Considerations for DC Fast Charger Complex System Design

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TRB 97th Annual Meeting
January 11th, 2018

www.inl.gov

Idaho National Laboratory

INL/CON-18-44291

Charging Infrastructure Needs are Changing

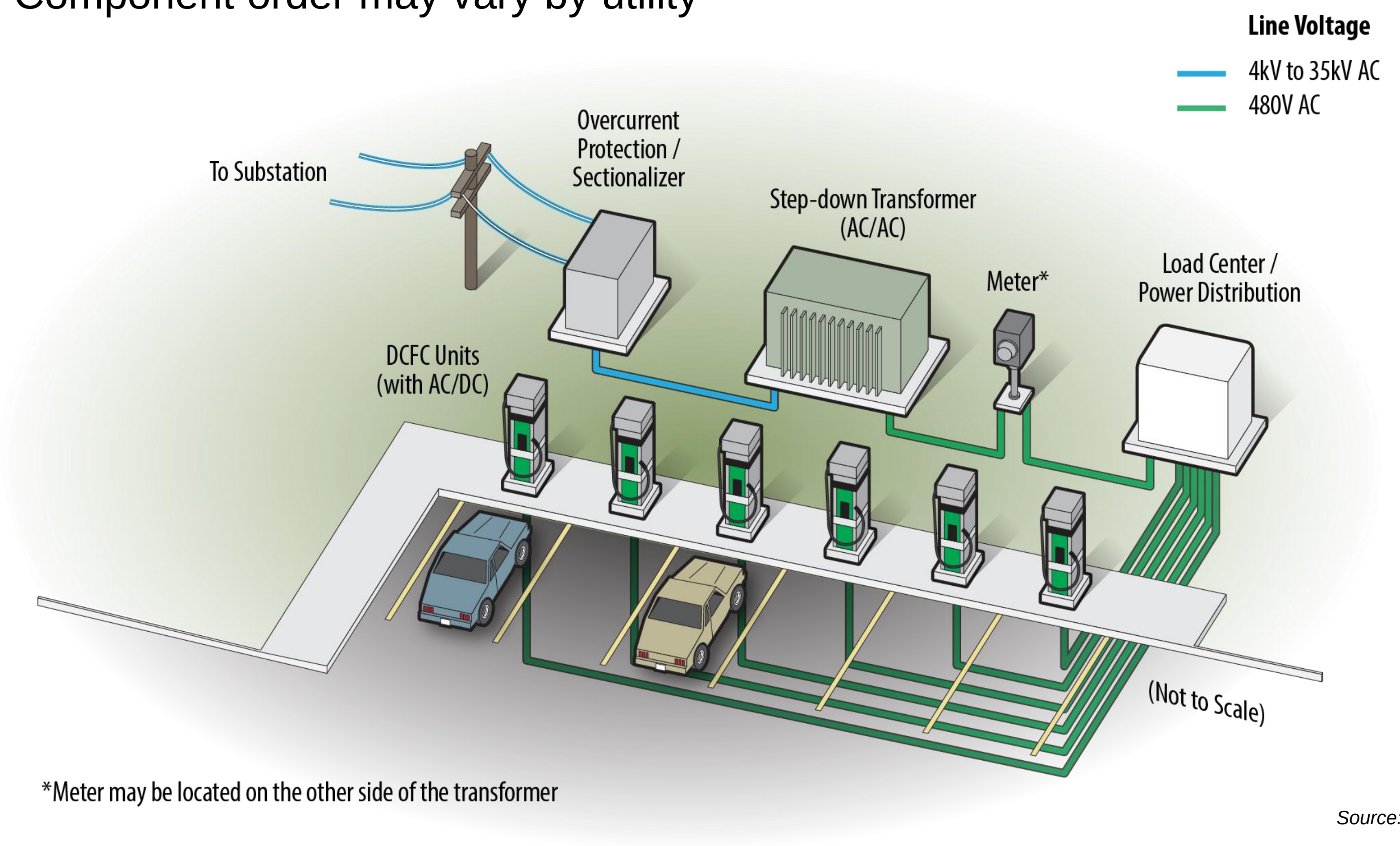
- Profitability of current fast charging infrastructure is challenging
  - High capital and operational costs
- Battery electric vehicles (BEVs) with larger battery packs, longer ranges are being introduced at mass-market prices
- Consumers are accustomed to gasoline refueling experience
  - 10-15 minutes at gas station
  - Faster charging may be needed

Source: media.chevrolet.com

- This project studied the design and costs of high-power, multi-port DC fast charging complexes that provide gas station-like experiences

DCFC Complex Design Considerations

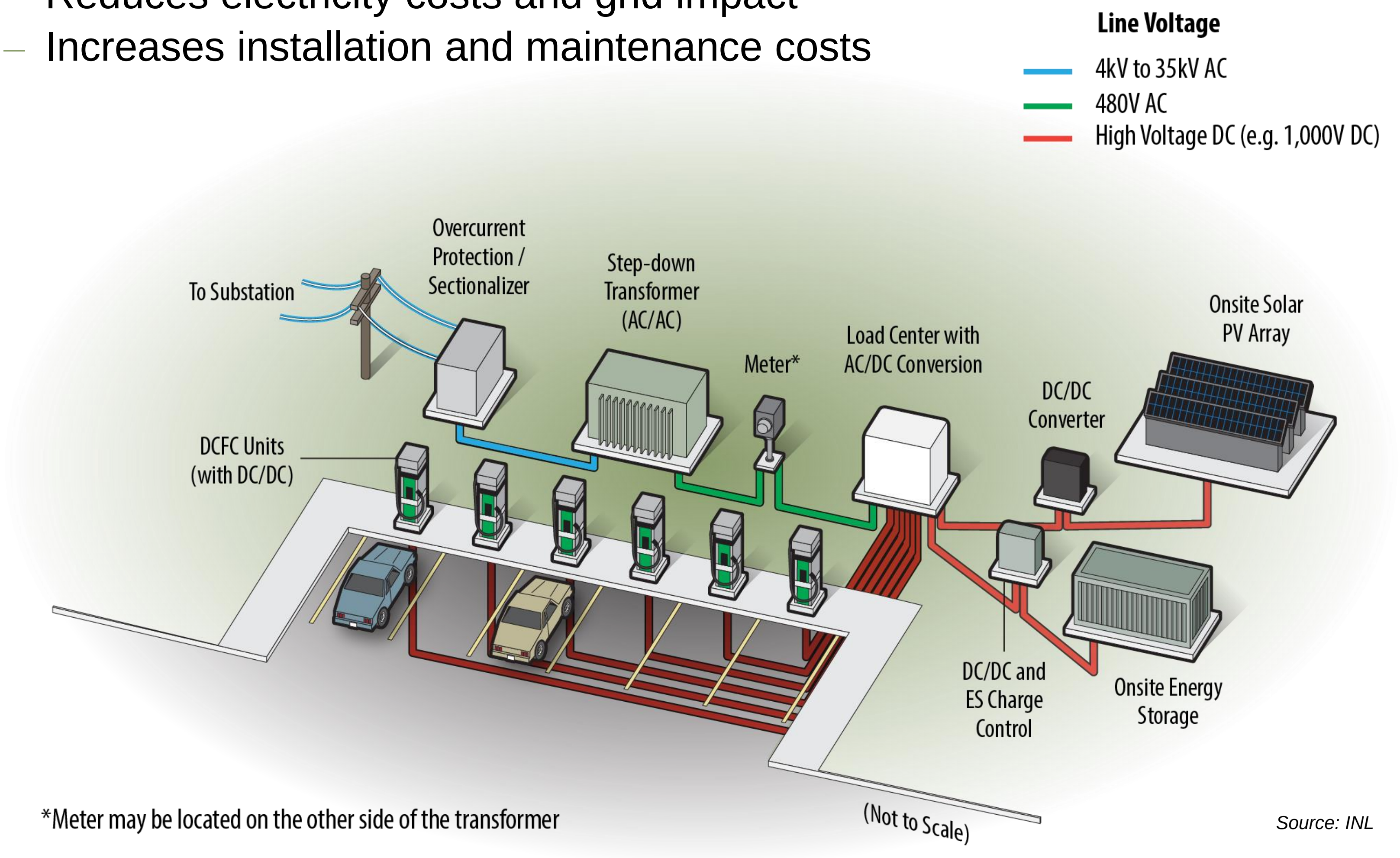
- DCFC complex expected to include components similar to those shown
- Component size may vary for urban vs. rural complexes
- Component order may vary by utility



Source: INL

DCFC Complex Design Considerations

- On-site energy storage (ES) and photovoltaic (PV) solar generation decouples power/energy provided to vehicles from power/energy drawn from the grid
  - Reduces electricity costs and grid impact
  - Increases installation and maintenance costs



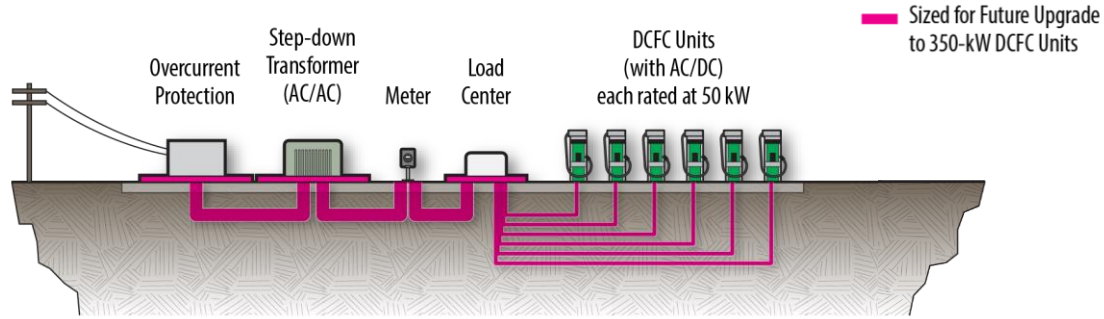
Source: INL

Upgradability

- Complex may be designed to accommodate upgrades to higher capacity
- Portions of site can be sized for future power expansion on initial install
  - Choose component size so surface/underground work (trenching, conduit, paving) only needs to be done once
  - Concrete pads, transformer vault sized for higher power to reduce cost, ensure adequate expansion space

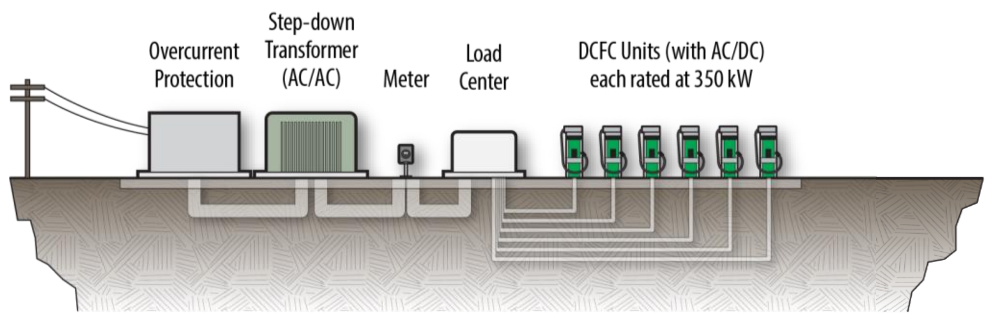
Strategy to upgrade to higher power without ES and PV

6 x 50 kW DCFC units installed but site constructed to support 6 x 350 kW units



A) DCFC complex with 50-kW chargers and no ES and PV systems

Components upgraded for 6 x 350 kW DCFC units



B) DCFC complex with 350-kW chargers and no ES and PV systems

Design Case Studies for Cost Estimation

- Designs were chosen for hypothetical DCFC complexes
- "Minimum" and "Ultimate" capability requirements were specified to approximate short-term and future scenarios
- Different usage and cost assumptions for "Urban" and "Rural" complexes

	Minimum Capability	Ultimate Capability
# of Charge Units	6 charge units	6 charge units
Charge Power	50 kW	350 kW
Grid Power Supply w/o Energy Storage	160 kW	1,060 kW
Grid Power Supply w/ Energy Storage	110 kW	210 kW

Cost Comparison

- Developed ROM cost estimates for station capital cost and operating cost
- Given the assumptions used,
  - For minimum capability, it is more cost-effective without ES and PV
  - For ultimate capability, it is cheaper to use ES and PV and keep grid power low

Minimum Capability – Six 50 kW					
		Rural Corridor		Urban Community	
Design Configuration	Maximum Grid Power (kW)	Capital Cost	Annual Operating Cost	Capital Cost	Annual Operating Cost
With ES and PV	110	$574,500	$170,600	$502,000	$163,000
Without ES and PV	160	$392,000	$170,700	$385,500	$165,500
Difference		-$182,500	$100	-$116,500	$2,500

Does not pay back

Does not pay back

Ultimate Capability – Six 350 kW					
		Rural Corridor		Urban Community	
Design Configuration	Maximum Grid Power (kW)	Capital Cost	Annual Operating Cost	Capital Cost	Annual Operating Cost
With ES and PV	210	$2,030,500	$389,000	$1,636,500	$343,000
Without ES and PV	1,060	$1,728,000	$514,500	$1,721,500	$500,500
Difference		-$302,500	$125,500	$85,000	$157,500

~3 year pay-back period

Favorable costs

Business Case Analysis

- Cases for urban and rural complexes using 50 kW and 350 kW chargers were analyzed using tool developed by Atlas Public Policy
- In the cases studied, break-even cost per kWh was calculated:

Financing Period	Customer Cost metric	Minimum Rural Six 50-kW	Minimum Urban Six 50-kW	Ultimate Rural Six 350-kW	Ultimate Urban Six 350-kW
5 Years	Electricity Cost ($/kWh)	$0.88	$0.93	$1.04	$1.01
	Equivalent Gasoline Cost ($/gal)*	$7.54	$7.91	$8.91	$8.65
10 Years	Electricity Cost ($/kWh)	$0.69	$0.73	$0.77	$0.76
	Equivalent Gasoline Cost ($/gal)*	$5.91	$6.25	$6.60	$6.51

* Based on 30 mpg vehicle

- Other revenue streams may be necessary
  - On-site sales (e.g. gas station model)
  - Investment through public and/or private partnership

***** CAUTION *****

Refinement of assumptions and design optimization strongly recommended

Currently Underway: Phase 2 with NREL

- Building on work done in this project, with a more refined and rigorous approach
  - Data-driven fast charger usage predictions
  - Considering varied electric utility rate structures using URDB
  - Investigating cost reduction methods
- NREL using ReOpt tool to find optimum station designs given different usage patterns and rate structures
  - Energy storage systems
  - PV solar systems
  - Colocation of charging sites with existing building loads
- Further analysis of business case using alternative revenue streams

Thank you!

For More Information:
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Full Report Available:
https://avt.inl.gov