Data Center Peak Shaving Using Batteries

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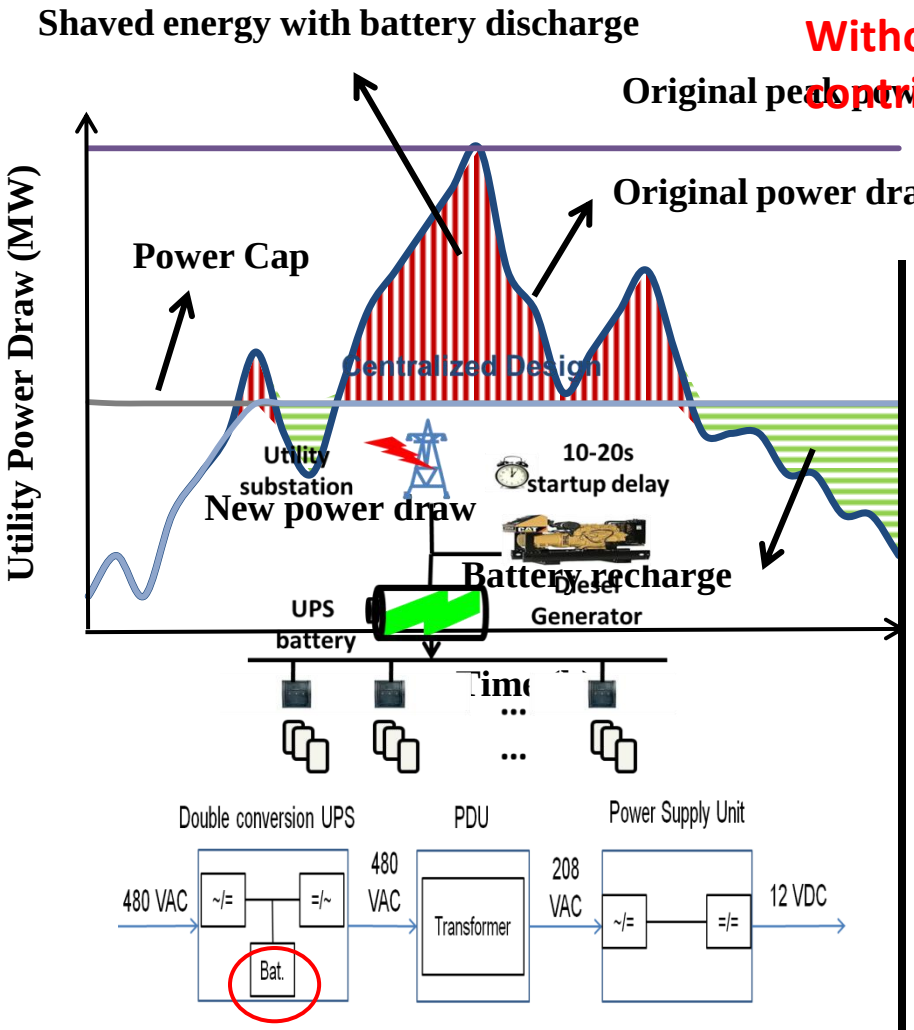
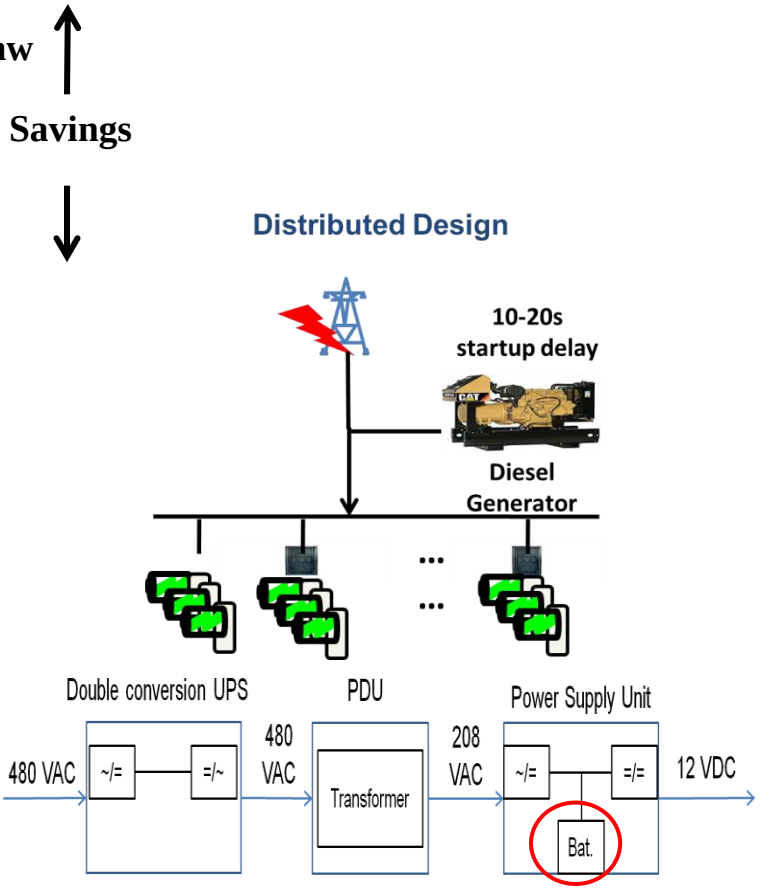
This work was sponsored in part by Google, NSF ERC CIAN (grant number 812072), NSF IRNC TransLight–StarLight (grant number 962997), CNS and MuSyC.

Peak Power Shaving with Batteries



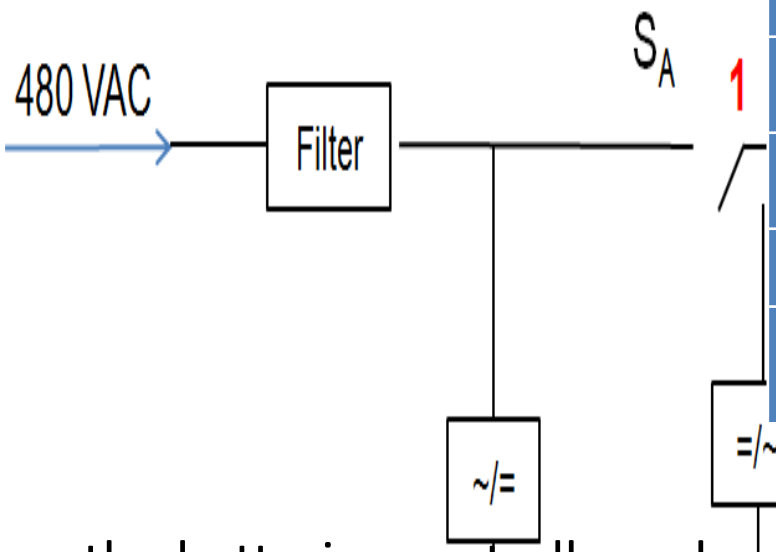
Without peak shaving, peak power can contribute up to 50% to the utility bill.



- Battery powers the entire data center
  - Results in much lower peak shaving duration

- Requires a centralized controller for the best performance
- Each battery still powers an entire server

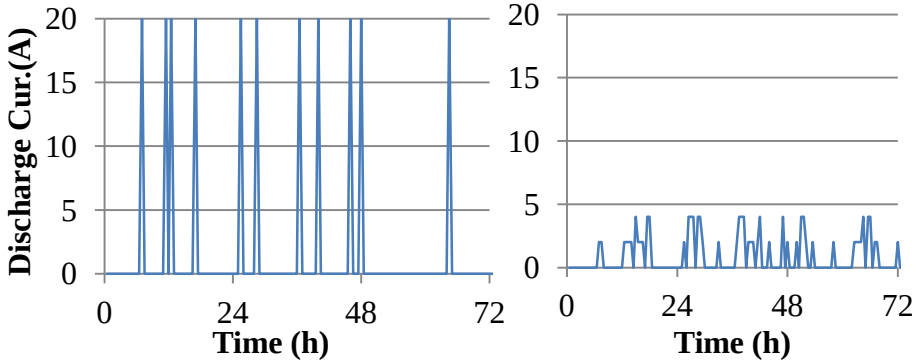
Our Grid-Tie Design



	SoA centralized	SoA distributed	Our design
Placement	Centralized	Distributed	Centralized
Selective Discharge	X	✓	✓
Adaptive Current	X	X	✓
Battery Model	X	X	✓
Coordination Medium	N/A	Data center network	Dedicated network

- Place the batteries centrally and connect the battery output to the main power distribution with grid-tie inverters
  - Any amount of battery power can be combined with grid → can scale down the discharge current
  - Batteries are placed together → can leverage a dedicated network
  - We can still select the batteries individually to discharge!

Results: Performance of Our Grid-tie Design



The discharging current with distributed design (left) vs. ours (right)

Peak Power Per Server (W) – Shaving %	Power Shaving Duration (min)	
	Distributed – LFP	Grid-tie – LFP
300 – 15%	552	516
310 – 17.5%	451	418
320 – 20.3%	381	351

Conversion losses require 8% more battery capacity

Results highlights vs. SoA distributed:

	LFP	LA
Peak power performance	Similar	
Colocation rental cost savings	70% more	100% more
Total cost of ownership savings	48% more	107% more
Battery lifetime	60% better	78% better
Communication overhead	4x less	

Summary

- Peak power shaving with batteries is an effective method to decrease the operational costs of a data center

- State-of-the-art centralized and distributed battery designs have problems
  - Capturing battery behavior
  - Scalability vs. performance

- We propose a new battery placement architecture
  - Up to 78% longer battery lifetime
  - Up to 107% more cost savings
  - 4x less communication overhead

- Current research:
  - Data centers in smart grid
  - Energy management in residential neighborhoods and smart grid