environmental concerns, and advancements in manufacturing technologies associated with PV systems. Renewable energy systems, particularly photovoltaic (PV) cells, heavily rely on fluctuating external factors like solar radiation and temperature[224]. This variability leads to non-linearity in the current-voltage (I-V) characteristic curve of PV cells, resulting in time-varying maximum power outputs. Without tracking systems, the rated power stated in PV module data-sheets remains underutilized, diminishing the cost-effectiveness of PV systems[253]. This limitation, coupled with low power output capacity and high associated costs, drives the investigation into developing efficient PV converters and controllers to maximize power extraction while ensuring cost and energy efficiency.

DC-DC Power Processing Units (PPUs), equipped with power point tracking, play a vital role in optimizing the operational state of PV systems by regulating voltage and current to approach the maximum power point (MPP) in response to varying atmospheric conditions [60]. The Maximum Power Point Tracker (MPPT) ensures efficient energy transfer by balancing incoming and outgoing power based on the equality principle [95]. The functioning is based on the equality of power, i.e. power input P_{in} is equal to the power output P_{out} [95]. Moreover, during nighttime or low solar irradiance conditions, the MPPT prevents

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by Barnam Jyoti Saharia

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