Microgrid: The Technology Issues and Environmental/Economic Benefits

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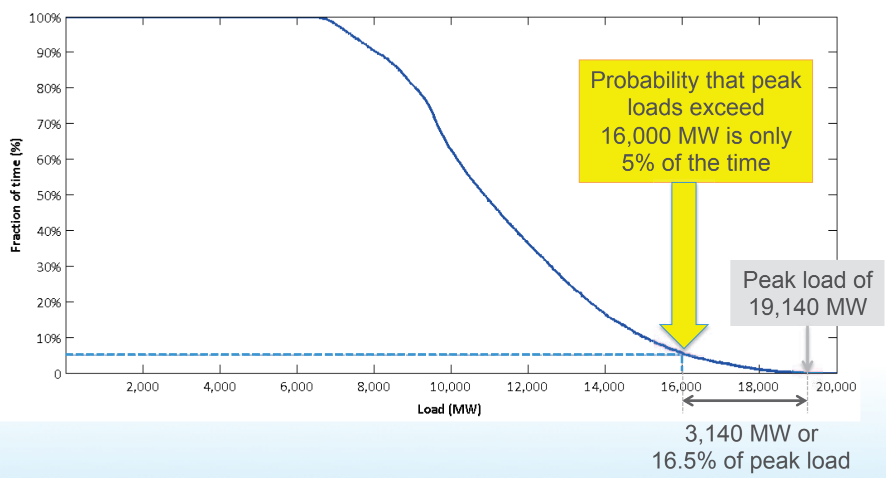
Technical Objective

We propose to explore the feasibility of and provide guidelines for the development of microgrids in campus-type facilities for energy conservation, reduction of greenhouse gas emissions and peak load reduction.

Load Duration Curve
Dominion Virginia Power (2010)

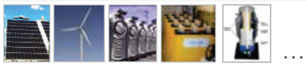


Peak load and its duration

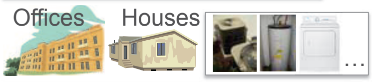
- In the US 20% of the load happens 5% of the time
- In Australia 15% of the load happens 2.5 days in a year or less than 1% of the time
- In Egypt 15% of the load happens 1% of the time

Technical Objective

Choices of DER technologies:



Choices of controllable loads:



Choices of microgrid topologies:

This test bench can be used to:

-compare and evaluate different peak shaving options: load control or running generators

-compare operating performance of different DER technologies (operational, economic and environmental)

-study microgrid operation in the grid-connected and islanded modes

-etc.

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Load & Generation Control Algorithms can be initiated to:

Case 1:

Keep electricity demand/consumption low to avoid high peak prices

Case 2:

Manage internal loads and generation during a utility outage

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Load & Generation Control Algorithms Case 1: To Avoid High Peak Price

Step 1: Renewable generation
- Electricity from PV is treated as negative loads.

Step 2: Demand Response
- At the circuit level, the operator sets the demand limit.
  - The limit is allocated to customer groups.
  - The limit is then further allocated to each customer.
- At the customer level, the customer sets their own preference and load priority.
  - Load control is performed at the appliance level.

Step 3: Storage control
- Storage will be used to complement demand response.

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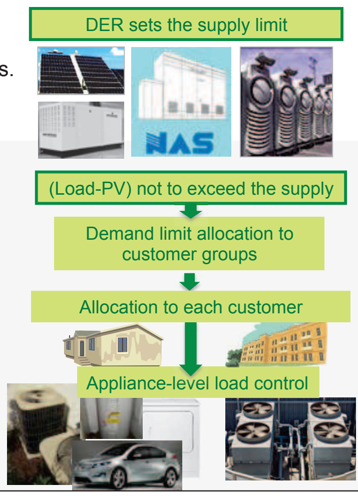
Load & Generation Control Algorithms Case 2: To Manage a Utility Outage

Step 1: Generation Control
- Electricity from PV is treated as negative loads.
- DER is called upon to serve the circuit's internal loads.

Step 2: Load control:
- At the circuit level, the demand limit is set based on the internal generation availability.
  - The limit is allocated to customer groups.
  - The limit is then further allocated to each customer.
- At the customer level, the customer sets their own preference and load priority.
  - Load control is performed at the appliance level.



Economic/Environmental Benefits

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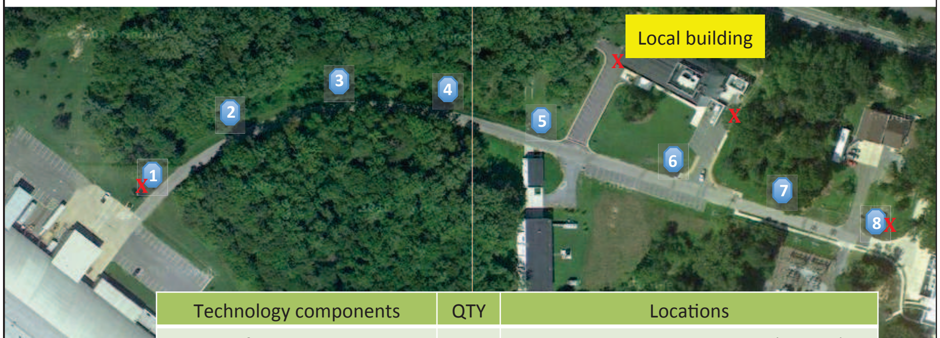
Demonstration Site

- A service road in West Bethesda, MD



Technology components	QTY	Locations
LED light fixtures	8	Installed on existing light poles (no. 1-8)
Streetlight controllers	8	Installed inside each LED fixture
Traffic sensors	4	Installed at the locations marked by X
Smart server and photocell	1	Local building
Network mgnt center	1	Local building

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HPS vs LED

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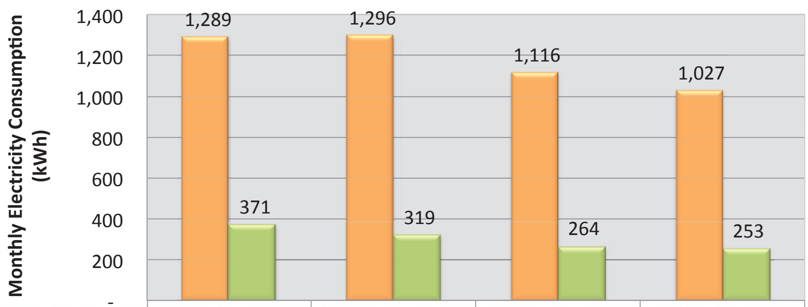
HPS vs LED
Monthly Electricity Consumption

Average electricity **savings of 75%** was experienced during four months after the installation.



	Feb	Mar	Apr	May
HPS	1,289	1,296	1,116	1,027
LED	371	319	264	253

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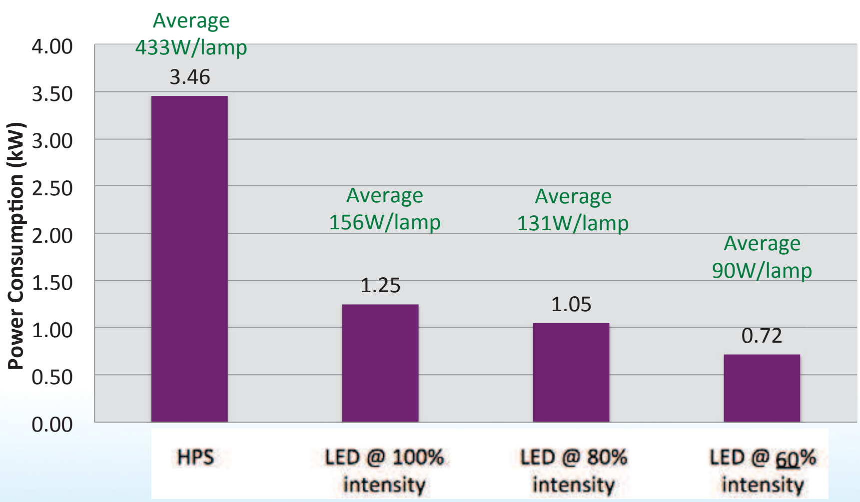
HPS vs LED – May 12, 2012
Power Consumption (kW) for 8 Units



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HPS vs LED
Life Cycle Cost (LCC) Analysis

	Base Case (HPS)	Alternative (LED)
Initial Capital Cost	8*$300 = $2,400	8*$1,300 = $10,400
Recurring Cost		
(a) Maintenance – replacement cost	Light bulb: $20 every 3 years Ballast: $150 every 6 years Labor: 5 man-hrs, $50/hr Bulb replacement & labor costs: = 8*$20+$250 = $410 Bulb & ballast replacement and labor costs: = 8*($20+$150)+$250 = $1610	Life: > 12 years No maintenance cost
(b) Operation – electricity cost @ 11.83c/kWh	14,753 kWh/year or $1,745/year, 3% inflation	5,620 kWh/year or $664/year, 3% inflation
Note: CO_2 emission @ 1.232 lbs/kWh*	18,176 lbs CO_2/year	6,924 lbs CO_2/year

* From EIA's eGRID 2012

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Thank you

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