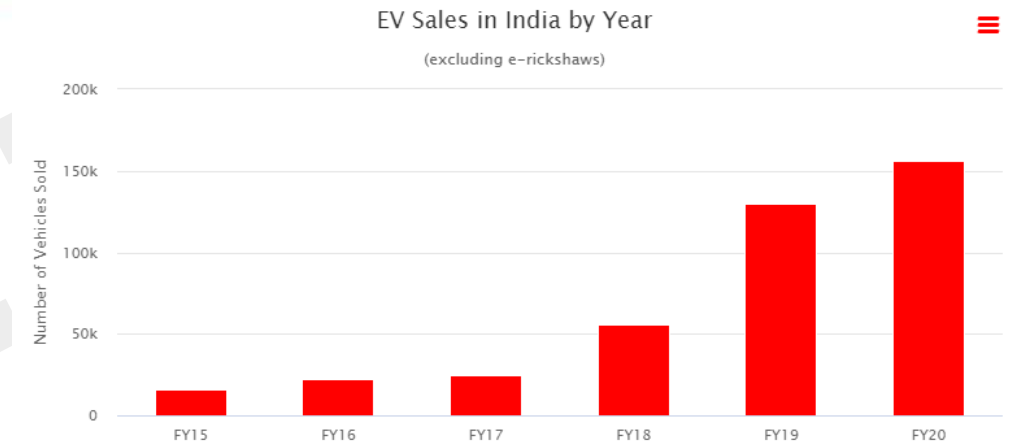


RE and EV Integration with Distribution Networks

Integration Challenges and Opportunities

Dr. Killian McKenna
Senior Research Engineer,
National Renewable Energy Laboratory

- India's ambitious renewable energy targets has largely been met by large non-rooftop solar photovoltaic systems connected to the bulk power system.
- Rooftop solar has been growing rapidly, with a total of 5.1 GW of rooftop solar connected in July 2021, and an annual growth rate of 116% between 2012 and 2018, with 70% from commercial and industrial consumers.
- EV sales have also been rapidly growing, but still accounts for a very small percentage of total vehicle sales with targets for 30% of new vehicles sales to be electric by 2030.
- NREL has been working with India DISCOMs to develop tools for:
 - Understanding tariff and DER interactions and untapped benefits
 - Understanding distributed solar integration and smart inverter capabilities
 - Analyzing changes to net load and distribution network loading with increased DER adoption
- NREL has been developing open-source tools to aid DER integration in India



Source: [DazeInfo, SMEV](#)

● Number of Electric Vehicles Sold

© Dazeinfo / Data Source: SMEV

Historic market growth and projections³

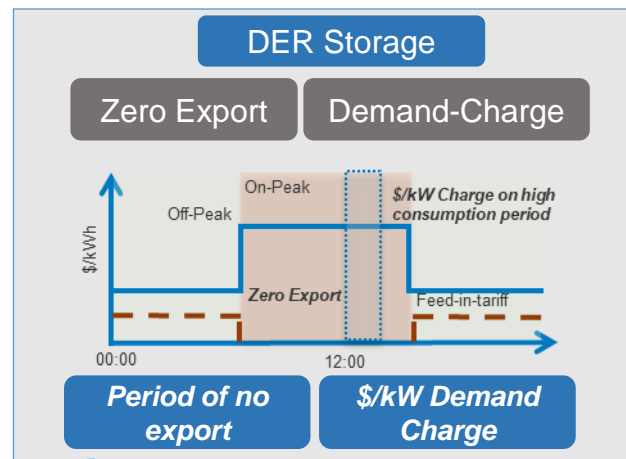
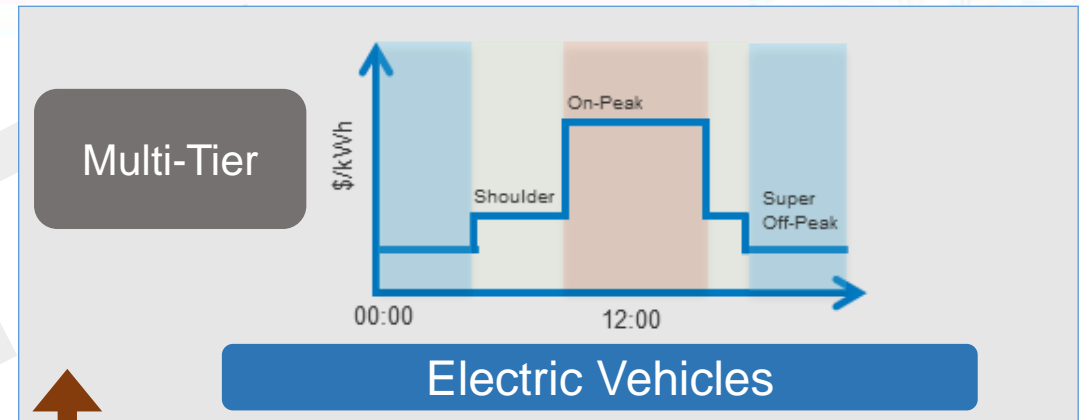
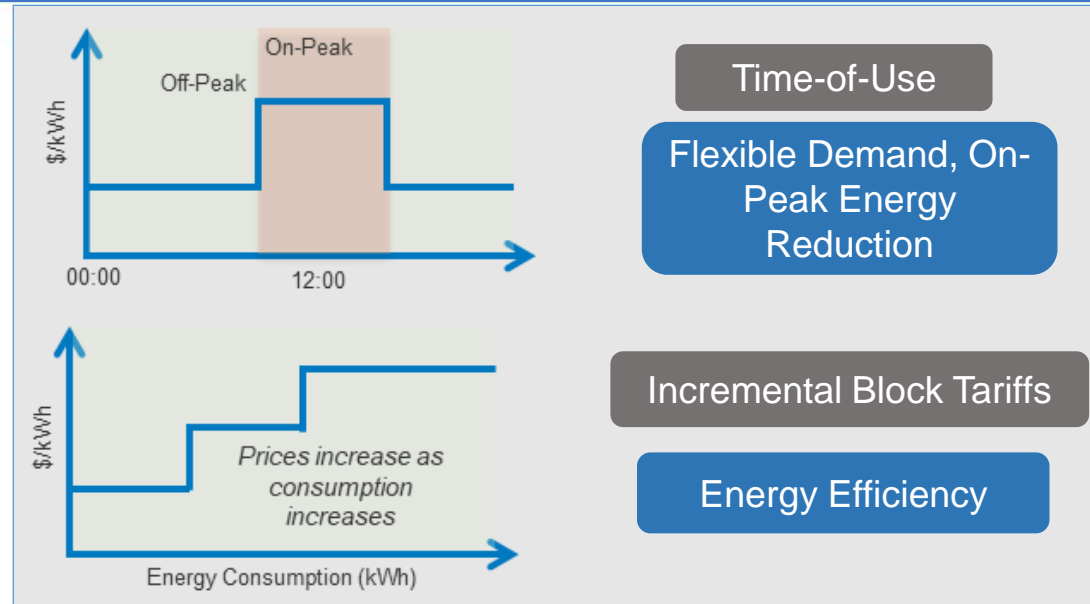


Source: [Bridge to India](#)

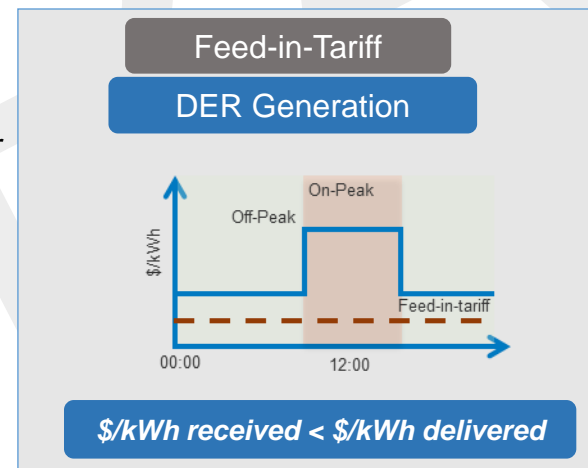
Evolution of Price-Plans

Flat Rate

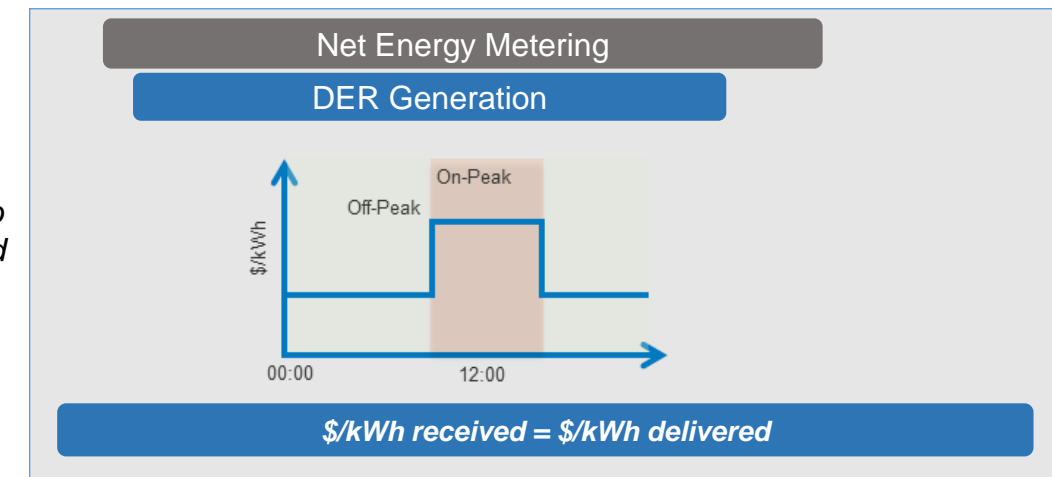
To encourage flexible demand and energy efficiency utilities introduced time-of-use or stepped tariff structures



As solar adoption further increases, utilities encourage customers to adopt storage to use generation locally



As solar adoption increases, to recover fixed costs, utilities introduce a feed-in-tariff

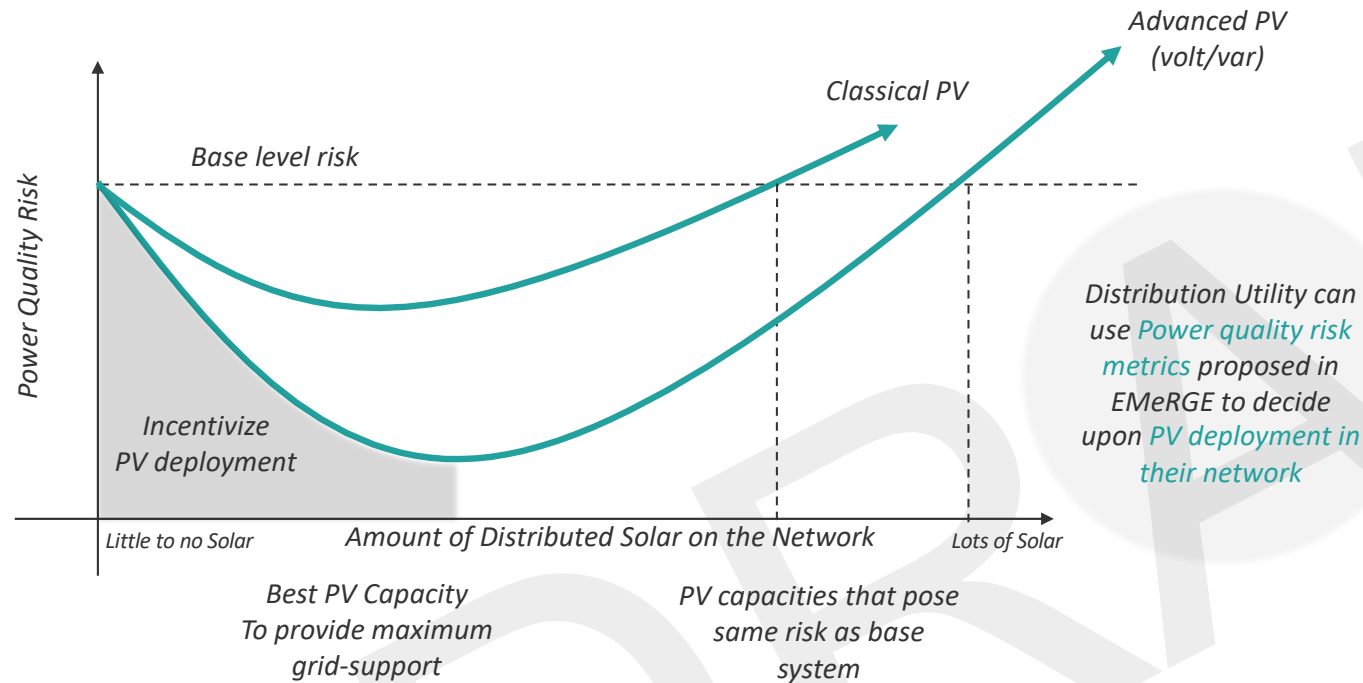


Transactive energy markets

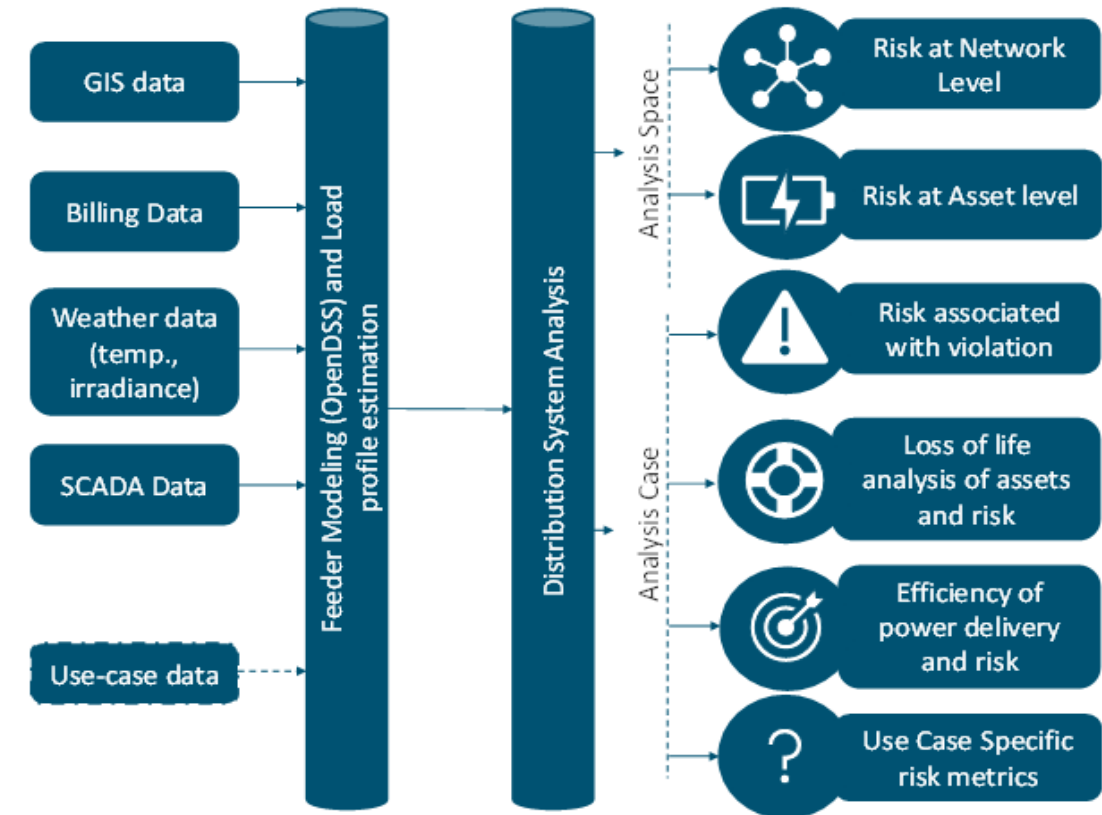
Distributed nodal pricing

Distributed ancillary services

TANGEDCO – Distributed Solar in Tamil Nadu

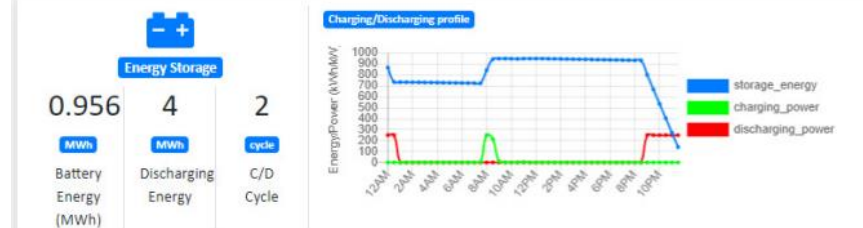
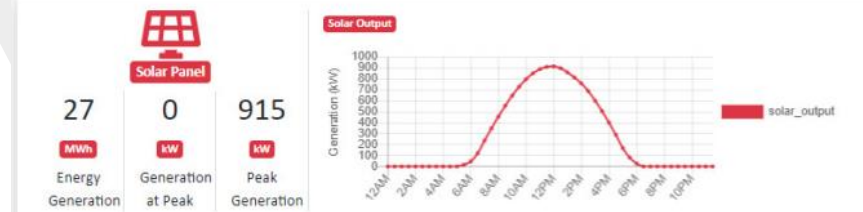
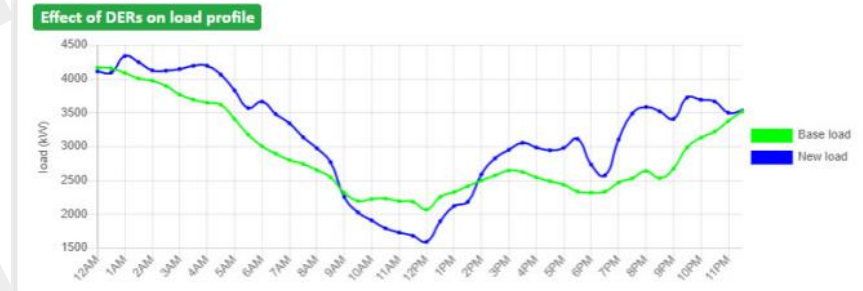
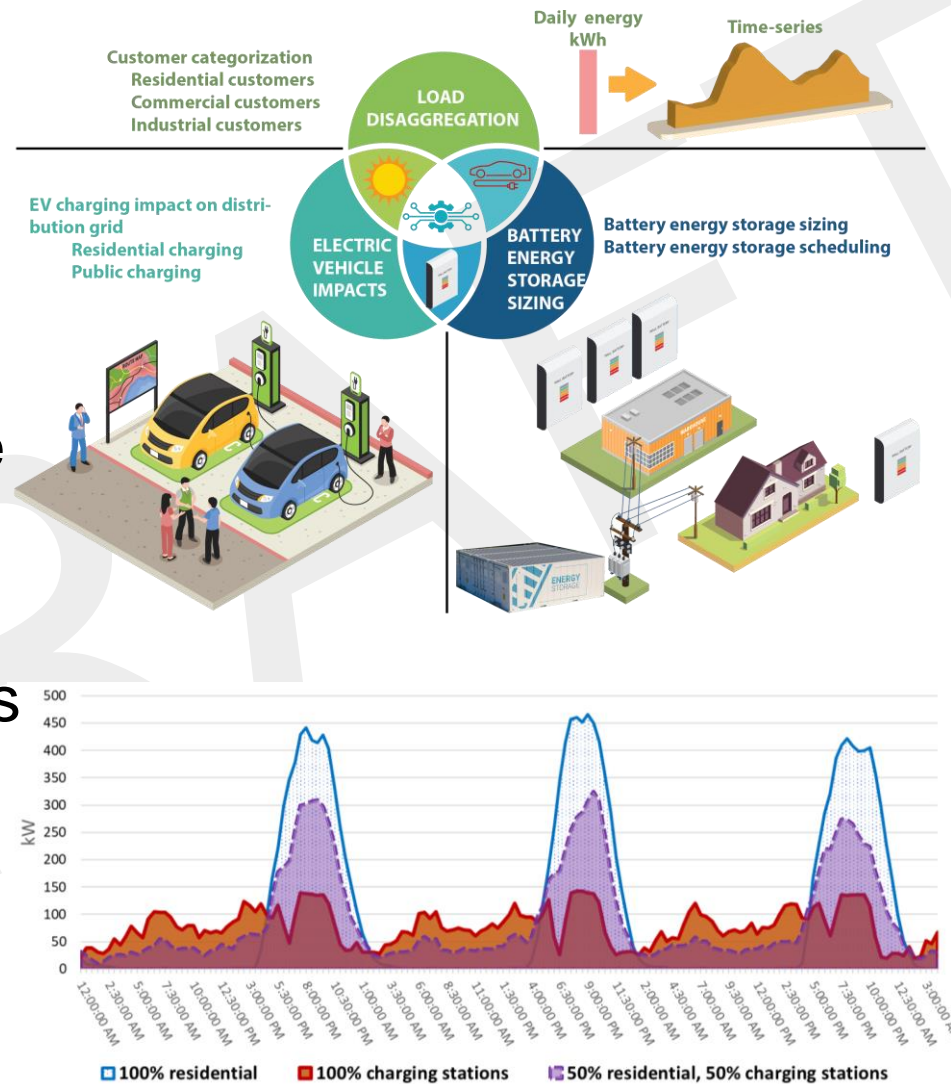


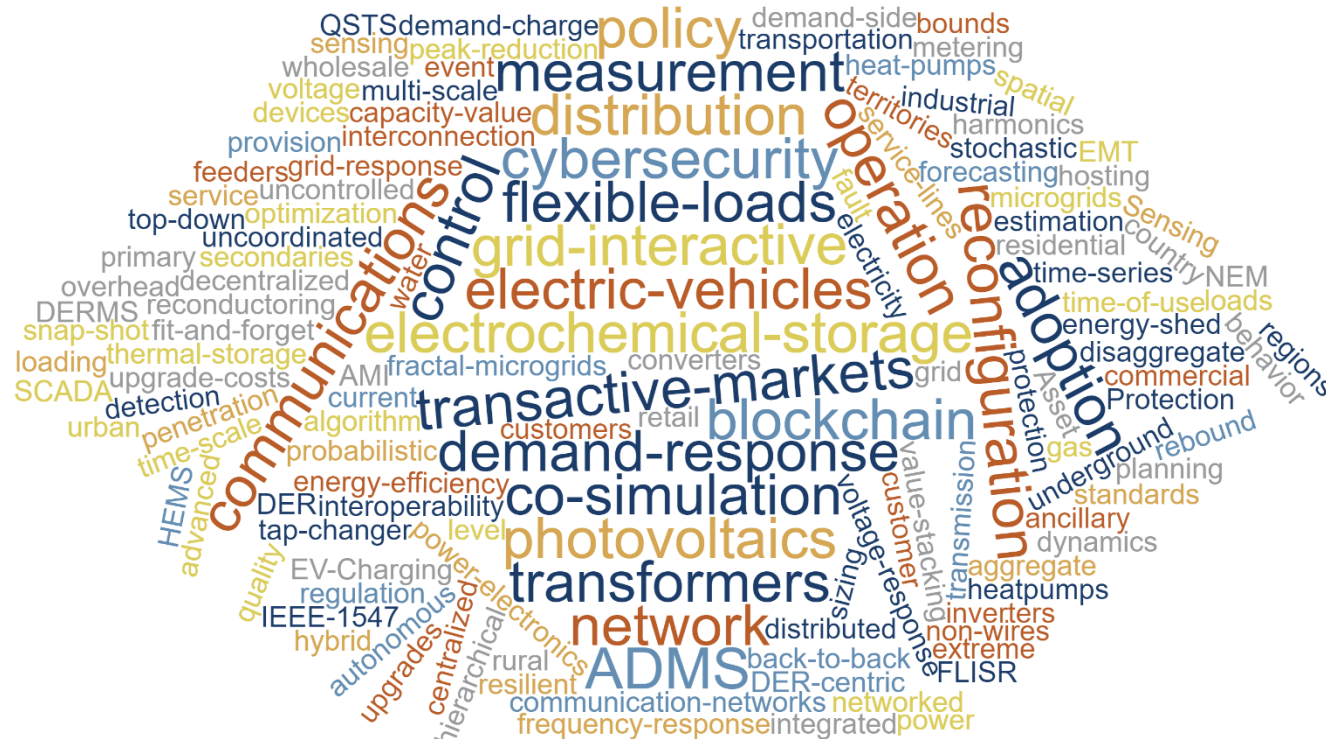
EMeRGE Framework



- EMeRGE was developed working with TANGEDCO engineers to help with distribution planning
- Study results showed that TANGEDCO is set to benefit from increased distributed PV
- Continuous volt-VAR support may help TANGEDCO control grid-edge under voltages

- NREL has developed tool and analysis to examine the impact of DER (solar, batteries) and changes to the demand-side such as EV adoption on utility net load profiles at BYPL
- EV's are set to heavily increase distribution network peak demand
- Battery systems can be used as a means of peak shaving as an alternate to network upgrades and can provide ancillary benefits





- **NREL Open-source tools developed for India:**
- **EMeRGE** - Emerging technologies management and risk evaluation on distribution grids evolution
 - <https://github.com/NREL/EMeRGE>
- **EVOLVE** - Evolution of net-load variation by emerging technologies
 - <https://github.com/NREL/EVOLVE>
- **EFFORT** - Effectiveness of rate structures for enabling demand response
- **Contact:** Killian.McKenna@NREL.gov

Thank You

Contact: Killian.McKenna@NREL.gov

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

India Smart Grid Forum
CBIP Building, Malcha Marg,
Chanakyapuri,
Delhi-110021
Website: www.indiasmartgrid.org