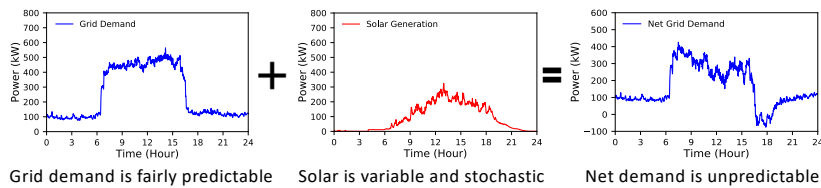# Breakthrough: Software-defined Solar Systems

David Irwin (PI) and Prashant Shenoy (Co-PI); University of Massachusetts Amherst
https://www.nsf.gov/awardsearch/showAward?AWD_ID=1645952

Challenge

- High solar penetration makes managing supply/demand difficult
- Current solution places hard caps on grid-tied solar capacity
- Hard caps unfair to late adopters, and waste capacity to use solar

Grid demand is fairly predictable   Solar is variable and stochastic   Net demand is unpredictable

Solution

- **Helios** – a programmable software-defined solar module
- Implements voltage control to set solar output between 0 and max
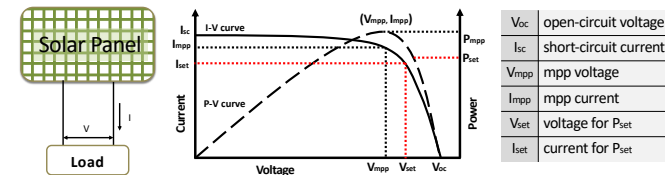- REST API that admits simple implementation of rate control policies
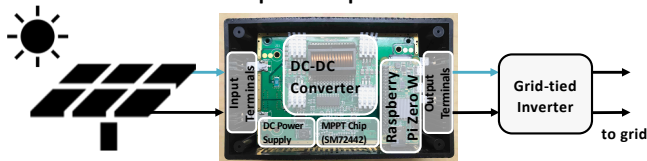
Impact on Society

- More owners can install solar (3.5x)
- Grid operates better equipped to manage supply/demand
- Environment is cleaner, as more solar energy can be added to grid
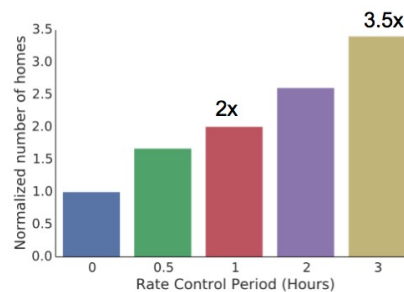
Scientific Impact

- I-V curves defines relationship between solar power, current (I), and voltage (V)
- MPPT algorithms search for voltage that maximizes solar power
- Same voltage control mechanism can be used to operate solar at any voltage yielding a desired power

V_{oc}	open-circuit voltage
I_{sc}	short-circuit current
V_{mpp}	mpp voltage
I_{mpp}	mpp current
V_{set}	voltage for P_{set}
I_{set}	current for P_{set}

- Permits control of solar "flows" in grid similar to network flows
- Enables new policies for dynamically controlling solar
- Introduces notion of grid neutrality, akin to net neutrality

Education and Outreach

- **UMass Summer Engineering Institute (SENGI):** Taught a class and tutorial on solar and software-defined solar to high school students
- **ECE 674 Green Computing**: Integrated software-defined solar as a part of new graduate-level course in UMass ECE department
- **UMass Trace Repository:** Provide solar irradiation, solar power, and weather traces to the research community for analysis