



## Solar Energy for Traction of High Speed Rail Transportation: A Techno-economic Analysis

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### Abstract

To meet the growing expectation of traveling public, world railways are going ahead in a big way to introduce high speed trains. Electric railways require huge amounts of energy. Many rail networks run their own dedicated power plants. With a view to augment the capacity of the rail networks grid connection so as to make the railway self-reliant, a grid tied PV solar plant with battery storage has been proposed. The present concept is based on installing solar panels along the length of a HS rail network so that the ballast-less tracks could be used as energy carriers. Ballast less tracks require little or no maintenance, and the space along the tracks provides a large surface area on which arrays of PV modules can be mounted to generate electricity from sunlight. An example demonstrates that a 330 MW grid connected PV solar plant with battery storage for the Mumbai–Ahmedabad high speed rail link, generates electricity at  $\$1.67 \times 10^6$  /MW output and levelized electricity cost at 12.05 c/kWh. Net saving in tariff after payback period is about \$ 58 million per annum.

*Keywords:* HS Railways; Slab Track; Solar Plant; Battery Storage; Shinkansen.

### 1. Introduction

To meet the growing expectation of traveling public, railways worldwide are going ahead in a big way to introduce high-speed (HS) trains. Electric railways require huge amounts of energy. Many rail networks run their own dedicated power plants. To augment the capacity of the rail networks grid connection, the abundant solar energy available in nature can be harnessed and converted to electricity in a sustainable way. Recently, there have been a few articles dealing with the application of PV sources to railway network. In Hayashiya et al. (2012) studies the potential of using solar generation on platform roofs have been analyzed [1]. The feasibility of a fixed PV system with battery storage was studied for urban rail transit [2]. Another feasibility study was made for rail coaches with rooftop solar systems [3]. Ciccarelli et al (2018) have demonstrated the technical feasibility of integrating a PV power plant in order to supply a railway system [4]. In Chino (2009) research, a plan is proposed to introduce solar powered Bullet trains in Arizona with power generated by solar panels mounted on a solar canopy [5]. Indian Railways (IR) has realized the potential of using the rail corridor to produce solar energy and has installed solar panels on the roof of 250 local trains [6]. A source of large surface areas for solar photovoltaic (PV) generation that has been largely overlooked is the space along the rails. Installing PV modules at these locations would transform every km of railway line into a photovoltaic field, able to produce solar energy, which could be used to provide electricity for traction. For this to be feasible, it is important that the PV panels are not disturbed during maintenance of sleepers. The use of concrete slab track for high speed (HS) railways provides an ideal platform for locating these panels. Here the ballast is replaced with a rigid concrete track slab

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