NASENI RESEARCH COMMERCIALIZATION GRANTS PROGRAMME (NRCGP)

Project Proposal:

Design and Development of a Solar Hybrid Welding Machine for Sustainable Manufacturing in Nigeria

Submitted to:

National Agency for Science and Engineering Infrastructure (NASENI)

Submitted by:

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1. Executive Summary

Nigeria's welding industry, a backbone of manufacturing and construction, continues to struggle with unreliable electricity supply, high fuel costs, and dependence on imported machines. These challenges increase production costs, reduce productivity, and contribute to carbon emissions.

In response, the Projects Development Institute (PRODA), Enugu, has design and developed a Solar Hybrid Welding Machine a locally engineered solution that integrates solar PV, battery storage, and grid input to guarantee reliable and affordable welding. The system reduces operational costs by up to 60%, ensures uninterrupted performance, and is optimized for Nigerian conditions.

Through the NASENI Research Commercialization Grants Programme, PRODA seeks further support to fabricate, test, and deploy prototypes with local welding clusters. With commercialization, the Solar Hybrid Welding Machine will foster import substitution, job creation, and industrial self-reliance**,** while advancing Nigeria's clean energy transition and the Renewed Hope Agenda**.**

2. Abstract

Nigeria's manufacturing and construction sectors rely heavily on welding machines powered by grid electricity and fossil-fuel generators. Persistent power shortages and high fuel costs hinder productivity. This project proposes a Solar Hybrid Welding Machine that ensures uninterrupted welding operations using solar, battery, and grid hybridization. The innovation promises cost savings, environmental benefits, and scalability.

3. Introduction

Welding is the lifeblood of Nigeria's manufacturing, construction, and repair sectors, yet millions of artisans and small businesses remain trapped by unreliable electricity, soaring fuel prices, and costly imported machines. These challenges not only limit productivity but also threaten Nigeria's drive toward industrial self-reliance. The Solar Hybrid Welding Machine, developed by the Projects Development Institute (PRODA), presents a bold, homegrown solution. By combining solar power, battery storage, and grid input in a single system, this innovation ensures uninterrupted welding, slashes costs by up to 60%**,** and promotes a cleaner, more sustainable future for Nigeria's industries.

4. Problem Statement

1. Heavy reliance on unstable grid and costly generators.
2. High emissions and environmental pollution.
3. Dependence on imported machines not adapted for Nigerian conditions.
4. No locally available solar welding technology.

5. Objectives

1. To design, fabricate, and produce up to 50 prototype units of 3KW Solar Hybrid Welding Machine.
2. To deploy and test the machines in selected welding clusters, workshops, and SMEs across Nigeria.
3. To reduce welding operation costs by 50–60%.
4. To provide technical support and training on installation, operation, and maintenance of the machines.
5. To foster collaboration between government, industry, and local artisans for the commercialization of indigenous welding technology.

6. Innovativeness & Novelty

The proposed Solar Hybrid Welding Machine is the first indigenously designed and developed solution of its kind in Nigeria, it features **a** compact, all-in-one module that integrates control circuitry, battery storage, and grid connection in a single durable enclosure requiring only external solar panels as the input source. At the heart of the machine is an intelligent energy management system that seamlessly balances solar, battery, and grid power to ensure reliable and efficient welding operations. Purposefully engineered for Nigeria's climate and working conditions, the design is cost-effective**,** portable, and scalable, offering a solution that supports both small-scale artisans and industrial users while driving import substitution and clean energy adoption.

7. Commercial Viability

Target Market: Welders, SMEs, construction companies, workshops.
Market Size: Over 2 million welders in Nigeria.
Cost Advantage: Saves ₦30,000–₦50,000 monthly in fuel.
Pathway: Local manufacturing partnerships .

8. Preliminary Results / Proof of Concept

PRODA has successfully developed and tested prior inverter welding machine prototypes locally, providing a strong foundation for this solar-hybrid welding system. Simulation studies confirm its technical feasibility, with validation achieved at TRL 4–5. The project team brings proven expertise in solar-inverter design, welding technologies, and battery management systems. A compact all-in-one prototype (Figure 1) has already been produced, demonstrating clear progress toward a practical and scalable solution.

Figure 1: Compact prototype design of the solar-hybrid welding machine (excluding solar panels).

9. Technology Readiness Level

Current: TRL 4–5. Goal: TRL 7–8 with working prototype ready for commercialization.

10. Methodology

The project will commence with the design of an integrated solar–battery–grid hybrid **system**, incorporating an intelligent energy management unit for seamless operation. This will be followed by the fabrication and assembly of up to 50 compact prototypes**,** using locally available components to ensure affordability and scalability. The prototypes will then undergo rigorous field testing to evaluate welding performance, energy efficiency, and durability under real workshop conditions. Finally, the project will focus on commercialization through pilot deployment and SME partnerships. The units will be installed in selected workshops and enterprises, coupled with user training and technical support to drive adoption and sustainability.

11. Expected Outcomes

1. Delivery of 3kW functional compact solar-hybrid welding machine prototypes.
2. Up to 60% reduction in fuel **costs** compared to petrol/diesel welding systems.
3. Job creation through local manufacturing, assembly, and technical support.
4. Scalable and modular design adaptable for wider deployment across Nigeria and West Africa.

12. Scalability & Sustainability

The solar-hybrid welding machine is designed for growth, with capacity expandable from 3kW to 10kW to suit different welding and fabrication needs. Its modular architecture enables simple upgrades and system improvements, while reliance on locally available spare parts ensures long-term sustainability and affordability. To further drive adoption, a business model developed to support local assembly hubs and artisan training**,** which can be shared in detail upon request. This approach guarantees not only technology scalability but also economic empowerment and skills transfer within Nigerian communities.

13. Budget Estimate (₦)

Item	Quantity	Unit Cost (₦)	Total Cost (₦)	Notes
Improved Prototype design and Fabrication	50	400,000	20,000,000	covering control &power circuits , batteries, casing, solar panels and assembly
Testing & Validation	--	--	2,000,000	Performance, durability, and safety tests on selected units
Deployment (50 welders)	--	---	5,000,000	Installation, logistics, and field support
Commercialization & Training	---	--	7,500,000	Local assembly setup, artisan training, and awareness
Contingencies	--	--	2,000,000	To cover unforeseen cost variations
Total			**36,500,00**	—

14. Timeline (6 Months)

Month 1: Procurement of components and final design adjustments

Months 2–3: Prototype fabrication of 50 units

Month 4: Testing, validation, and optimization
Month 5: Pilot deployment to selected welders and SMEs
Month 6: Training, commercialization activities, and final reporting

15. Conclusion

This project demonstrates a practical, scalable, and innovative solution to Nigeria's welding and fabrication challenges by introducing the first locally designed solar-hybrid welding machine**.** With its compact, modular design, reliance on local materials, and potential to reduce fuel costs by up to 60%, it directly supports Nigeria's industrialization, renewable energy, and job-creation agenda. With NASENI's support, this initiative will not only empower welders and SMEs but also establish a sustainable model for clean energy–driven manufacturing in Nigeria and across West Africa.