EVSE In Grid Strained Environments

Prepared For:

LAUNCH ALASKA

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Jule is the leading provider of grid optimized ultra-fast EV Charging and Energy Storage Solutions

Products	Services
Battery Energy Storage	Energy Management
EV / Fleet DCFC	Distributed Energy Integration
Transit DCFC	

MANUFACTURING	DEPLOYMENTS	EMPLOYEES
Canada + U.S	Canada + U.S	70

CURRENT NETWORK

1,110,500	345	515
miles	mWh	tonnes
Range Delivered	**Energy Delivered**	**CO2 Offset**

Agenda

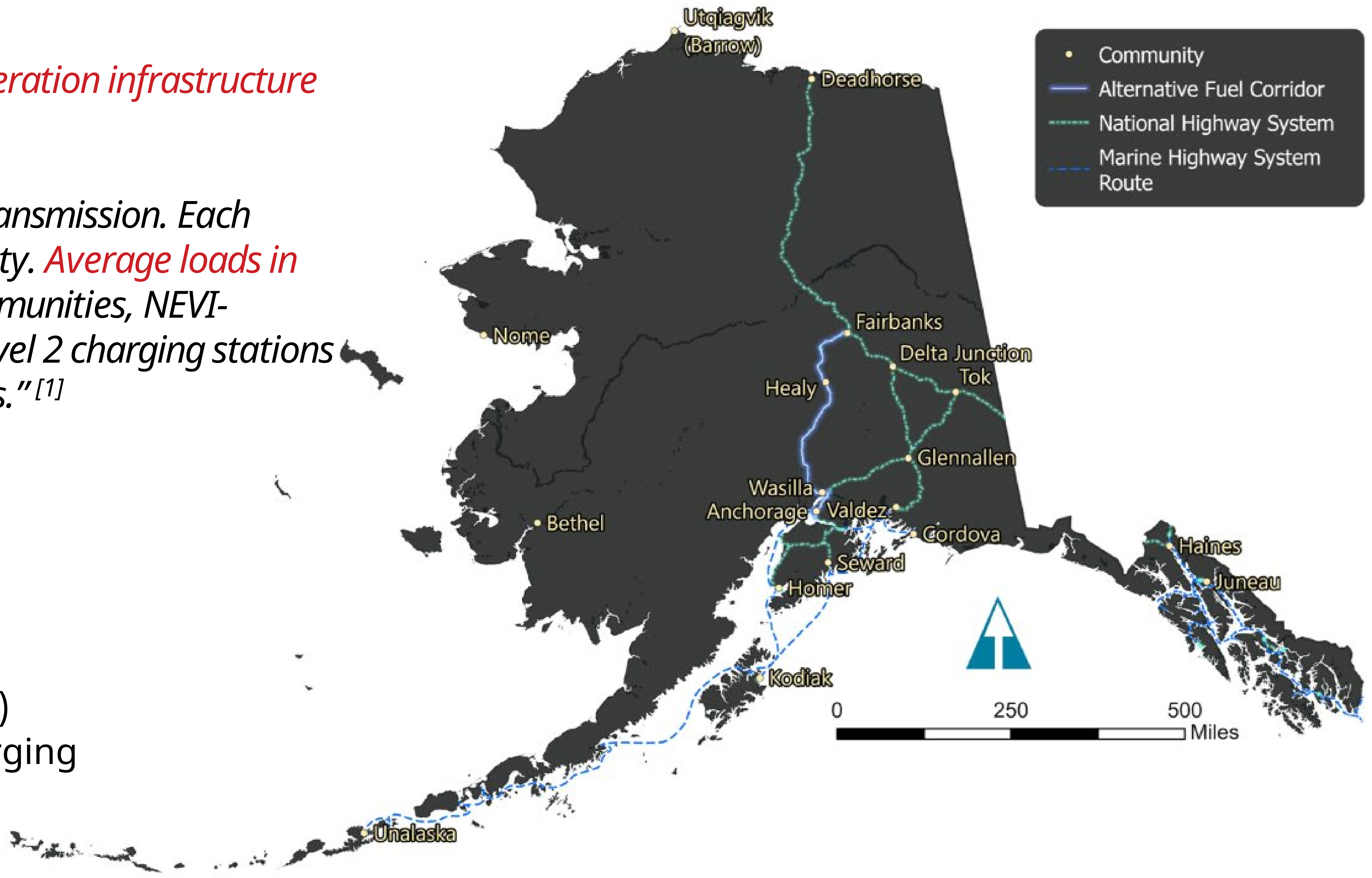
- **Grid constraints for EVSE Deployments**
- **Design philosophy for grid applications**
- **Safety challenges with EVSE + ESS equipment**
- **Future of EVSE + Jule**

Grid Constrained EVSE Deployment

Key limitations of the Alaska NEVI Plan:

"Some isolated communities may not require or have the generation infrastructure to support 150 kW charging or four charging ports." [1]

"Rural communities are generally not connected by road or transmission. Each community self-generates its power through a small local utility. Average loads in rural communities range from 100 kW to 1 MW. In many communities, NEVI-compliant DCFC equipment may not be feasible; therefore, Level 2 charging stations are preferred. This will be evaluated against community needs." [1]



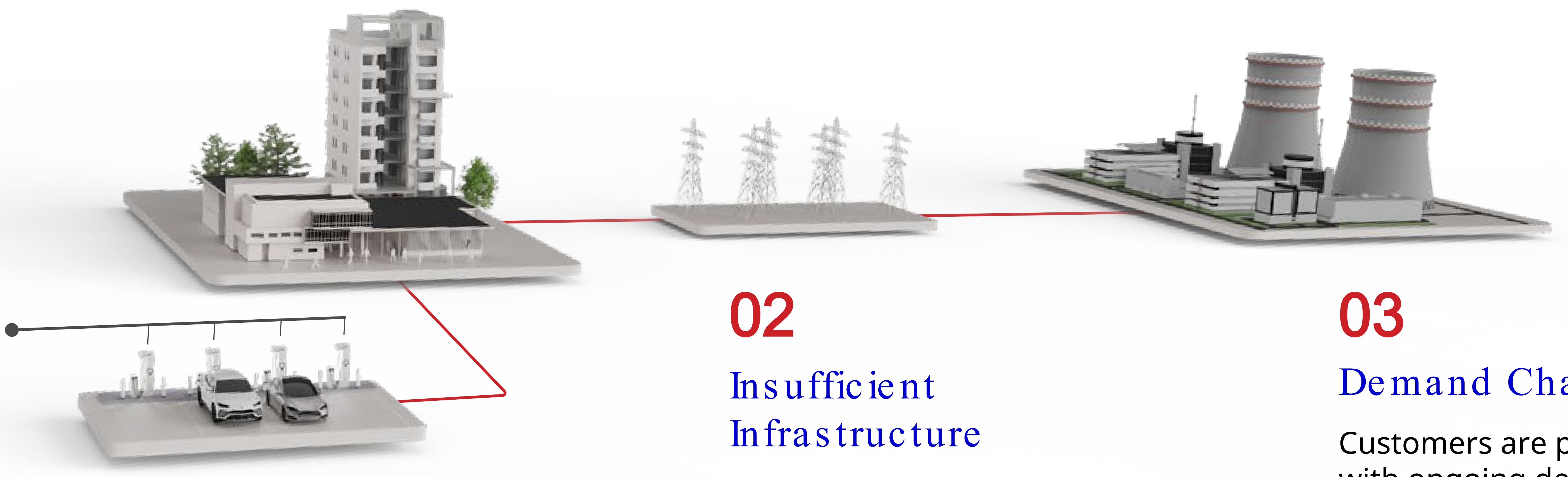
Alaska's EVSE requirements are unique:

- Limited utility infrastructure in remote communities
- High-energy storage capacity requirements (> MWh)
- High-power output to meet light-duty and fleet charging needs (150 kW to > MW)
- Longer than national average distances between charging stations (< 80 miles)
- Survive in adverse environmental conditions

[1] Thayer, Curtis. "State of Alaska Electric Vehicle Infrastructure Implementation Plan FY24." Alaska Energy Authority, Alaska Energy Authority, https://www.akenergyauthority.org/What-We-Do/Renewable-Energy-and-Energy-Efficiency-Programs/Electric-Vehicles/EV-Fast-Charging-Network

Distributed Generation + Level 3 Charging are Grid Constrained

Charging an EV at the same rate as refueling a gas-powered vehicle requires 5MW of power



01

Transition to EV Charging

Seamless EV adoption requires infrastructure to support
"gas station" mentality

02

Insufficient Infrastructure

The grid will need timely and costly upgrades to support the power requirements of fast charging

E.g. Installing a 320 kW Charger cost **$108,157** USD in infrastructure upgrades[1]

03

Demand Charges

Customers are penalized with ongoing demand charges to request high power for EV charging

E.g. Customer must pay an additional **$23/kW** USD per month[2]

(1) Based on market intelligence
(2) PG&E Demand Charge

Grid Constrained EVSE Deployment

Dynamics of electric vehicle (EV) charging

Battery Size

- Light-duty vehicles: 90 kWh – 212 kWh
- Heavy-duty vehicles & Fleets - > 300 kWh

Typical energy demand based on 20% - 80% charging

- Light-duty vehicles: 54 kWh – 127 kWh
- Heavy-duty vehicles & Fleets ~ 180 kWh

Charging time based on various charging rates

Energy Required by Vehicle (kWh)	Charging Power Rates (kW) 7	19.2	50	150
45	6.43	2.34	0.90	0.30
50	7.14	2.60	1.00	0.33
75	10.71	3.91	1.50	0.50
85	12.14	4.43	1.70	0.57
100	14.29	5.21	2.00	0.67
130	18.57	6.77	2.60	0.87
150	21.43	7.81	3.00	1.00
180	25.71	9.38	3.60	1.20
200	28.57	10.42	4.00	1.33
	Level 1	**Level 2**	**Level 3**	

To illustrate future-proofing, let's contrast with gasoline refueling dynamics

Tank size

- Light-duty vehicles: 12 – 16 gallons (46 - 60 Liters)
- Heavy-duty vehicles & Fleets: 120 – 300 gallons (454.3 – 1135.6 Liters)

Typical energy demand based on 34.6 MJ/Liter [4]

- Light-duty vehicles: 442 kWh – 576 kWh
- Heavy-duty vehicles & Fleets: 4.37 MWh – 10.9 MWh

Equivalent power for gasoline refueling

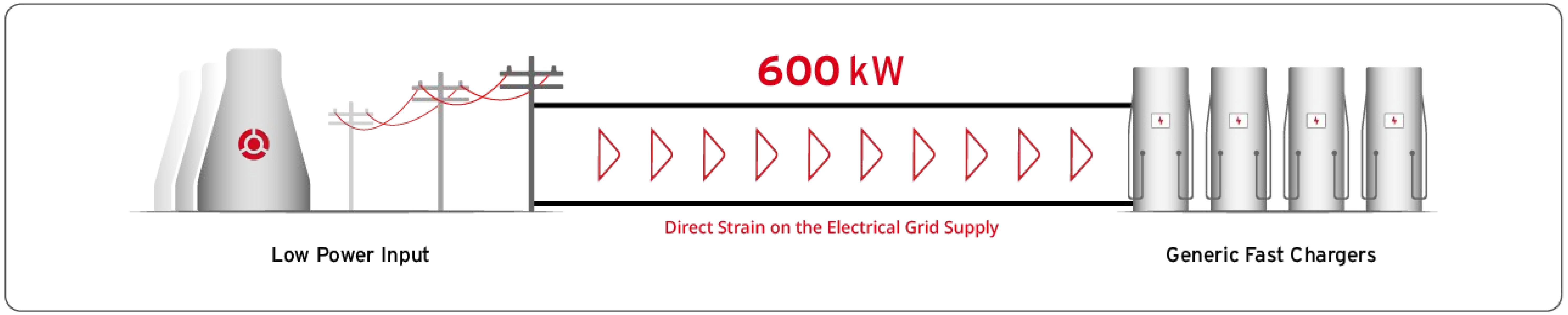
- Light-duty vehicles (2 minutes): average – 15 MW
- Heavy-duty vehicles & Fleets (15 minutes): average – 30.54 MW

[4] Fischer, M. W. (2009). Batteries: Higher energy density than gasoline? Energy policy, 37(7), 2639-2641.

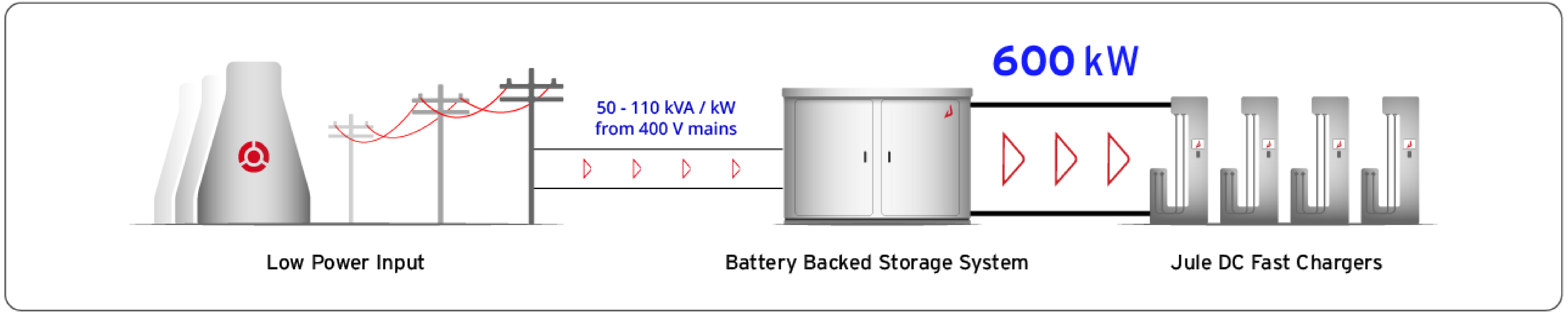
How Our Ecosystem Works

Jule Design Philosophy

Existing EV Charging stations draw their power directly from the grid



Jule EV Chargers mitigate demand charges by trickle charging from the grid and storing that energy in the Jule Hub



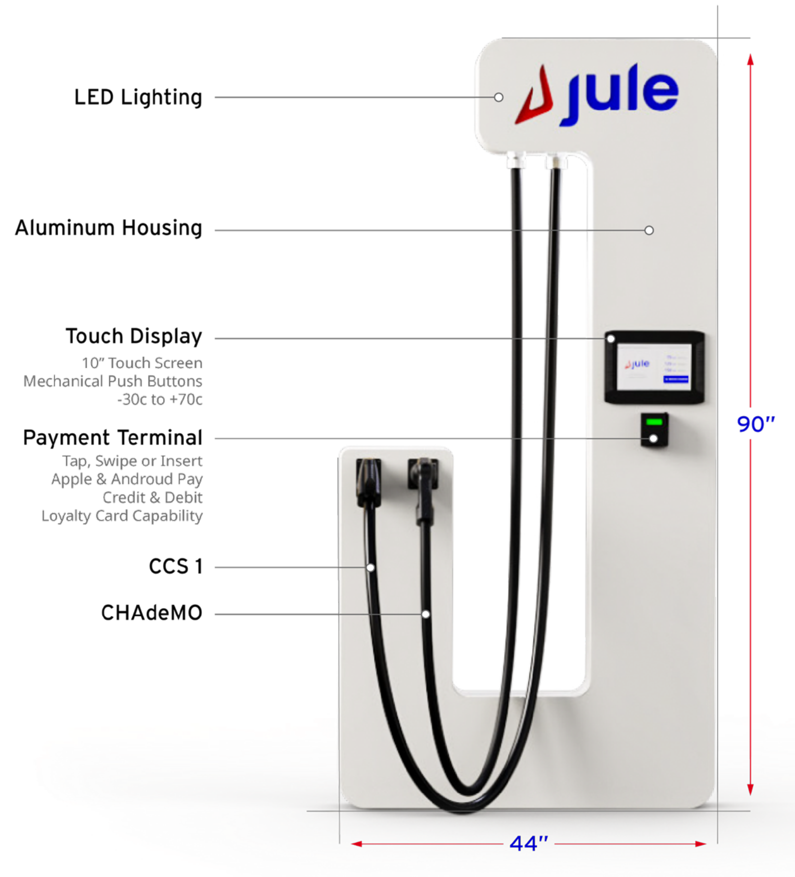
System Specifications

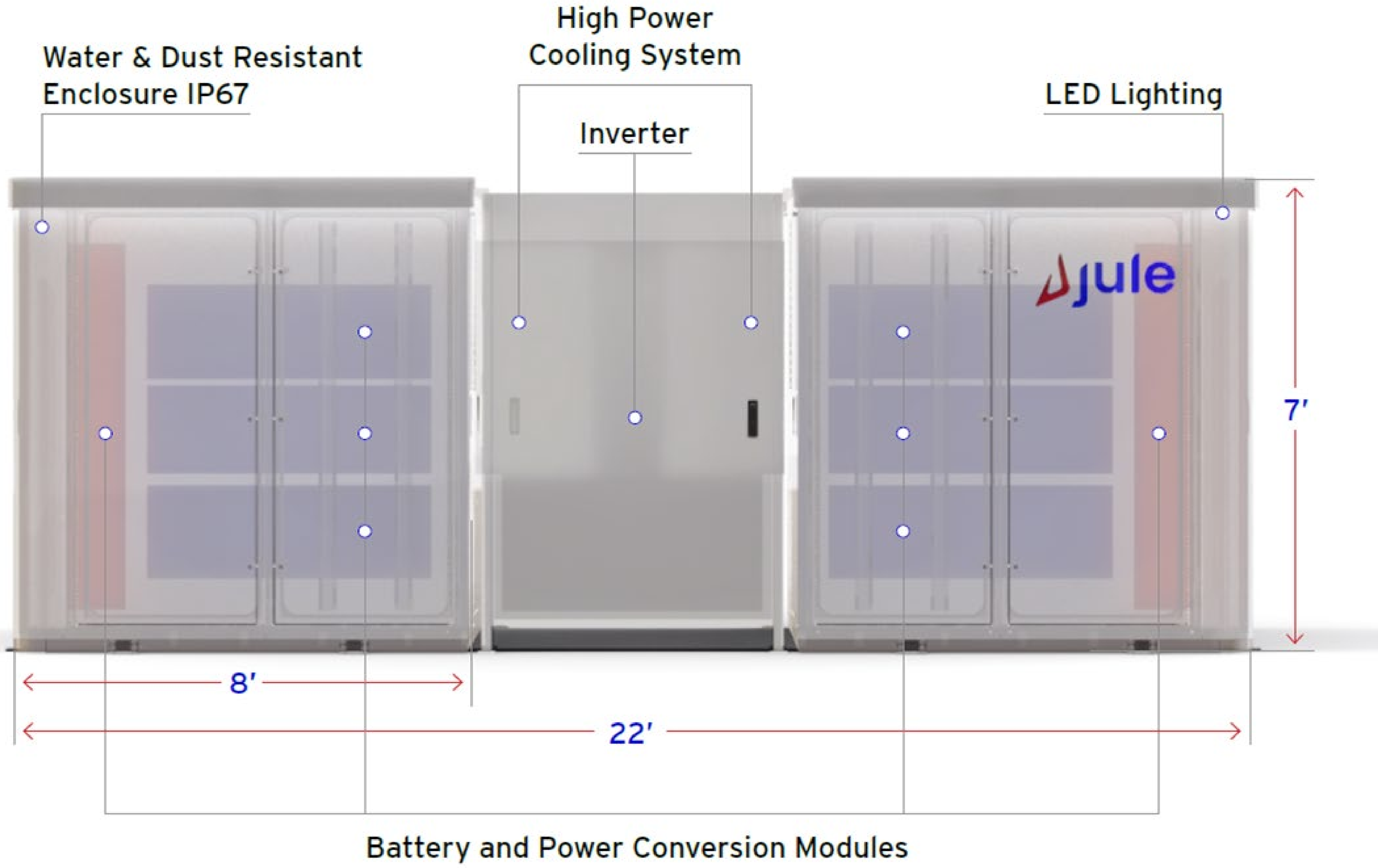
Jule Hub ESS

220 – 660 kWh
ESS Capacity

650 – 790 V
ESS Voltage

165 – 330 A
ESS Max Output Current





Jule Charger

350 kW
Dispenser Max Power

> 97 %
System Uptime

OCPP 1.6 + 2.0
Compliance Network

UL & ESA
System Compliance

System Specifications

	jule 	FREEWIRE 	adstec Energy 
Body Style	Split-System	Uni-Body	Split System
Max Output Power	300kW (air-cooled Cable)	200kW (Air-cooled cable)	320kW (liquid-cooled cable)
Supported standard	CCS 1, CHAdeMO, NACS[1]	CCS 1, CHAdeMO	CCS
Battery size	N x 220kWh (shared)	160kWh (non-shared)	140kWh (non-shared)
Max Battery Power	N x 300kW	200kW	201kW
Standard Grid input options	30kW, 100kW, 250kW, 750kW	27kW	50 or 100kW
Grid-off Mode	YES, Grid In = 0W	YES, Grid In = 0W	NO (Grid is main source)
Generation Back into Grid	YES (UL1741, IEEE1547, IEEE519)	NO (no UL1741)	NO (function not exist)
Revenue-graded metering	Yes (AC & DC options)	NO	NO
Fire Safety	UL9540 & UL9540A (preventive Fire Suppression)	Not Listed (may have reactive fire suppression)	Not Listed (may have reactive fire suppression)

NFPA 855 relation to UL9540 – 40A

- NFPA 855 is an installation level code covering design, construction, operation, maintenance and decommissioning
- Applies to lithium-ion battery systems greater than 20kWh (1kWh for residential)
- Contains system energy limits (50 kWh array / 600 kWh system) and separation distances (3ft)
- Fire and explosion testing is used to allow larger capacities and smaller spacing
- UL 9540A is a typical test method used to cover fire and explosion testing

UL9540 relation to UL9540A

UL 9540 is the certification standard for ESS required per NFPA 855

- To obtain UL9540, UL1973 and 9540A are mandatory prerequisites

Clause 23.2 of Edition 2 requires large-scale fire testing per UL 9540A under the following conditions

- Increased capacity as required in codes (NFPA 855)
- Indoor/outdoor systems with decreased separation distances
- Indoor wall mounted systems
- Systems for installation in residential applications
- If explosion analysis is required per codes or AHJ

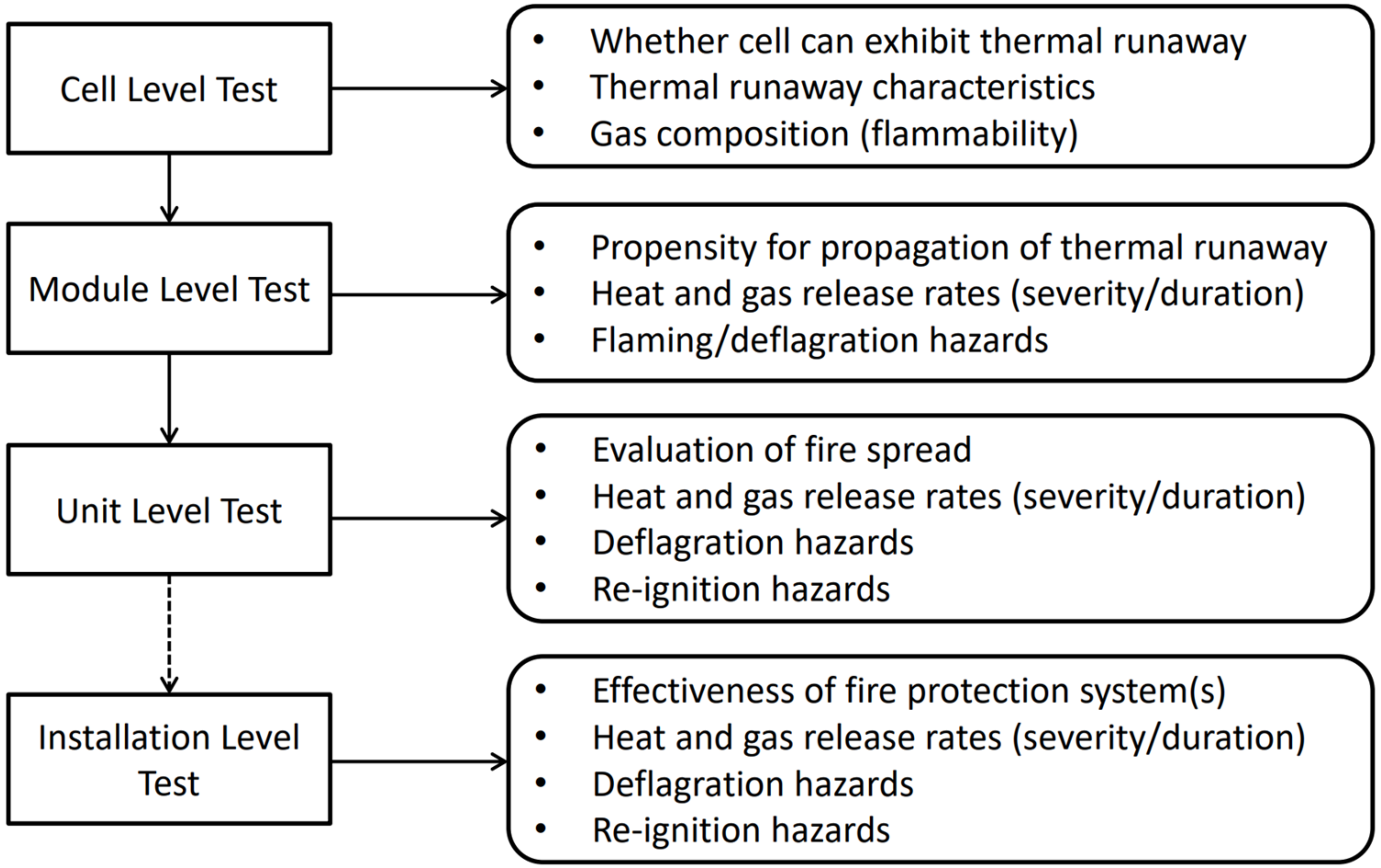
What is UL9540A?

UL 9540A is a test method to evaluate fire and explosion hazards from thermal runaway

- Testing performed in a specific sequence with data collected at each level
- Performed in special test environments with sufficient safety procedures and infrastructure

Test performed at 4 possible levels:

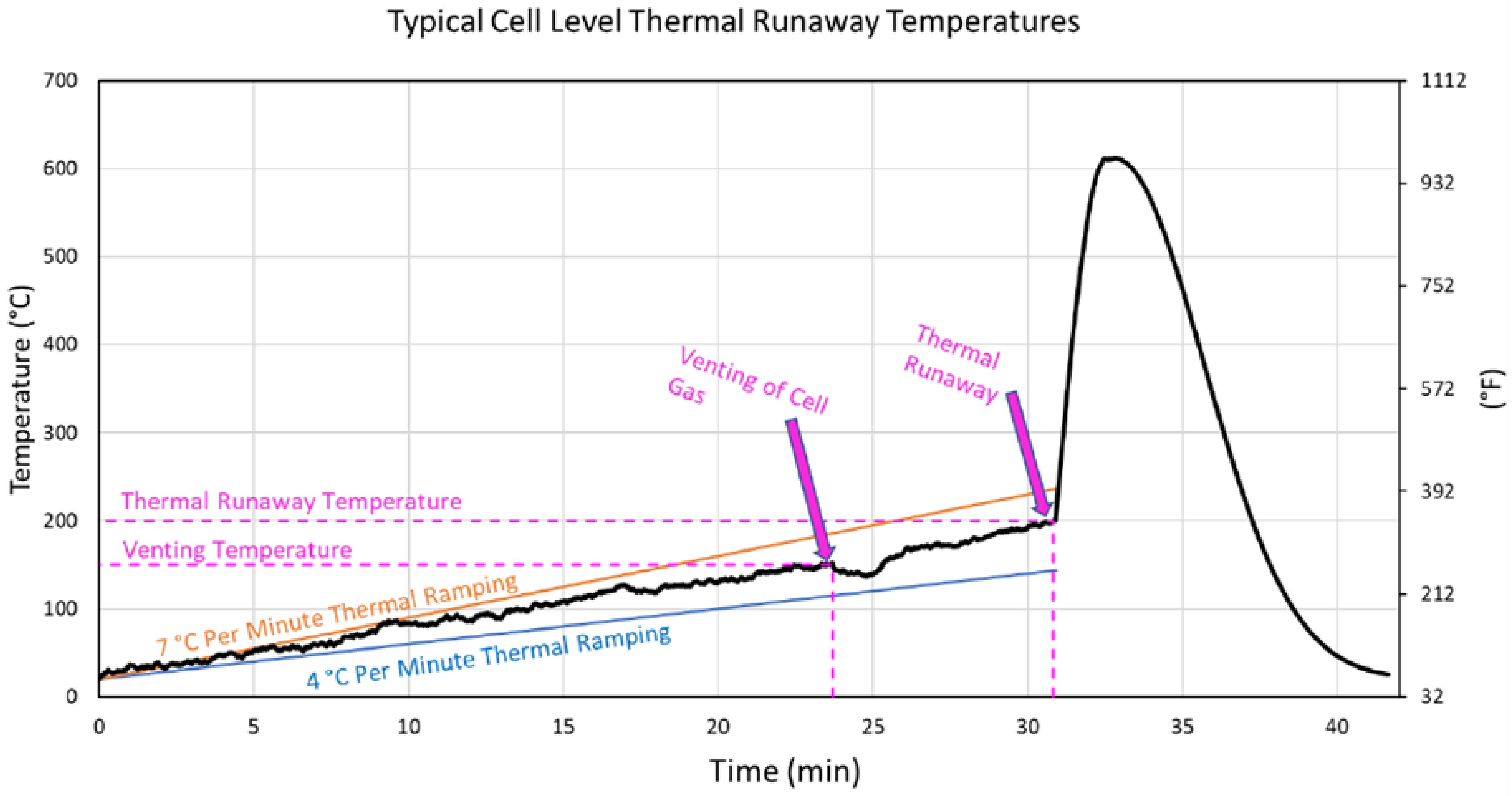
- Cell
- Module – group of cells (block)
- Unit – rack or enclosure of modules
- Installation



Cell Level UL9540A

Testing Procedure

- Cell samples cycled and charged to 100% SOC before testing
- Preferable method is flexible film heaters with rate of 4°C to 7°C per minute
- Other methods can be used if heating does not cause thermal runaway
- Thermal runaway – cell surface temperature increases through self-heating in uncontrollable fashion
- Thermal runaway not the same as gas venting
- Test is performed total of 4 times to demonstrate repeatability



Cell Level UL9540A

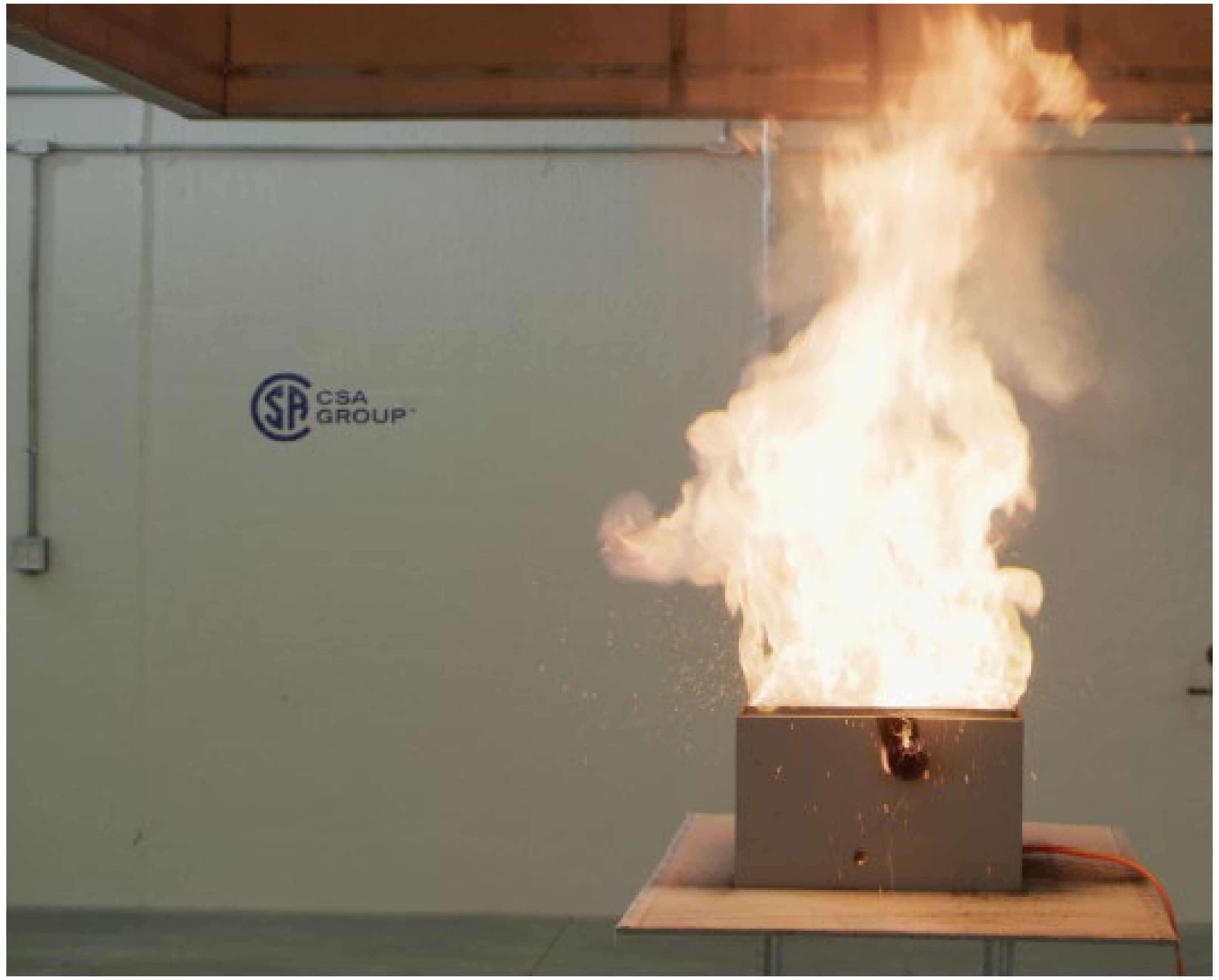
Data Collection

- Cell vent gas is collected during thermal runaway in pressure vessel
- Pressure vessel atmosphere inert during testing
- Gas composition determined using Gas Chromatography (GC) to detect component gases such as hydrocarbons and other flammable gases
- Lower flammability limit determined on synthetically replicated gas mixture
- Gas burning velocity and Pmax determined using industry standard methods on synthetic gas
- If cell vent gas is not flammable and cell does not enter thermal runaway, no module test required

Module Level UL9540A

Testing Criteria

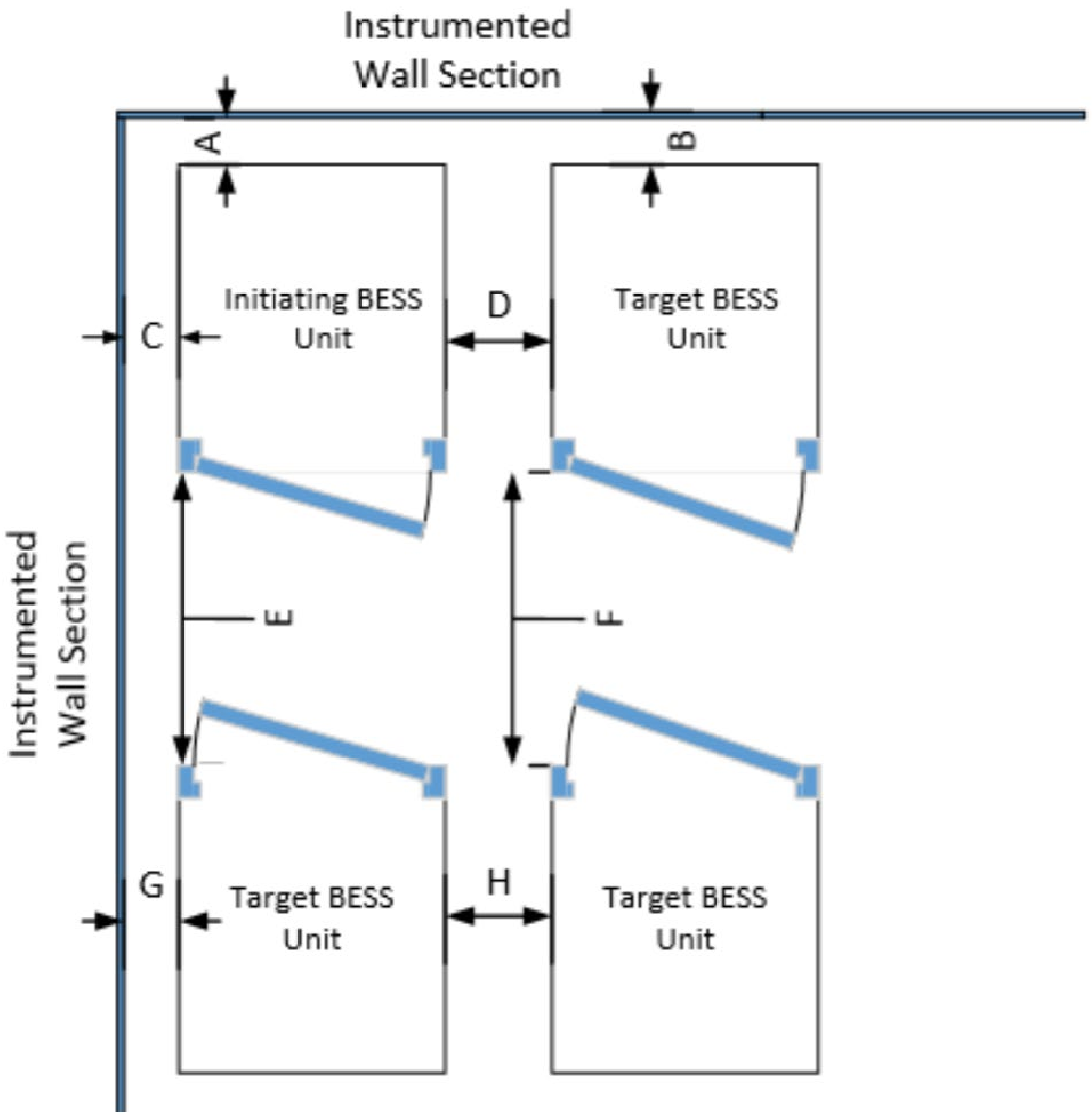
- Thermal runaway is contained by module design, AND Cell vent gas is nonflammable as determined by the cell level test
- If the cell vent gas was non-flammable you would not conduct the module test to begin with
- Module level testing is inherently UNPASSABLE
- A Unit level test will always be necessary as flammable gases are produced
- It should be viewed more as a verification of the method and number of initiating cells needed to achieve thermal runaway at unit level
- Much cheaper to repeat than a unit level test
- Value-added gas, heat, and smoke production data for fire protection analysis and design



Unit Level UL9540A

Testing Procedure

- Various unit level test configurations based on installation instructions in product manual
- Initiating unit forced into thermal runaway with adjacent target units spaced with desired specification
- Target units include the same components as the initiating unit with no live cells
- Safety controls, such as the BMS, are not relied upon for this testing
- Instrumented wall sections used for unit test configurations intended for combustible/building
- Exposures
- Internal fire condition created using single module with same method as module level testing



Unit Level UL9540A

Testing Data

- Initiating units may be positioned under smoke collection hood, may not be required for outdoor use only units
- Initiating unit charged up to 100% SOC

Following measurements are taken for typical testing but may vary based on configuration:

I. Smoke release rate
II. Chemical and convective heat release rates
III. Wall surface temperatures
IV. Heat flux at surface of adjacent target units
V. Initiating module temperatures
VI. Gas composition, velocity, and temperature
VII. Hydrocarbon content

Unit Level UL9540A

Testing Variations
Different Setup Conditions, Data Requirements, and Evaluation Criteria Apply to Unit Level Testing Depending on Application and Location of Installation

Installations
- Indoor/outdoor
- Wall or floor mounting
- Residential or non-residential
- Rooftops and open garages

Test Criteria
- Temperatures of adjacent modules – Less than cell venting temperature
- Temperatures on wall surfaces – Less than 97°C above ambient
- Heat fluxes to surfaces and in egress paths – Less than 1.3 kW/m2
- Charring of cheesecloth material – No charring
- Extension of visible flames from unit cabinets – None / Less than separation
- Gas production rates – For indoor residential application / Less than 25% LFL
- Unit spacing to walls and other units
- Exposure to adjacent target units

Installation Level UL9540A

Testing

- If unit level testing does not meet performance criteria, installation level testing required
- Intended to assess external fire and explosion mitigation measures used at the installation level
- Test to not result in external fire, no observation of detonation, excessive heat flux, or re-ignition after test concluded
- 2 different test methods:
  - Effectiveness of sprinklers
  - Effectiveness of fire protection plan – gaseous agents, water mist systems, etc.

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Installation Level UL9540A

Testing Criteria

- Sprinklers – Respond early enough (response temperature) and apply sufficient water (k-factor) to:
    - Prevent adjacent modules from reaching cell venting temperatures
    - Maintain temperatures of surfaces below 97 °C
    - Prevent flame spread through wiring and cables
    - Stop flames from exiting room
    - Maintain egress path heat fluxes below 1.3 kW/m^2
    - Prevent detonation hazards
    - Prevent re-ignition

- Fire Protection Plan
- Alternative detection/activation/suppression agents
- Explosion mitigation
- E.g., water mist, clean agent, detection devices to actuate agent release, wetting agents, gas venting, etc.

EVSE / ESS Safety Challenges

LAUNCH ALASKA

Questions?

Please reach out to our team for more information

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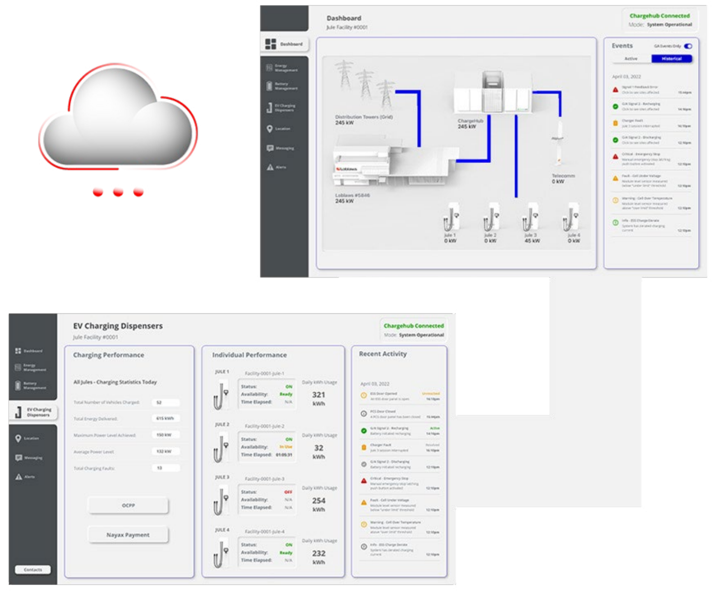
Core Products

jule | Charger
s

- Generate up to 350 kW
- Convenient payment transactions
- OCPP 1.6 with UL & ESA Compliance

jule | Hu
b

- 1 MWh of continuous energy supply
- Instantaneous discharge time
- Grid power quality correction



jule | Link

- Monitor performance conditions
- Control energy load shifting
- EV charging analytics

EV Fast Charging

Generate up to 350 kW of DC fast charging power to multiple EV's from as little as 50 kw drawn from the grid.

- Provide Industry Leading Charging Speeds
- Increase Customer Satisfaction
- Build Customer Loyalty

Notable Delivered Projects

Canadian Grocery Retailer

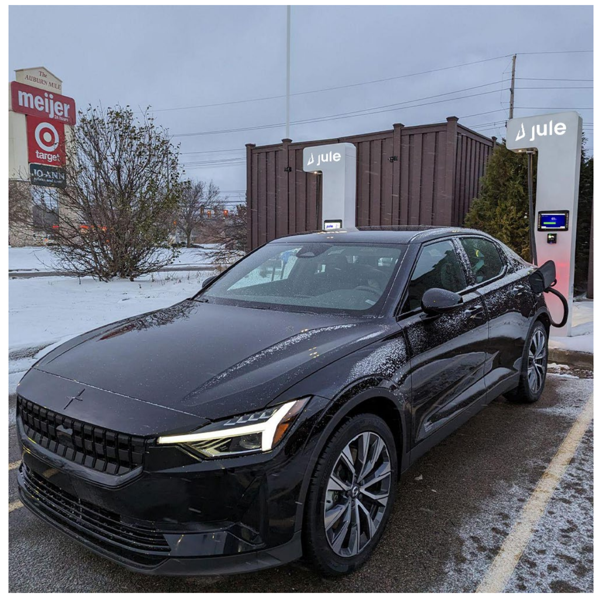
Toronto, Brampton, Kitchener, Kanata, Georgetown

Florida, Department of Environmental Protection

Naples, Palm Coast, Venice, Quincy

Trans-Canada Highway

Northen Ontario (3 Locations) & Manitoba (1 Location)



Energy Storage

Upgrade your site's electrical infrastructure without significant installation costs, all while lowering utility bills and increasing resiliency.

- Optimize your building's energy distribution
- 1 MW of continuous high power output
- Future-proof your site

Notable Delivered Projects

Grid Support

Alberta

Battery Energy Storage Systems

New York, California

Jule's Microgrid Capabilities

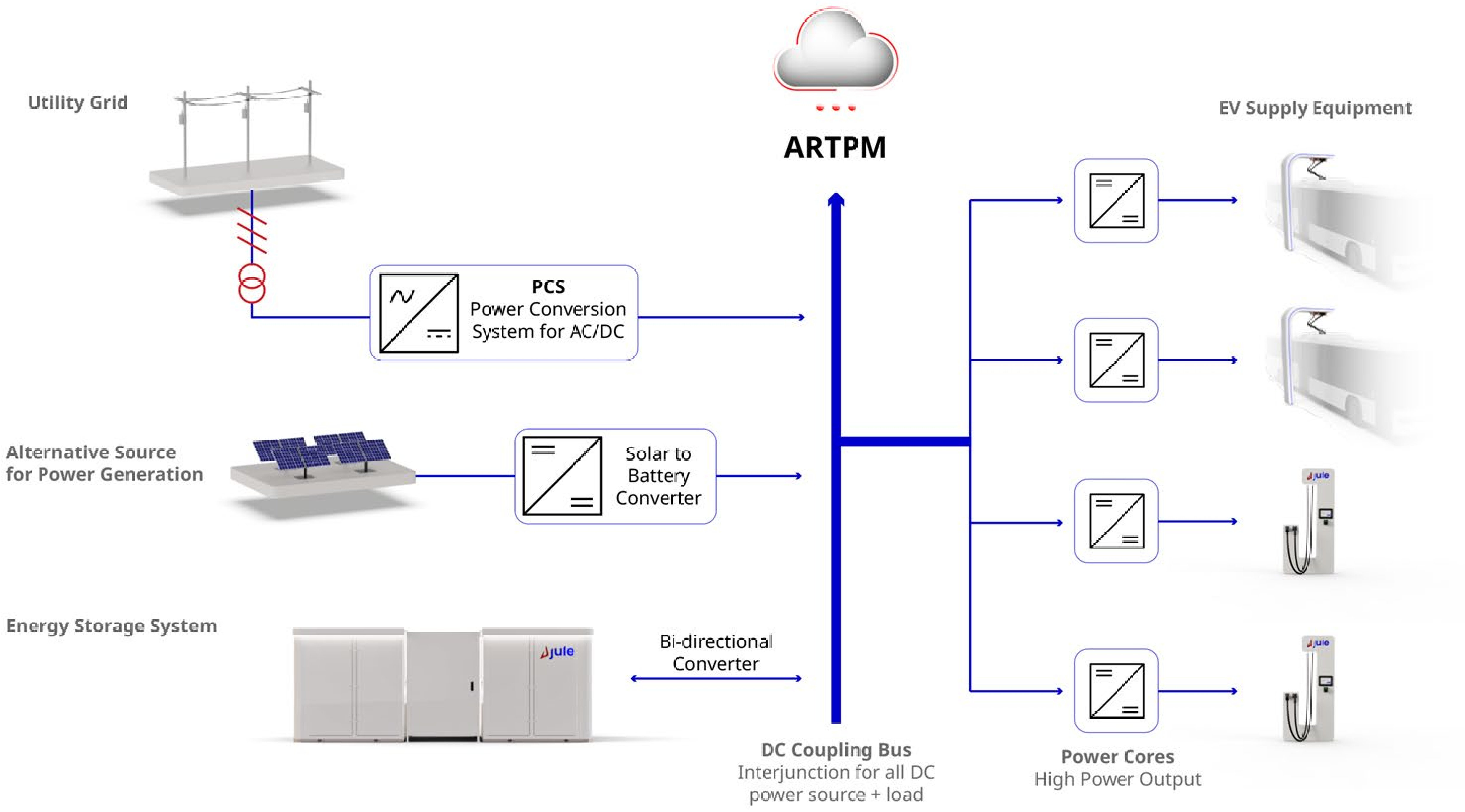
Maximizing Efficiency:
Minimize steps of power conversion and reduce loss

Simplified Setup:
Simplified power electronics and control steps for more robust system controls

Enhanced Safety:
Consistent system-wide DC circuit provides the same insulation ratings to mitigate electrical failure

Enhanced System Control:
Act as one box of device on the grid to eliminate most utility integration challenges in AC-coupling design

Empowering Off-Grid Applications:
Direct DC Connection of Solar Panels to Batteries and EVFC enables the system to go off-grid



Jule is an End-to-End Solution Provider

Planning + Installation	Hardware	EV Charging Services	Operations	Smart Energy Services	Data Intelligence
Jules performs site provision, site inspection, installation and commissioning	Robust Modular Technology allows for easy installation and future proof solutions for easy expansion	Full suite EV Charging Software allows for optimized monitoring and maintenance	Integrated hardware and software provides flexibility in maintenance and operations for streamlined troubleshooting and resolutions.	Utilize Energy Storage to participate in Energy Market Trading for additional savings and revenue streams	Data storage and analytics provide insights for improved operations, proactive monitoring and business intelligence

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