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Empowerment Through Energy: How Empower a Billion Lives Seeks to Address Energy Access

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In the modern era, access to energy is synonymous with the opportunity for development and prosperity. Yet, reliable and affordable access to modern energy remains an elusive goal for a significant portion of the global population. There are still three billion people in some form of energy poverty today [1]. Empower a billion lives (EBL), organized by the IEEE Power Electronics Society (PELS), harnesses the power of technology and talented, dedicated people to address this issue.

Breaking Down Energy Access

Energy access refers to the availability and affordability of energy services to all members and organizations of the community, such as households, businesses, and public institutions. It encompasses a range of applications from basic lighting to the higher power and energy density needs required for economic development.

Energy access should not be measured as a binary attribute. In the context of energy poverty, there are many levels of energy access. A binary definition of energy access hides important details and gives the world a false sense of progress. When EBL was first conceived in 2016, 1.2 billion people were living without any access to electricity and three billion people were living in energy poverty. Today, that number is 675 million people living without access to electricity and 2.3 billion people without access to clean cooking. Of the additional 500 million people who now have access to energy, only 15 million have realized Tier 2 energy access [1].

The challenge is not only to provide some minimal level of daily electric power, but to help people move up the Tiers through productive use, compatible appliances, and

bottom-up infrastructure utilizing clean technologies and local empowerment. Empower a Billion Lives requires solutions to meet the Tier 2 level of 50 W for at least 4 hours per day. The tiers of energy access were defined in the Multi-Tier Framework for Energy Access developed by the energy sector management assistance program (ESMAP) of the World Bank with some of the characteristics of each Tier described in Figure 1.

Energy access is a crucial service to enable many global initiatives to improve the quality of life and economic opportunity of people worldwide, not least the United Nations sustainable development goal (SDG) 7: Ensure access to affordable, reliable, sustainable, and modern energy for all. Figure 2 lists some of the SDGs that are highly impacted by the supply of energy to communities.

The world will score progress based on the metrics it chooses to measure. Giving a family an LED light (Tier 1) counts as energy access but does not enable families to increase income and alleviate poverty. This further substantiates the importance of promoting solutions that enable the productive use of energy, which positively impacts people's livelihood, health, income, education, and security and helps them move up the Tiers through a virtuous cycle of access to a productive level of energy and increased income.

The History of Empower a Billion Lives

EBL began as a competition but has since blossomed into a global community that fosters partnerships and nurtures sustainable, renewable energy solutions. It has its genesis in the November 2016 PELS workshop in Atlanta, Georgia, USA. Key attendees from a wide variety of organizations, including the Global Lead Energy Access, World Bank,

		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Capacity	Power Capacity Ratings (in W or daily Wh)	Less than 3W	At Least 3W	At Least 50 W	At Least 200 W	At least 800 W	At Least 2 kW
		Less than 12 Wh	At Least 12 Wh	At least 200 Wh	At Least 1kWh	At Least 3.4 kWh	At Least 8.2 kWh
	Services		Lighting of 1,000 lmhr/day	Electrical lighting, air circulation, television, and phone charging are possible			
Availabilities	Daily Availability	Less than 4 hours	At Least 4 hours		At Least 8 hours	At Least 16 hours	At Least 23 hours
	Evening Availability	Less than 1 hour	At Least one hour	At Least two hours	At Least 3 hours	At Least 4 hours	

FIG 1 A subset of the criteria for each Tier of Energy Access as defined by ESMAP of the World Bank.



FIG 2 United Nations sustainable development goals.

senior advisors from USAID, CTO of GE Energy, Clasp, GOGLA, CleanTech, IEEE Smart Village, GE Global Research, EPRI, Light the World, and Equifax, came together to discuss the challenges and the opportunities to providing energy access. The main recommendation was that organizing a global competition, including field testing, could derisk market entry for solutions while being the means to unleash innovation and entrepreneurship, creating holistic, sustainable, and financially viable solutions that can scale rapidly to >1 billion users.

EBL was cofounded by late Bram Ferreira, past PELS President and faculty at the University of Twente, Enschede, Netherlands and Deepak Divan, faculty at Georgia Tech., Atlanta, GA, USA and the Director of the Center for Distributed Energy. Divan served as the International Chair for EBL 2019 and EBL 2023 while Jelena Popovic serves as the current International Chair leading the planning and execution of EBL 2025.

In pursuit of IEEE’s mission of “advancing technology for the benefit of humanity” and with the support of the IEEE PELS, the next year was spent designing and planning this competition. A few threads have carried through to our current competition cycle, EBL 2025.

The first principle is that it must be open to all: students, companies, research labs, and other organizations. We would like to tap into the creativity, passion, and ambition of people worldwide and provide expert guidance as they develop scalable, sustainable, renewable energy solutions designed for energy access at a productive level (Tier 2). We do not claim to have the solution, but instead seek to crowdsource a wide range of solutions from people who know their market best.

Second, the competition aims to foster interdisciplinary innovation worldwide to develop and demonstrate energy access solutions that are designed to scale, regionally relevant, holistic, and leverage 21st-century technologies that feature exponentially declining prices. Let’s break that down a bit. Solutions should have a solid, feasible business plan. This means a path to profitability and funds that can be used to expand or replicate the solution to new customers. On top of all that, the service must be affordable to people who live below the global poverty line of USD 2.15 per day.



FIG 3 EBL team Entrepreneurs du Monde—Project Cambodia.

A good example is the 2019 EBL winner Entrepreneurs du Monde, who won under the category “Best Emerging Utility Solution” for spearheading a new model of nano distribution systems that has immeasurable potential. It is a French NGO created in 1998 to support the social and economic integration of people from deprived communities in Africa, Asia, Haiti and France. The organization helps them create businesses, access energy and adapt to climate change, increase their independence, improve their daily life, and that of their family as well as their community (Figure 3).

The solutions must incorporate affordable, robust technology. By harnessing 21st-century technologies, the technical solution can capitalize on the affordability of photovoltaics (PV), storage, digital technologies, and other technologies. These costs have decreased to the point where they are now lower per watt than traditional grid-delivered power. The shift to a new paradigm is crucial (Figure 4), as the existing model of grid expansion has proven inadequate—95% of the utilities in Sub-Saharan Africa cannot recover their operating or capital expenditures [1]. This does not point to a scalable model that can be the basis of an energy ecosystem.

Finally, modern energy generation and power electronics technology are inherently complex, but any solutions should not rely on Ph.D.s air-dropped in to troubleshoot the system. The complexity of the technology needs to be hidden by making it integrated and plug-n-play with simple troubleshooting, allowing the entrepreneurs and their

teams to manage the installation, operation, and maintenance of the energy systems in the field (Figure 5).

With these guiding principles, we launched the first global competition, EBL 2019. EBL 2019 held five regional rounds in the Asia-Pacific, South Asia, Africa, Europe, and the Americas. Of the over 450 teams from 70 countries that registered for the competition, 83 teams were invited to the regional rounds, and 23 teams were selected to field-test their solutions. Depending on the solution, some teams were provided a data logger so that the actual output of their solutions could be verified. The EBL reviewers also conducted live interviews with the field-testing teams in the energy access communities and interviewed their customers. After a successful field test, teams were invited to the global final in Baltimore, Maryland, USA.

The second iteration, EBL 2023, selected teams based on their full proposal, and 23 teams were invited to field test; and then they were invited to the global final in Orlando, Florida, USA, held alongside IEEE APEC 2023. All the past prize winners can be seen at <https://empowerabillionlives.org/winners/>. Figure 6 shows the number of entrants from a given country, demonstrating the worldwide reach of the competition.

The tracks were modified to reflect some of our learnings, with categories for Productive/End-Use Solution, Enabling Technology Solution, Impact Solution, and Automation-Centric Solution. The last of these was inspired by the participation of the IEEE Control Systems Society and reflects the role that intelligence and control can play in automating energy systems to optimize the production and sharing of power.



FIG 4 The 2023 EBL winning team Standard Microgrid—Project Zambia. Winner under category “Best Centralized Solution” for reimagining power.



FIG 5 Team SolarworX—EBL 2019 and 2023 Track Prize winner (Interoperable, expandable, solar home system management device allowing for the owner to be a consumer or prosumer).

When originally conceived, it was planned that EBL’s ongoing competition cycles would drive a continuous learning process that allows successive generations of competitors to leverage past learnings, adopt fast-moving new emerging technologies, and demonstrate these capabilities and impact in realistic environments. The second round (EBL 2023) showed just that EBL has achieved the goal of keeping past winners in our community, to promote their news and share their experiences in our workshops and special sessions, while inviting teams back to subsequent rounds to enter their solutions that have leveraged advancing technology to enhance their upgraded solutions. Table 1 outlines the EBL 2019 and 2023 winning teams and their impacts.

Currently, we are accepting proposals for the third iteration, EBL 2025, and we are updating the competition tracks. The Technical Solution Tracks will include Energy Supply, End-Use/Productive Use, Enabling Technologies, and Clean Cooking. A new category will focus on Local Entrepreneurship which will include two tracks: Last Mile Distributor and Leave No One Behind.

Power Electronics for Energy Access

The advances in power electronics continue to deliver efficiency gains and lower costs in systems that are getting more flexible and intelligent by the day. For billions of people needing access to energy, power electronics can deliver key components with controllers, inverters, converters, power semiconductors, and many other advancing technologies to provide solutions that are expandable and extendable to be grid-forming and ultimately grid-connected. Power electronics will provide the key technologies for making this achievable.

With the exponentially declining costs of 21st-century technologies, the world has an opportunity, while negotiating the Global Energy Transition, to utilize these greenfield energy infrastructure regions to implement leapfrog technologies in testing grounds that have the potential to shape the future of energy access worldwide.

EBL’s foundation in IEEE allows us to bring a wide range of technologists and problem-solving engineers together



FIG 6 Worldwide locations of EBL 2019 and 2023 teams.

Table 1. EBL winning teams tracks, impacts, and locations.

Solution	Beneficiaries	Notable Impacts
<p>SoULS Initiative, IIT Bombay, India – Global Grand Prize Winner - 2019 Solar Urja through Localization for Sustainability (SoULS) initiative is based on the ‘Power to All’, including active interventions for providing clean, efficient, affordable, and reliable energy access even to the last mile households. By providing assembly training in 34 languages and offering an open-source supply chain. https://www.soulsiitb.in</p>	Over 7 million	9,000 people trained in Solar Home System assembly. 245,000 trained in climate literacy
<p>Entrepreneurs du Monde and Okra – Cambodia – Best Emerging Utility Solution – EBL 2019 Entrepreneurs du Monde is an International NGO created in 1998 with the objective to tackle extreme poverty by supporting people’s own entrepreneurial ventures and giving them access to products that can bring significant health, economic and environmental benefits. https://www.entrepreneursdumonde.org/en/</p>	180,000	23 Programs; Operating in 11 Nations
<p>Reeddi – Nigeria; Best Student Team – EBL 2019 Reeddi sustainably provides clean energy and allied innovations at a price point that individuals and businesses operating in energy-poor regions of the world can afford. https://www.reeddi.com</p>	70,000 (3,000 monthly)	120,000 KgCO2 offset. Entrepreneurs created. 30% off the costs if by other fuel source.
<p>Havenhill Synergy Limited – Nigeria; Best Commercial Utility Solution EBL 2019 Ending Blackouts in Nigeria Havenhill Synergy is a cleantech micro-utility company that uses solar energy to generate clean, safe, cost-effective, and sustainable electricity in rural and urban Nigeria. http://www.havenhillsynergy.com</p>	2,000	
<p>Xpower Inc. – Rwanda; Best Base of the Pyramid Solution – EBL 2019 Xpower designs, builds, and operates next-generation solar microgrids for rural electrification. Combining mains AC and low voltage DC, these grids are optimized for cost, yet designed to scale with users’ needs over time. https://www.meshpower.co.rw/</p>	10,000	Created 25 full-time jobs and employment for 40 field-based agents. Saves 6.0 tons of CO ² eq per nanogrid per year.
<p>SolarWorX – Cameroon/Zambia; Best Emerging Decentralized Solution – EBL 2019 and EBL 2023 SolarWorX is a Berlin-based start-up, designing and manufacturing the next generation of solar pay-as-you-go solutions sold on a B2B basis to distribution partners across sub-Saharan Africa and beyond. https://www.solarworx.io</p>	6,000	The Mesh-Grid model allows for individuals or businesses to be prosumers by participating in the grid.
<p>Nanoé – Madagascar – Global Grand Prize Winner – EBL 2023 For developing access to electricity and employment by creating a new electrification model for Africa, progressive and modular, based on renewable energies, information and communication technologies, and local entrepreneurship. Nanoe.net/en/</p>	10,000 homes	80 employees and 150 locally trained entrepreneurs.
<p>Green Empowerment – Malaysia; Best Automation Centric Solution winner – EBL 2023 Working with in-country partner organizations to build clean water and renewable energy infrastructure with indigenous and rural communities across the globe. Greenempowerment.org</p>	483,000	247 infrastructure projects; 122 schools and clinics
<p>Atutu – Myanmar; Best Impact Solution – EBL 2023 Solar energy solutions are designed to efficiently address the needs of off-grid and marginalized communities in Southeast Asia. Atutu.org</p>	1,300 people in off-grid indigenous communities	22 community centers, 250 households
<p>DeOlivette – Nigeria; Best End-Use Solution – EBL 2023 Easy-to-use digester products that provide a safe alternative for clean cooking and with the aid of a modified generator can be used for electricity with the by-products of non-harmful fertilizer and clean water. Doe.com.ng</p>	200,000	50,000 Trees saved; 5,000 local women entrepreneurs; winner of 20 international awards.
<p>Standard Microgrid – Zambia; Best Centralized Solution – EBL 2023 Using an innovative approach to distributed renewable power services. Providing reliable power services to communities, growth opportunities for partners and staff, and financial returns for investors. Standardmicrogrid.com</p>	7000 households	Trains and employs regional technicians. 40 Jobs for women created, and 23 Community Institutions powered. CO ² offset 532 t/year.



FIG 7 EBL teams, judges, leadership, and invited supporters at EBL 2023.



FIG 8 SolarworX project Cameroon is redefining energy access in the remote regions of West Central Africa.

with the organizations which are addressing the problem on the ground, in target communities (Figure 7). The huge problem we are trying to address will need collaboration from a wide range of parties, built on clean, efficient, and intelligent power technologies. These technologies already exist, but they need to be applied to the challenging market environments of communities in energy poverty regions of the world. It is time for the incredible knowledge, talent, and innovations of renewable energy and power electronics to be applied toward the pressing global problems of energy poverty.

Conclusion

EBL's transformation from a competition to a collaborative community is a testament to the power of shared goals and collective action. What began as a challenge to innovators around the world to create scalable and sustainable energy solutions has evolved into a network of partnerships, comprising NGOs, and private sector players, all working in tandem to deliver on the promise of energy for all.

Each cycle of competition has advanced us along the learning curve of understanding and serving energy needs. EBL's journey has embraced the evolving developments of technology as we continue to expand the competition tracks and provide opportunities for teams to partner between technologists and last-mile distributors. As a competition, we can de-risk market entry and leverage the respect IEEE and PELS have for our review process and technical expertise providing our teams with a valuable spotlight that helps them to deploy and scale their solutions and attract follow-on funding.

EBL would be delighted by your participation in any form: reviewers, organizers, contestants, funders, promoters, mentors, and as a member of the Empower a Billion Lives Forum, an energy access community dedicated to establishing mechanisms for sharing information on needs for those in the energy access community. For those in the industry, check with your CSR department to see if EBL is a good fit with the company's giving priorities, especially if it is already participating in the energy transition. Please go to empowerabillionlives.org for more information.

EBL is more than just an initiative; it is a movement that is redefining the landscape of energy access (Figure 8). By understanding the historical context, embracing a tiered approach, fostering partnerships, and constantly learning and adapting, EBL seeks to make significant inroads in the fight against energy poverty. The road ahead is long, but with continued effort and collaboration, the dream of powering a billion lives with sustainable and equitable energy is within reach.

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