IEEE POWER ELECTRONICS SOCIETY
Powering a Sustainable Future

Energy Access Working Group Report to PELS Adcom

4/18/2019

The Grand Challenge

People who could be electrified using today's technology are already being served

Only **1.8 million** of those living off-grid have tier 2 access (<200 Wh)

Solving energy access with today's technology is not affordable and would result in **3.7 Gt** of excess CO_2 emissions – a disaster

Philanthropy for providing energy access is expensive and is not scalable or sustainable

New exponential technologies may offer the best chance to leapfrog the limitations and costs of current approaches

EMPOWER
A BILLION LIVES

PELS Energy Access Working Group

Mission (*strawman*)

The IEEE Power Electronics Society Energy Access Working Group (EAWG) will advance the global fight against energy poverty by providing expertise, guidance and services to identify future research and technology development and innovation, particularly as it relates to off-grid, edge-of-grid, and grid-integrated decentralized energy technologies for addressing energy access and energy poverty issues.

Vision (*strawman*)

The IEEE Power Electronics Society Energy Access Working Group coordinates broad and deep activities throughout the society, and with other groups within and outside IEEE, in the growing decentralized energy access solutions sector, including off-grid energy access and poverty alleviation, resilient and advanced energy communities, and forward operating and ad hoc environments. We create leadership, professional development, standards development, and other opportunities for practitioners, researchers, students, and all IEEE members interested in energy access.

EAWG Activities

Decentralized Energy Access Workshop (DEAS) (*to discuss*)

DEAS provides a venue for the global community focused on developing decentralized control solutions for energy systems which can be applied in a diversity of end-use applications, with a strong focus on solutions that are effective for energy access communities.

The approach is holistic, including technology issues that cover:

- power electronics, energy constrained power systems, adhoc and fractal grids, efficient energy appliances, decentralized real-time control, simulation & modeling, energy generation & storage, communications, IoT, markets, gaming theory, cybersecurity, regulatory/market issues, scalability

It is expected that these new technology solutions will enable a flexible, resilient, reliable and affordable electricity system that is significantly superior to the present grid, and lays the foundation for a decentralized energy future.

IEEE DEAS 2019 – Technical Program

IEEE DEAS / IEEE EBL – Feb 5-6, 2019

Feb 5th – Tutorial on Energy Access – Henry Louie, Seattle University

Feb 6th: 7:30 am – 8:30 am: Registration and Continental Breakfast

8:30 am- 9:35 am: Plenary Session
Welcome and Objectives: Deepak Divan, DEAS/EBL Chair
Invited Keynote: Imre Gyuk, DOE
Ben Kroposki, National Renewable Energy Lab

9:35 am - 10:45 am: Panel – Advanced Energy Communities
Session Chair: Bruce Rogers, EPRI*
Panelists: Joe Gammie, PowerSecure, Xuan Zhang, Envision; Yi Yang, Eaton

10:45 am – 11:00 am: Break

11:00 am - 12:10 am: Panel – Resilient Energy Communities
Session Chair: Ben Kroposki, NREL
Panelists: Brian Lindsay, Alabama Power; Shen En Chan, UNCC; Stan Atcitty, Sandia National Labs

12:10 am – 1:15 pm: Lunch & Exhibition

1:15 pm – 2:25 pm: Panel – Off-Grid Energy Access Solutions
Session Chair: Matt Jordan – EA Fellow, CDE GT
Panelists: Graham Pugh, PROPEL Clean Energy
Dan Estes, IEEE Smart Village; Gary Oppedahl, Emera Technologies

2:25 pm – 3:35 pm: Panel – Ad-Hoc Power Systems
Panel Chair: Deepak Divan, DEAS/EBL Chair
Panelists: Selma Matthews, US Army
Phil Krein, UIUC; Qianwen Xu, Aalborg University, Denmark

3:35 pm – 3:50 pm: Break

3:50 pm – 5:50 pm: Technical Paper Session 1
Session Chair: Sudip Mazumder, University of Chicago
Technical Papers:
- A Novel Approach for Bump-less Connection of Microgrids with the Grid; N Bilakanti
- Energy Access in Community Microgrids based on Decentralized Real-Time Pricing; Rohit Jinsiwale
- Power Smoothing Control Using Spline Function in Photovoltaic Generation System; Akiko Takahashi
- Intermittent Renewable Energy Source (IRES) Model of Solar Energy in Cipayung Microgrid System; Handrea Bernando Tambunan

5:30 pm – 8:00 pm: Exhibition, Posters & Reception

IEEE DEAS / IEEE EBL – Feb 7, 2019

7:30 am – 8:30 am: Continental Breakfast

8:30 am – 9:30 am: Plenary Session
Session Chair: Frank Lambert, IEEE PES President, GT CDE
Invited Keynote: Shay Bahramirad, Com Ed
Invited Keynote: Deepak Divan, Platinum Sponsor GT/CDE/GRA

9:30 am - 10:25 am: EBL Winning Team Presentations
Session Chair: Szilard Liptak, CDE GT

10:25 am -10:40 am: Break

10:40 am - 11:35 am: EBL Presentations 2 and Awards
Session Chair: Matt Jordan, CDE GT

11:35 am - 12:45 pm: Technical Papers Session 2
Session Chair: Issa Batarseh, University of Central Florida
Technical Papers:
- Implementing Pay-As-You-Go Functionality in Microgrids using Mobile Ad-Hoc Networks; Shreyas Kulkarni
- Single-Stage PV-Battery Microinverter Energy Solutions with Decentralized Model for Single-Family Homes; Xi Chen
- Decentralized Energy Access Solutions; Vencat Shiva
- Self-Organizing NanoGrid; Szilard Liptak

12:45 pm - 1:30 pm: Lunch

1:30 pm - 2:30 pm: Integration of Ideas Presented at DEAS
Deepak Divan – CDE GT
Ben Kroposki – National Renewable Energy Lab
Matt Jordan – EA Fellow CDE GT

2:30 pm: DEAS Adjourn

2:30 pm: IEEE PELS Energy Access Working Group (EAWG)

2:45 pm: Visit to GT Center for Distributed Energy (Optional)

5:00 pm: EAWG Meeting Adjourn

~50 attendees for DEAS 2019

EAWG Activities

Empower a Billion Lives (*strawman*)

EBL is a biennial competition to crowdsource innovation to develop solutions for energy access that are economically sustainable and rapidly scalable.

The approach is holistic, looking for innovation across diverse areas that are critical for a successful outcome.

Teams from around the globe compete and are focused on demonstrating innovative solutions suitable for off-grid communities living in extreme energy poverty.

A major thrust for EBL is to reduce technical and market risk for the teams, and providing guidance to them, so that their chances of success are increased.

IEEE Empower a Billion Lives – competition details

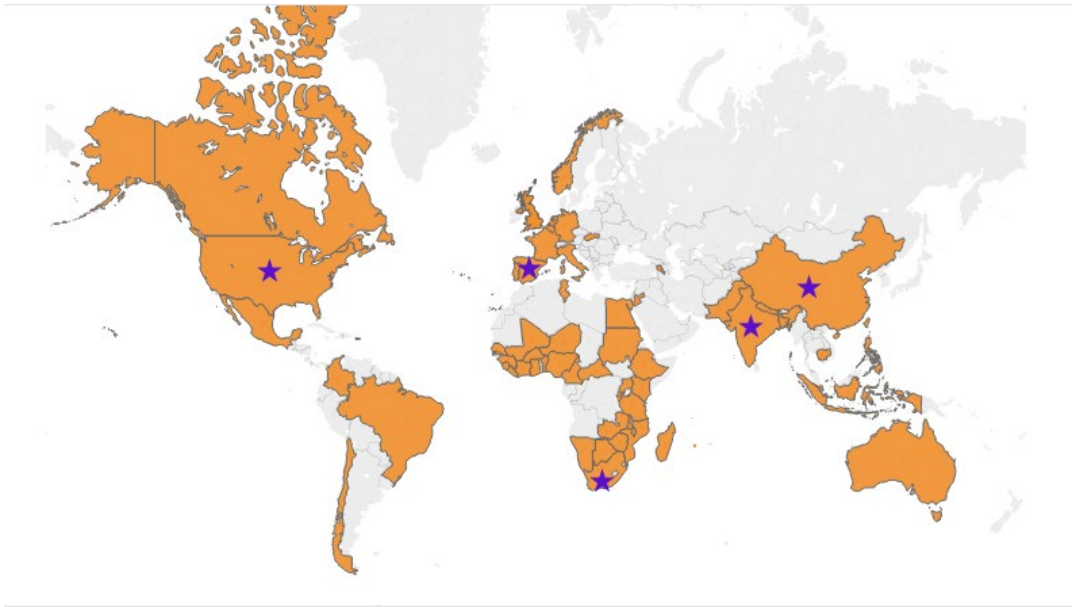
- **TRACK 1: DECENTRALIZED MODEL (TR1):** Serve single homes at the Tier 2 or equivalent level without creating an entire distribution infrastructure in advance of when it is needed.
- **TRACK 2: CENTRALIZED UTILITY MODEL (TR2):** Centrally planned and implemented power generation and distribution model offering the core service at the community level.

Competition	Date
On-Line Round	May 1 – Aug 31, 2018
Regional – EBL Shenzhen, China	Nov 4-7, 2018
Regional – EBL Joburg, S. Africa	Jan 16-18, 2019
Regional – EBL Chennai, India	Dec 18 – 22, 2018
Regional – EBL Atlanta, USA	Feb 5-7, 2019
Regional – EBL Seville, Spain	Jan 22-24, 2019
Global Final – EBL Baltimore, USA	Sept 2 – 5, 2019

What Are the Targeted Electricity Needs?

Tier 2 electricity access (200 Wh/day) and above including:

- **Household uses:** lighting and phone charging, telecommunication, entertainment, air circulation, refrigeration, water pumping, etc.
- **Community uses:** public lighting, water pumping & purification, etc.
- **Productive uses:** agricultural manufacturing, light manufacturing, commerce, etc.



EBL Organizing Committees

GLOBAL EBL COMMITTEE

- Deepak Divan – General EBL Chair
- Jerry Hudgins – Treasurer
- Jane Celusak – IEEE PELS Coordinator
- Szilard Liptak – Overall CDE Coordinator
- Matt Jordan – Judging and Fund Raising
- Braham Ferreira – Africa Chair
- Aline Banboukian – EBL Administrator
- Mark Dehong Xu – Pacific Asia Chair
- Surya Doolla – South Asia Chair
- Pedro Rodrigues – Europe Chair
- Szilard Liptak – Americas Chair
- Stan Retif – IEEE Foundation Coordination

INTERNATIONAL STEERING COMMITTEE

- Deepak Divan – General Chair
- Braham Ferreira – Co-Chair
- Alan Mantooth – Past PELS President
- Frede Blaabjerg – PELS President
- Arun Majumdar - Stanford
- Ashok Jhunjhunwala – IIT Madras
- Philip Krein – UIUC/Zheizhang
- Liuchen Chang – PELS VP

AFRICA

- Toit Mouton - University of Stellenbosch
- Willie Cronje - Wits University
- Nickey Janse van Rensburg - University of Johannesburg

SOUTH ASIA

- Surya Doolla - IIT Bombay
- Santanu Mishra - IIT Kanpur
- Krishna Vasudevan - IIT Madras

EAST ASIA

- Mark Dehong Xu - ZJU
- Jinjun Liu - University of Louisville
- Po-tai Cheng - National Tsing Hua University, Taiwan

EUROPE

- Pedro Rodriquez - Universidad Loyola
- Marta Molinas - NTNU
- Yongheng Yang - University of Aalborg

AMERICAS

- Deepak Divan - GT CDE
- Szilard Liptak- GT-CDE
- Sudip K. Mazumder - UIC

Empower a Billion Lives' Accomplishments

Solution Development and Submission

May 2018 - August 2018

- 459 teams registered
- 70+ countries
- 120+ student teams
- 137 proposals accepted

Online Review by Experts

August 2018 - October 2018

- Reviewed & judged by experts
- 82 teams invited to 1 of 5 Regional "Shark Tanks"

In-Person "Pitch" Review at Regional Events

November 2018 - February 2019

- 23 Global Finalists named

Regional Winners Deployed for Field Testing

November 2018 - August 2019

- Teams preparing for field testing

Announcement of Global Winners

October 2019

Regional Rounds - Overview

EBL's five regionals had 82 teams from which 23 highly innovative teams from 15 different countries won awards.

Team Name	Country	Award
Dream Grid	China	Student – Pac Asia
Apollo	Taiwan	1B – Pac Asia
Okra	France	Grand – Pac Asia
Power@NUS	Singapore	Student – S Asia
Bombay Bijlee	India	1B – S Asia
Cygni Energy	India	2A – S Asia
SoULS Initiative	India	Grand – S Asia
Agro Hub	Nepal	2B – S Asia
Café Lumiere	Madagascar	2B – Africa
Havenhill Synergy	Nigeria	2A – Africa
Nanoe'	Madagascar	Grand – Africa
Simusolar	Tanzania	1A - Africa

Team Name	Country	Award
Winnie the Power	Canada	Student – Americas
XPower	USA	Grand - Americas
Perryman	USA	2B – Americas
Reeddi	Canada	1B - Americas
Baobab+	France	1A – Europe
Smart Grids Lab	Scotland	Student – Europe
Solaris Off-grid	Spain	1B – Europe
Solar WorX	Germany	2B – Europe
FDU – Light Up	China	2A – Pac Asia
Green Spark	China	2B – Pac Asia
Solageo	China	1A – Pac Asia

Power Secure · ABB · DELTA · Texas Instruments · TATA · Wellness Telecom

Georgia Tech Center for Distributed Energy · Georgia Research Alliance · Mahindra ELECTRIC · CEEV

Technology Highlights from Global Finalist Solutions





Innovation Highlights from the 23 Global Finalists

Training Locals to Construct, Operate & Profit from DC Nanogrids
Madagascar | Africa Grand Winner

AC+DC Hybrid Extends Reach & Productivity of DC Microgrids
Rwanda | America Grand Winner

Peer-to-Peer Community Microgrids Serving the Last Mile
Cambodia | Pacific Asia Grand Winner

Frugal Approach to Battery Management Enabling Longer Life
Tanzania | Europe 1B Track Winner

Open Source Technology Empowering Women Entrepreneurs
India | South Asia Grand Winner

Pay-As-You-Go Solar 2.0 with the Power of Microfinance
Ivory Coast | Europe 1A Track Winner

Affordable, Mobile Agricultural Processing As A Service
Nepal | South Asia 1A Track Winner

Stackable, Expandable Solar Home Systems that are Easy to Use
Tanzania | Europe 2B Track Winner

Global Finalists have already been awarded more than $225,000. You can support the fight against energy poverty by supporting Empower A Billion Lives' Global Finalists.

EMPOWER
A BILLION LIVES

EBL 2018/19 Global Final

EBL Global Final

- Currently scheduled for ECCE 2019 (Sept 29 – Oct 3, 2019)
- Teams will present to judges (technology, venture capital and social impact) in a 'shark tank' format, as a pitch to potential investors, highlighting the 'wow' factor for their solution, and their ability to build a scalable and viable business
- Judging starts on Saturday (Sept 28), with a poster session for the broad audience, presentations by winners, and a special reception for media and investors
- Targeting $400K (ideally), with a minimum of $225K for awards – Grand, 3 x tracks and 1 student
- Very high visibility program with a potential for great impact, positioning IEEE and PELS as leaders in applying technology for solving hard energy access issues

EBL Financials

EBL Regional Budget – at ECCE 2018

Budgeted	Team reg. PELS	PELS for Award	Local Raise Target	Total
Pac Asia	7.5	10	32	50
South Asia	7.5	25	25	57.5
Africa	7.5	25	25	57.5
Europe	23.5	10	40	73.5
Americas+DEAS	7.5	25	25	57.5

PELS Committed: $148.5; Local Comms: $147

EBL Regional Actual Expenses (Prelim)

Actual	Award	Local Raise	Expenses	Net Surplus PELS
Pac Asia	30	20	15	(15)
South Asia	23	12	0	(18)
Africa	35	0	10	(45)
Europe	42	15	25	(49)
Americas+DEAS	35	46.5	7	12

Local Comms: $93.5; PELS Coverage: $115

EBL Final Proposed Budget

Actual	Team reg. PELS	Award	Travel	Field Testing	Total PELS	Total Outside
Global Final	37.5	400	50	25	112.5	400

- ECCE to be paid $37.5K by PELS for team/judge registration
- Food and conference access covered by ECCE
- ECCE to host a reception for team, judges, investors, VCs and key PELS members
- Actively looking for award support from outside PELS – critical discussion item

EBL Financial Status and Actions

Available Funds:
- Currently $163K in Foundation Account
- Currently $20K in EAWG Account
- Asking for $80K from Adcom (same as at ECCE, not needed then)
- Total Available: $263K

Outgoings:
- $127K to be paid to cover regional competition costs
- $112K for Global Finals (non-prize expenses)
- $20K for misc coverage needed
- Total Expected Outgoings - $259K

Action:
- Target raising $300-450K in award funding over next 3-5 months (looking for support)
- Meet PELS leadership team in 90 days to discuss progress and possible actions

Motion:
- Approve $80K in funding for the Energy Access Working Group to support the EBL Competition

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Powering a Sustainable Future

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4/18/2019

Xpower designs, builds and operates next generation solar microgrids for rural electrification. Combining mains AC and low voltage DC, these grids are optimised for cost, yet designed to scale with users' needs over time.

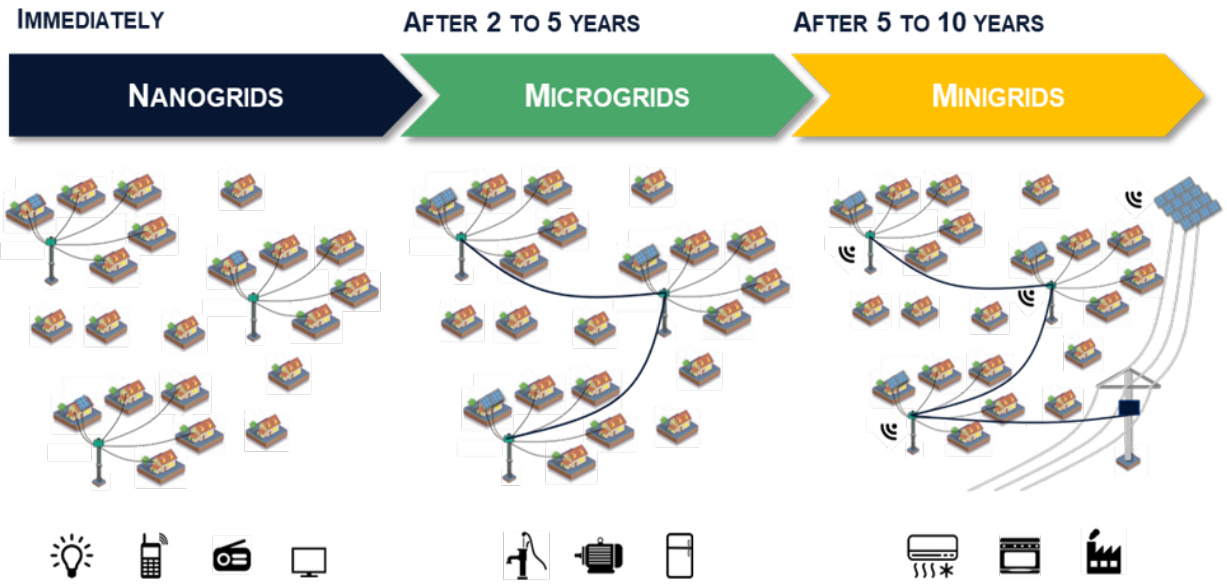
Americas Grand Award

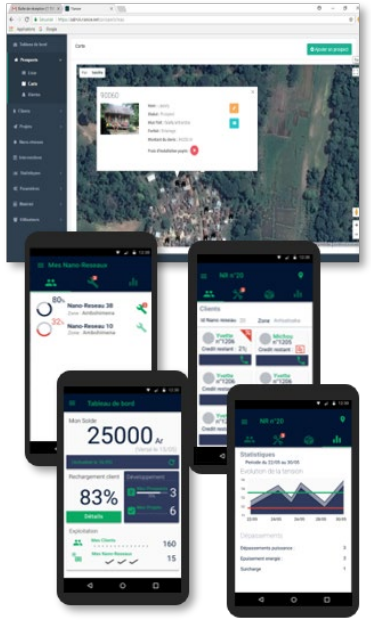
What's compelling? Xpower's DC/AC hybrid approach, based on their experience with more than 70 DC microgrids

Nanoé

Africa Grand Award

Lateral electrification: Towards a bottom-up smart power infrastructure development path for Africa



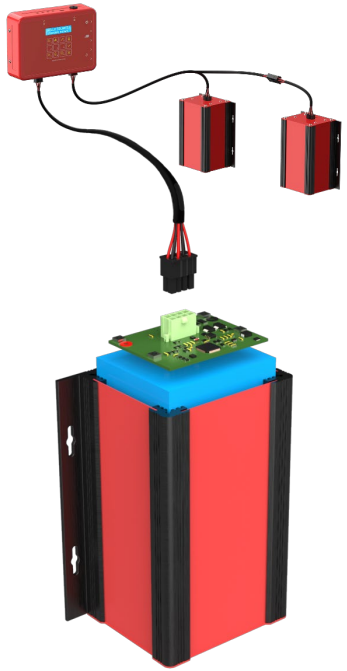


What's compelling? Nanoe's focus and expertise on training locals to construct, operate, and profit from the nanogrids, Nanoe receiving a 30% cut

Solaris OFFGRID

Europe 1B Track Award

Solaris Offgrid designs Pay-As-You-Go solutions to foster affordable and sustainable energy access in off-grid areas.



What's compelling? Solaris' frugal approach to battery management that enables delivering longer battery life at lower cost to the sector

Localized Energy Self-Sufficiency (SoULS)

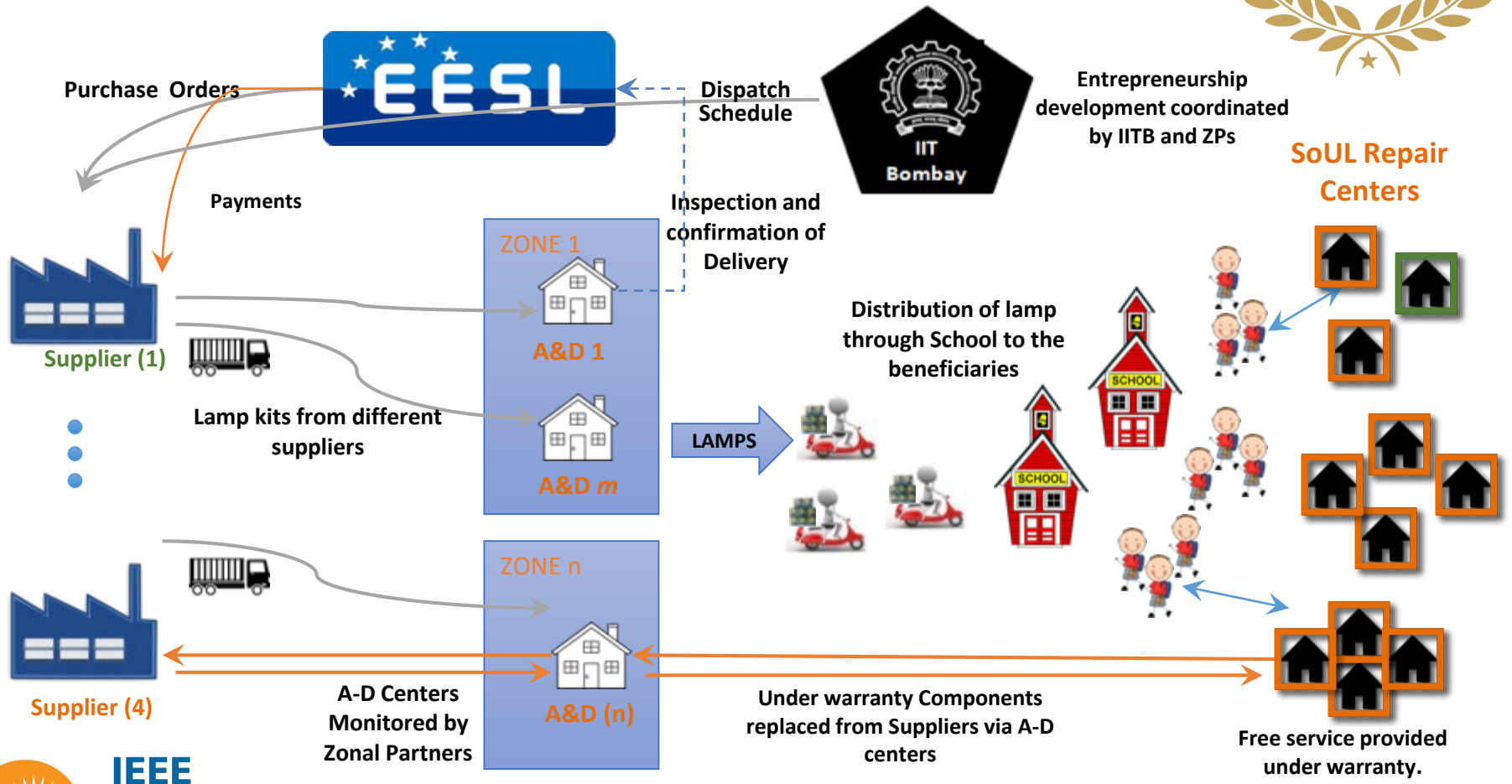
SoULS Vision: To create an **open-source market-based ecosystem** for **availability and adoption** of **off-grid solar products** through a sustainable **local supply/assembly/service** mechanism

South Asia Grand Award

6000+ Women are involved in assembly, distribution and repairs

290+ districts where program is currently running

3.7 million students have assembled/received solar lamps



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An IEEE-PELS Initiative

What's compelling? Open-source model for procurement/assembly of standardized flexible off-grid solutions with local assembly/service