EV Grid to Charger

Industry segment update

ABB U.S. Electrification
Agenda

Designing G2C circuits
Installation considerations / qualifying questions
Trends
Utility Impact Examples
Q&A
Site Design Considerations
Site Design Philosophy

Dramatic Pivot

2017-2022 EV site desired functionality

- Remote metering for mains and in some cases feeders
- Remote open/reclose of mains/feeders
- Status of main/feeders
- SPD
- Space Heaters w/humidistat
- 12-16 week delivery standard, 4-6 week available

- 2023
- After Biden Infrastructure Bill
- NEVI – National Electric Vehicle Infrastructure
- Condo design philosophy, each power cabinet with safety switch - 6 handle rule
- Fast and inexpensive, modular construction, in customer inventory
NEC 2017 625.41 & 625.42 requirements

625.41 Overcurrent Protection. Overcurrent protection for feeders and branch circuits supplying equipment shall be sized for continuous duty and shall have a rating of not less than 125 percent of the maximum load of the equipment. Where non-continuous loads are supplied from the same feeder, the overcurrent device shall have a rating of not less than the sum of the noncontinuous loads plus 125 percent of the continuous loads.

625.42 Rating. The equipment shall have sufficient rating to supply the load served. Electric vehicle charging loads shall be considered to be continuous loads for the purposes of this article. Where an automatic load management system is used, the maximum equipment load on a service and feeder shall be the maximum load permitted by the automatic load management system.
# ABB EV Charger Portfolio

<table>
<thead>
<tr>
<th>Terra AC Destination</th>
<th>Terra DC Destination</th>
<th>Terra 24/54</th>
<th>Terra 94/124/184</th>
<th>Terra 360</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-22 kW</td>
<td>11-24kW</td>
<td>24-50 kW</td>
<td>94/124/184kW</td>
<td>360kW</td>
</tr>
<tr>
<td>1PH or 3PH input, 240VAC</td>
<td>19.5kW (peak) @ 208 VAC/1PH input</td>
<td>480/277 VAC input</td>
<td>480/277 VAC input</td>
<td>480/277 VAC input</td>
</tr>
<tr>
<td>240VAC output</td>
<td>150-920 VDC output, current limited</td>
<td>150-920 VDC output, current limited</td>
<td>150-920 VDC output, current limited</td>
<td>150-920 VDC output, current limited</td>
</tr>
<tr>
<td>12-88A input</td>
<td>60A input</td>
<td>31/69A input</td>
<td>120/157/233A input</td>
<td>456A input</td>
</tr>
<tr>
<td>1.25 FLA for 80% rated feeder</td>
<td>1.25 FLA for 80% rated feeder</td>
<td>1.25 FLA for 80% rated feeder</td>
<td>1.25 FLA for 80% rated feeder</td>
<td>1.25 FLA for 80% rated feeder</td>
</tr>
<tr>
<td>4 kA withstand</td>
<td>65 kA withstand</td>
<td>65 kA withstand</td>
<td>65 kA withstand</td>
<td>65 kA withstand</td>
</tr>
</tbody>
</table>
208/240 Facility Power Distribution Options

- **Wye configuration, solidly grounded neutral**
- **Delta configuration, solidly corner grounded**
- **Open delta configuration, solidly grounded center tap**

208/3/60

240/3/60
Typical EVDC Charger power distribution topologies, Medium Voltage utility & multiple renewable sources for multiple dynamic 350kW & other loads.
Sizing & Configuration

**Power Distribution Equipment**

Dramatic Pivot

- 100% mains standard – LSIG/RELT typically > 1000A (sum of charger loads)
- 80% feeders standard   3 phase \( \frac{(kW \text{ of charger} \times 1000)}{(\text{RMS Vac input} \times 1.732) \times 1.1} \) = charger input
  FLA X 1.25 for 80% feeder MCCB 350kW @ 480 = 466 input A
- Beware of charger withstand ratings
- Typically NEMA 3 R type non-walk in outdoor installations. Shunt Trip on main for first responder safety.
- Sloped roof enclosure.
- Compartment space heaters, where necessary.
- Robust Type 2 SPD, where necessary.
- Brass mesh rodent screens to keep out wasps/rodents bugs/lizards & snakes
- Feeders to power cabinets required to have LOTO capability.
- To prevent vandalism all door located operator’s devices (RELT switch and light) must be located internal to SWBD.
- 480Vac, 3 phase, 3 wire, solidly grounded wye service from utility
Utility configuration, short circuit levels, interrupting rating & application specific considerations

Utility compartment in switchboard may be required, utility specific.

ABB switchboard engineering has over 200 utility approved, utility compartment designs.

Utility may locate PT & CT in utility pad mounted transformer with EC supplied remote meter base.

Limit of direct reading meters is 400A.

Utility may require PT & CT mounted in EC supplied, utility approved enclosure.

NEMA standard for pad mount transformer is 5.75% +/- 7.5%.

Conservative rule of thumb is 20x XFMR FLA = SCA

If three pole mounted transformers are used impedance can be 1.67% or 60X XFMR FLA!

Utility in most cases will apply .4 X main breaker rating to size utility transformer

Charger AIC rating is an often-overlooked issue.

Typically, largest utility transformer is 2500 kVA – 3008 A continuous, 65kA max

Beware of overhead clearance in parking decks.
Comms Topology MODBUS TCP/IP input from Devices, Data Acquisition Only

**Moxa UC 3111**

- Ethernet Ports x 2 (RJ45)
- Wi-Fi Antenna 1
- Cellular Antenna 1
- Wi-Fi Antenna 2
- Cellular Antenna 2
- LED Indicators (System, LAN1, LAN2, COM1, COM2, Wi-Fi, Cellular)
- SD Card Slot
- USB 2.0 Host x 1 (type A)
- Serial Ports x 2 (RS-232/422/485, DB9)

- 250mA @ 24VDC required. Customer supplied SIMM cards required 16 devices per switch – < 500mS response time. Unlimited maximum devices. Output Cat5 hardwire, WiFi, Cell Modem & Bluetooth. Local console port standard.

**XT2-XT4-XT5 – XT7-XT7 M**

- Ekip Com R MODBUS TCP/IP

**Emax2**

- Touch & HiTouch TU

**Moxa EDS**

- 2016-ML-T

**Tmax XT**

- Touch & HiTouch TU

**E1.2-E2.2-E4.2-E6.2**

- M Ekip Com MODBUS TCP/IP
Comms Topology MODBUS TCP/IP input from Devices, Data Acquisition & Remote Control

Moxa UC 3111

250mA @ 24VDC required Customer supplied SIMM cards required 16 devices per switch – < 500mS response time. Unlimited maximum devices. Output Cat5 hardwire, WIFI, Cell Modem & Bluetooth. Local console port standard.
Comms Topology Modbus RTU input from Devices, Data Acquisition Only

- **Moxa UC 3111**
  - 250mA @ 24VDC required
  - Customer supplied SIMM cards required
  - 16 devices per serial loop – 1-3 second response time
  - 32 devices maximum.
  - Output Cat5 hardwire, WIFI, Cell Modem & Bluetooth. Local console port standard.

- **XT2-XT4-XT5 – XT7-XT7 M**
  - M Ekip Com R Modbus RTU

- **Tmax XT**
  - Touch & HiTouch TU

- **Emax2**
  - Touch & HiTouch TU
Switchboard safety considerations and applicable UL & IEEE standards and NEC Articles

Typically NEMA 3 R type non-walk in outdoor installations. Shunt Trip on main for first responder safety.

UL 891 - Switchboard construction standard.

UL489 - ICCB & MCCB standard

UL 1741- Multiple source switchboard construction and operation standard

IEEE 519 – Harmonic contribution content standard

NEC Article 625.41 Overcurrent Protection – continuous duty, NEC Article 625.42 Service Equipment rating & load control, & NEC Article 625.43 Charger LOTO provision

NEC Article 626 (2017/2020 NEC Cycles) Service Diversity for Truck and Bus installations

NEC Article 240.86 A & B – Series Ratings

NEC Article 240.87 - Arc flash energy reduction

NEC Article 230.95-Service main GF protection
Trends
Trends

- Medium Voltage distribution
- Complex utility coordination
- Microgrids with alternative energy sources
- Load control by network – crucial for brownfield condo/office/apartment garages.
- Bidirectional operation
- Utilities in play as operators
- Unique vehicle applications
- Utilities forced to dramatically reduce kWh billing rate to dedicated EV sites.
Utility Impact Examples
PECO (Philadelphia Electric Company)

PECO “Blue Book”
https://www.peco.com/MyAccount/MyService/Pages/Guidelines.aspx
## PECO Service Drop Details

<table>
<thead>
<tr>
<th>Phases</th>
<th>Nominal Voltage</th>
<th>Wires</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>208Y/120</td>
<td>4</td>
<td>Intended for exclusive supply to a building or group of contiguous buildings. Available where accessible to grounded three-phase primary. Transformers and secondary will be installed on the Customer's premises at a suitable location provided by the owner. (The Company at its discretion may provide service from aerial distribution facilities located along public highways when no suitable transformer location is available on the premises and demand does not exceed 100 kVA.) Service capacity at this secondary voltage is limited to 750 kVA. If capacity exceeds this limit for transformers located inside the building, then the customer must take Standard High-Tension Service (see section 3.5 below). If capacity exceeds this limit but remains at or below 1,500 kVA for transformers located outside the building, then the customer can request either a 480Y/277v service, provided a padmounted transformer can be installed outside the building, or a Standard High-Tension Service (see section 3.5 below). See Fig 8.08</td>
</tr>
</tbody>
</table>

100 kVA = 278 FLA @ 208V  
750 kVA = 2,084 FLA @ 208V  
750 kVA = 903 FLA @ 480V  
1,500 kVA = 1,806 FLA @ 480V
PECO Service Drop Details

3.5 STANDARD HIGH TENSION SERVICES
All standard high-tension service available from the Company is three-phase primary. Where two or more standard voltages are present in a given area, the Company will select the voltage at which the required service can be supplied most economically.

NOTE: Customers requiring service with nominal voltages of 208Y/120v or 480Y/277v, who require transformation in excess of the secondary service limits specified above in Section 3.4, must take Standard High-Tension Service.

| TABLE 10.23 P |
| 13 KV SERVICE ASSEMBLY |
| FUSED SINGLE SERVICE WITH PRIMARY METERING |

HAVE TO PROVIDE A PECO APPROVED HV SWITCH
AND YOUR OWN TRANSFORMER
FROM 13.2Kv TO LV
AND YOUR OWN LV DISTRIBUTION EQUIPMENT (SWBD)
PECO Service Drop Details

3.5 STANDARD HIGH TENSION SERVICES
All standard high-tension service available from the Company is three-phase primary. Where two or more standard voltages are present in a given area, the Company will select the voltage at which the required service can be supplied most economically.

NOTE: Customers requiring service with nominal voltages of 208Y/120v or 480Y/277v, who require transformation in excess of the secondary service limits specified above in Section 3.4, must take Standard High-Tension Service.

HAVE TO PROVIDE A PECO APPROVED HV SWITCH
AND YOUR OWN TRANSFORMER FROM 13.2Kv TO LV
AND YOUR OWN LV PECO APPROVED DISTRIBUTION EQUIPMENT (SWBD)
ALSO HAVE TO PROVIDE A TRANSFORMER DATA SHEET FOR METER PROGRAMMING
# PECO Service Drop Details

<table>
<thead>
<tr>
<th>Phases</th>
<th>Nominal Voltage</th>
<th>Wires</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>208Y/120</td>
<td>4</td>
<td>Intended for exclusive supply to a building or group of contiguous buildings. Available where accessible to grounded three-phase primary. Transformers and secondary will be installed on the Customer’s premises at a suitable location provided by the owner. (The Company at its discretion may provide service from aerial distribution facilities located along public highways when no suitable transformer location is available on the premises and demand does not exceed 100 kVA.) Service capacity at this secondary voltage is limited to 750 kVA. If capacity exceeds this limit for transformers located inside the building, then the customer must take Standard High-Tension Service (see section 3.5 below). If capacity exceeds this limit but remains at or below 1,500 kVA for transformers located outside the building, then the customer can request either a 480Y/277v service, provided a padmounted transformer can be installed outside the building, or a Standard High-Tension Service (see section 3.5 below). See Fig. 8.08</td>
</tr>
<tr>
<td>3</td>
<td>480Y/277</td>
<td>4</td>
<td>Intended for exclusive supply to a building or group of contiguous buildings. Available where accessible to grounded three-phase primary. Transformers and secondary will be installed on the Customer’s premises at a suitable location provided by the owner. Service capacity at this secondary voltage is limited to 750 kVA for transformers located inside the building and to 1500 kVA for transformers located outside the building. If capacity exceeds these limits, then the customer must take Standard High-Tension Service (see section 3.5 below). See Fig. 8.21, 8.22, 8.23</td>
</tr>
</tbody>
</table>

- **100 kVA = 278 FLA @ 208V**
- **750 kVA = 2,084 FLA @ 208V**
- **750 kVA = 903 FLA @ 480V**
- **1,500 kVA = 1,806 FLA @ 480V**
Example of an EVDC Charger power distribution topology with PECO (Philadelphia Electric Company) at a Wawa convenience store in Glen Mills, PA
Example of an EVDC Charger power distribution topology with PECO (Philadelphia Electric Company) at a Wawa convenience store in Glen Mills, PA
All EV charger applications and load additions go through the PECO Green Power Connection team. This team was formed to handle solar and distributed generation applications but have evolved to include EV chargers.
PPL (Pennsylvania Power Light)

PPL Customer Reference Specification
CRS 6-19-100

PPL Service Drop Details

HAVE TO PROVIDE A PPL APPROVED INCOMING CABLE LIMITER LUG SECTION ALONG WITH A SEPARATE SECTION FOR THE PPL UTILITY METERING COMPARTMENT.

TYPICALLY, THIS ADDS 80" TO THE WIDTH OF THE LINEUP
Questions?