Study of On Hybrid Solar Battery Diesel System With Smart Inverter And Power Converters

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***Abstract*— Smart inverters, power converters on battery diesel, combined with other hybrid systems can reduce variability, shift peak loads, create reserve capacity, and support the voltage quality of the distribution network. The purpose of this article is to compare and plan the technical reliability, safety, and operational risk of solar sources, batteries, diesel engines, and equipment, and determine the daily operating mode. Thus, the selection of equipment is based on the market leading sales of the module, inverter block from the battery, storage system technology, reliability, and integration block from the Huawei smart inverter, battery storage, and solar module technology TOPCon, and the bifacial solar module is considered the most suitable. Smart inverters and power converters can operate in parallel or separately with a battery-powered diesel fuel or integrated grid, making them suitable for plants with weak grids like Mongolia, and are economically efficient.**

Keywords*— *quasi-dynamic simulation, operating mode, integration, hybrid system, SCADA architecture

I. INTRODUCTION

In the global energy transition, solar power generation technology has become one of the fastest-growing energy sources. Decreasing costs, increasing production volumes, and advances in inverters and control systems have led to widespread use from small-scale users to large-scale power plants. However, solar power generation is directly dependent on weather, seasons, and day-night fluctuations, which pose problems with power reliability, frequency stability, and grid capacity when used alone [1-6, 8].

Battery Energy Storage Systems (BESS) can balance electricity supply and demand and provide frequency regulation to manage peak loads. Therefore, the selection of a hybrid solar power generation and battery storage system is not just a matter of comparing equipment catalogues, but also an engineering optimization policy that depends on many factors such as load balancing, solar resources, safety, financial risks, and operation strategies [2]. The practical significance of the research lies in justifying decisions regarding the selection of solar power generators and battery storage systems across training, laboratory testing, university campuses, manufacturing, mining users, isolated microgrids, and distribution substations.

In the solar-diesel hybrid system technology comparison, the technical specifications, reliability, and integration capabilities of the leading solar modules, inverters, and battery storage systems on the market were compared. Modern engineering software was used to perform the research and calculations. The production and operating mode calculations of the solar-diesel hybrid system were performed using the Swiss PVsyst program version 8.0.20.

A quasi-dynamic simulation was performed in the 24-hour operating mode of the solar-diesel hybrid system, and the impact was evaluated and the relevant conclusions were drawn.

II. TECHNOLOGY SELECTION

A. Selection criteria and resulting configuration

The technology screening compared commercial alternatives using rated power, conversion efficiency, expected degradation, temperature range, cooling, fire protection, communication interfaces, warranty, and compatibility with the supervisory controller. N-type TOPCon bifacial modules were preferred because their 23.1–23.2% efficiency, low annual degradation, and favorable temperature coefficient reduce land and lifetime-energy requirements. Liquid-cooled LFP storage was selected for thermal uniformity, cycle life, and multi-stage safety.

TABLE I. COMPARISON OF CANDIDATE SOLAR MODULES

Brand	ZTT	JA Solar	Longi
Model	ZTT78NH BD	JAM66D46 LB	LR7-72HVHF
Type	N Type TOPCON	N Type TOPCON	Back contact
Maximum Efficiency, %	23.1	23.2	24.8
Maximum Power (Watts)	645	720	665
Open Circuit Voltage VOC, B	-	49.00	54.52
Length, м	2.465	2.384	2.382
Width, м	1.134	1.303	1.134
Bifacial (Double-Sided)	Yes	Yes	Yes
Back Transmittance / Bifaciality, %	80	80	70
Temperature Coefficient Pmax, %/C	-0.29	-0.29	-0.26
Temperature Coefficient VOC, %/C	-0.25	-0.25	-0.2
Max Operating Temperature, C	70	85	85
Min Operating Temperature, C	-40	-40	-40
Weight, кg	32.4	38.2	28.5

The resulting plant uses 720 W JA Solar JAM66D46 modules, Huawei SUN2000-460KTL-H0 smart string inverters, factory-integrated LUNA2000-4.5MWh-2H1 battery containers, and LUNA2000-213KTL-H0 bidirectional power converters. CAT diesel generators provide dispatchable reserve and grid-forming voltage-