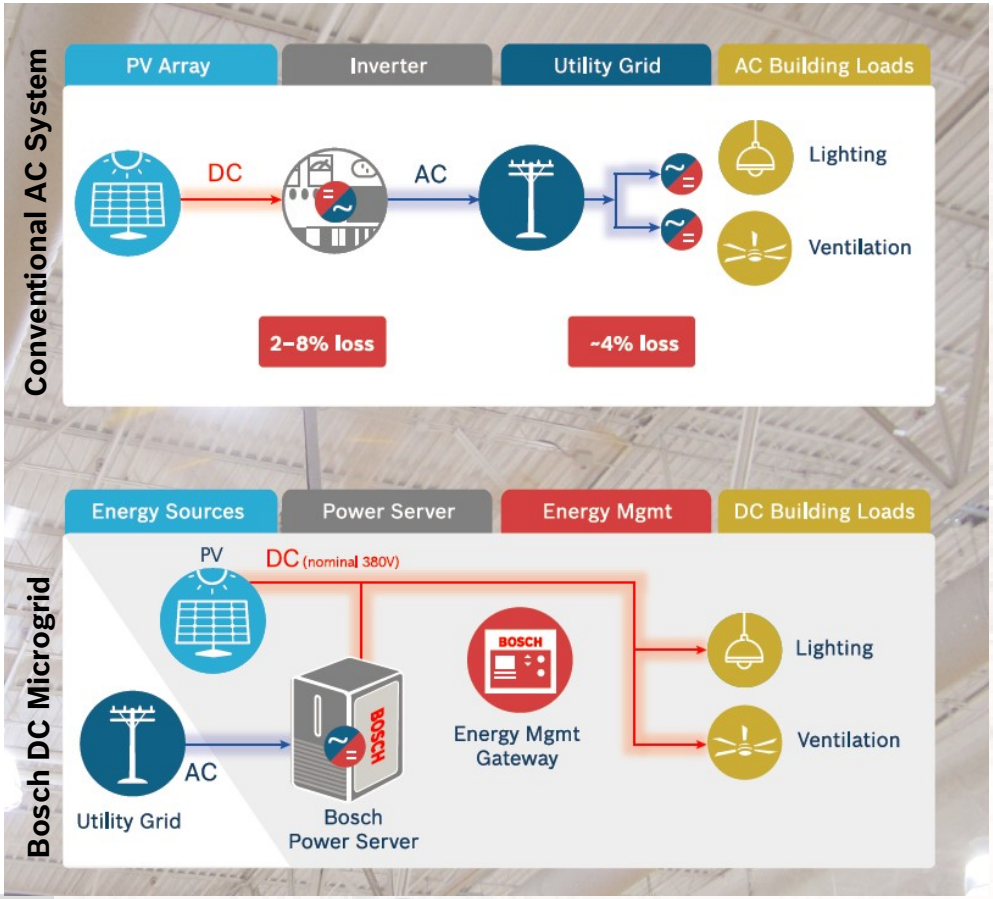
Direct Current Based Power Distribution Architectures for Commercial Buildings



Benefits of DC Micro-grid

- 7-10% average higher utilization of on-site generation
- Lower energy losses
- Higher reliability
- Resiliency during grid outages
- Minimizes grid interconnections
- Emergency lighting support
- Lower investment
- Significant reduction in greenhouse gas emissions

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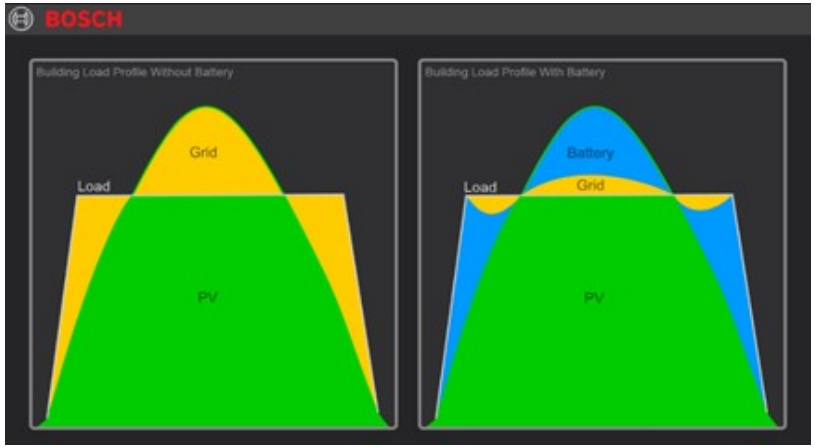
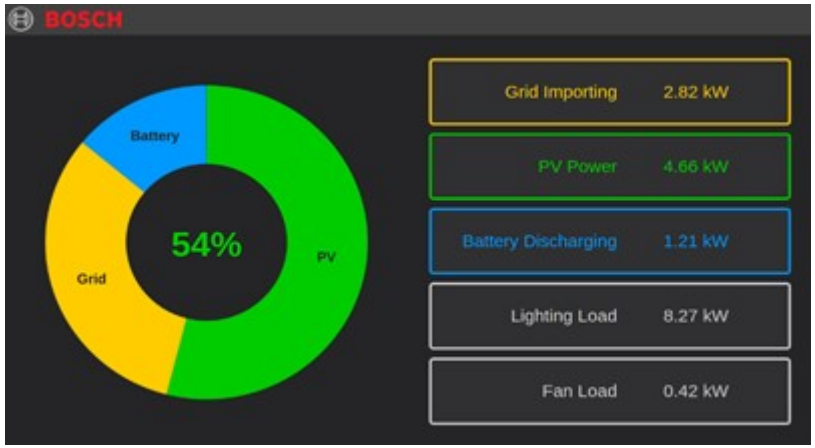
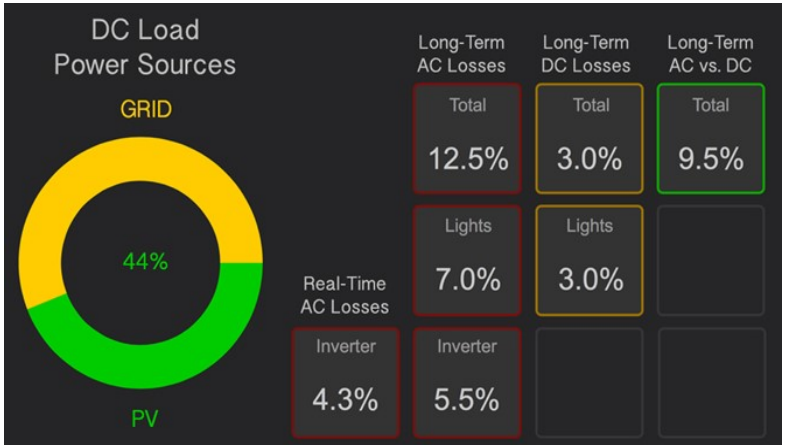
Cost Effective Zero Net Energy Approach



- **Maximize RE Usage on-site**
  - DC Load/Energy Storage optimization
  - Reduce export to utility grid
  - Higher renewable energy utilization
- **Minimize Power Conversion losses:**
  - Higher efficiency for loads and storage
  - Higher efficiency for PV array
  - Lower power dissipation losses





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Bosch DC Microgrid Pilot Demonstrations

1) **Lab Scale Demo** DC Load Size: 3.3 kW	Plymouth, MI | 2013	FINISHED
2) **Building Scale Demo** DC Load Size: 15 kW	Charlotte, NC | 2014	FINISHED
3) **DOD Awarded Demo** DC Load Size: 15 kW	Ft.Bragg, NC | 2015	FINISHED
4) **Bosch Building Installation** DC Load Size: 30 kW	Plymouth, MI | 2015	UNDERWAY
5) **Bosch Dev Lab 2.0** DC Load Size: 30 kW	Mooresville, NC | 2015	UNDERWAY
6) **CEC Awarded Demo (Honda)** DC Load Size: 175 kW	California | 2016	IN DESIGN

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DOD Project – DC Microgrid at Fort Bragg, NC

- **Features at Hercules Fitness Center**
  - Grid resiliency
  - Energy efficiency
  - Higher renewable energy utilization
- **System Details:**
  - 15 KW DC Solar array
  - 44 DC induction lights
  - 4 DC fans
  - 100 KW Li-Ion Energy Storage System

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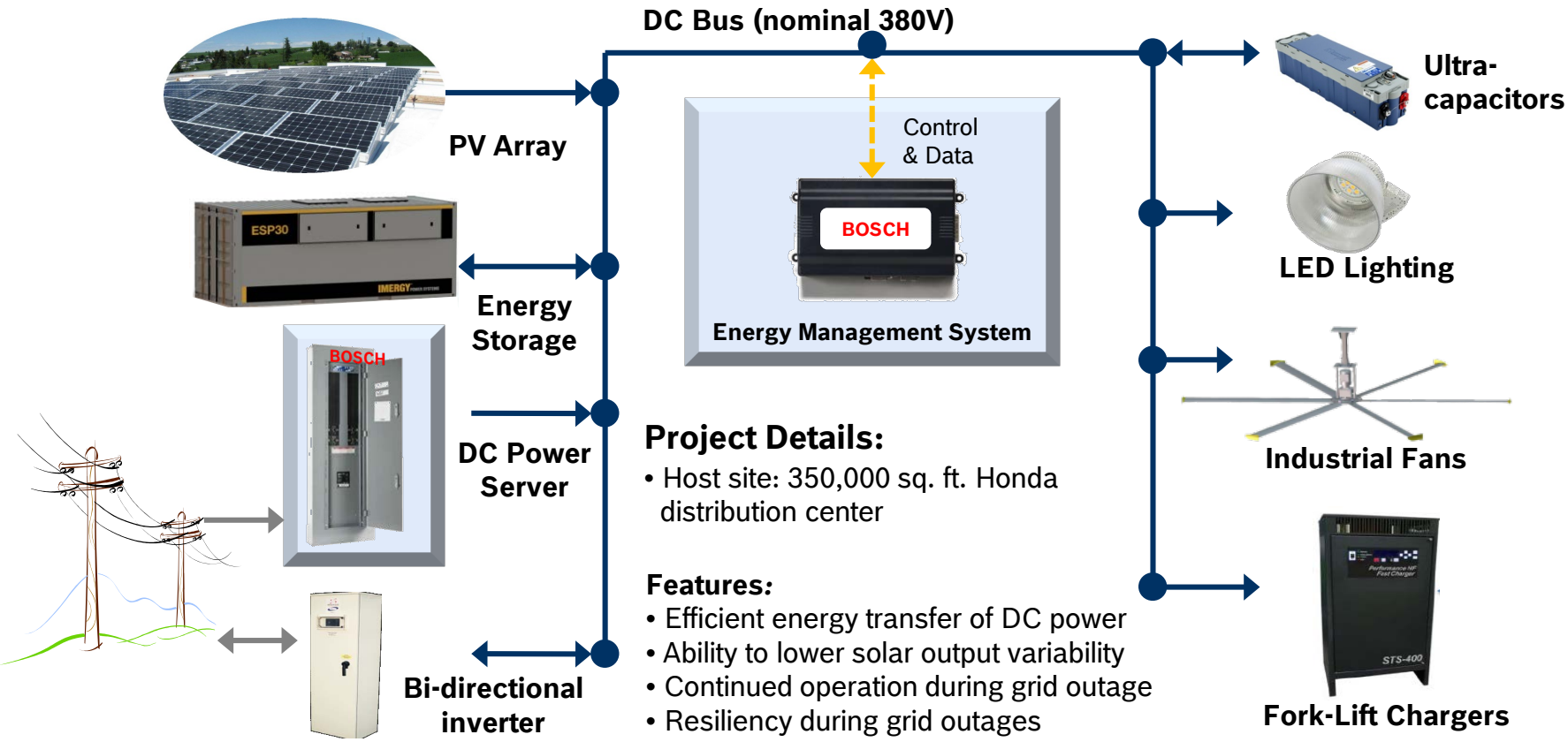
Project EPC 14-053 – 2.8 million USD funding award from CEC



Project Details:

- Host site: 350,000 sq. ft. Honda distribution center

Features:

- Efficient energy transfer of DC power
- Ability to lower solar output variability
- Continued operation during grid outage
- Resiliency during grid outages
- Advanced energy management
- Energy efficient devices

CEC: California Energy Commission

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Bosch DC Microgrid Project: EPC 14-053

Project Details and Status

- **CEC Reimbursable Project Costs: $2.817 million; Cost share: $1.78 million**
- **Project Partners:**
  - **California Lighting Technology Center**
  - **Navigant Consulting**
  - **Maxwell**
  - **Imergy Power**

- **Timeline: June 30, 2015 – March 30, 2018**

- **Project Status:**
  - **Status:** Design of DC Microgrid system underway
    - Lighting, Solar, Energy Storage and Ultra-caps
  - Testing of energy storage and ultra-caps underway at lab

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Bosch DC Microgrid Project: EPC 14-053

EPC 14-053 Project Benefits – Initial Analysis by Navigant

	Expected Project benefits at Host Site	Max Potential Impact in California
Demand Savings ($/ year)	82,097	2,524,129
Energy Savings ($/year)	28,420	873,779
Avoided RPS requirements (MWh/year)	118	3,628
Avoided CO2 emissions (metric ton/yr)	151	4,644
Avoided diesel gen fuel costs	300	9,224
MWh DC load served per year	1,863	57,291
MW DC islandable load	0.27	8
kTDV reduction (ZNE Retrofit goal)	23,529,519	723,428,659

Regulatory and Code Issues to be explored:

- SGIP incentives for on-site energy storage for DC connected systems
- Interconnection of non-export DC microgrids
- NEC 2014 Code on Emergency Lighting Support

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Future Technology and Development Topics

- **HVAC and refrigeration Systems operating on DC Microgrid**
  - **Optimal solar sizing**
- **Cost effective support for low voltage loads on the DC microgrid**
- **Analysis on how DC microgrids can help meet ZNE goals for commercial facilities**
- **Integration of renewable energy forecasts into load/ energy source management**

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