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Future of Solar & Storage

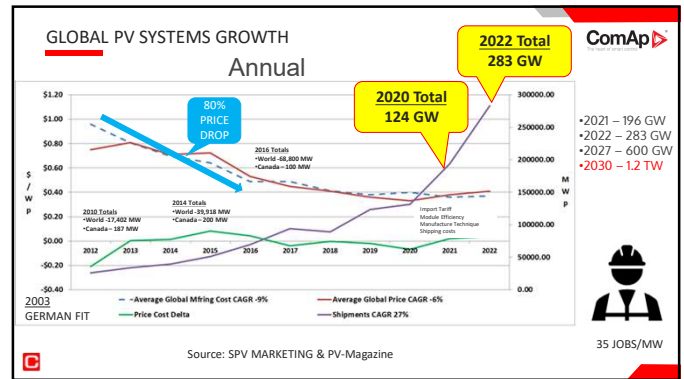
Ed Knaggs

October 2023

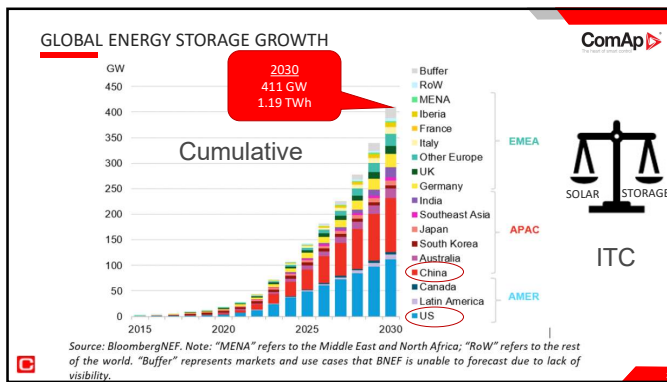


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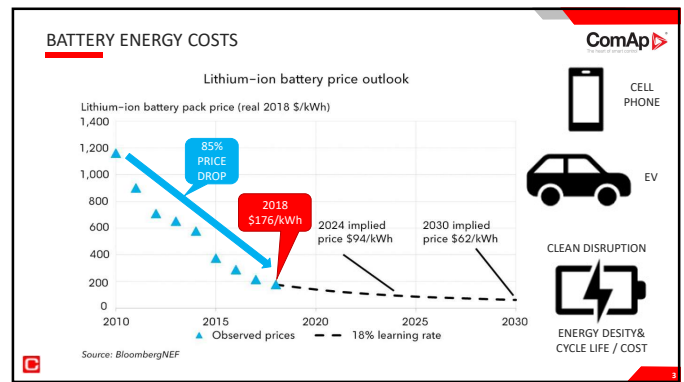
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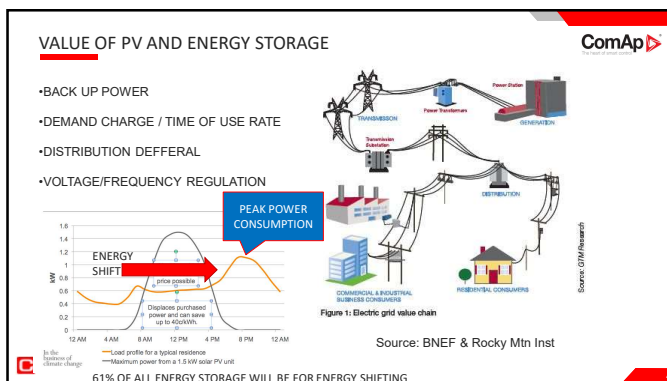
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Adapting codes and standards

PART 3 UTILITY INTERCONNECTION- CSA 22.3 No.09

PART 2 PRODUCT SAFETY – MODULES, INVERTERS, ETC

PART 1 ELECTRICAL CODE- INSTALLATION



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PART 3- UTILITY INTERCONNECTION

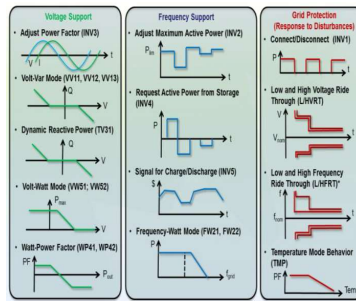
GRID MODERNIZATION

SAFETY

- IEEE1547
- CSA 22.3 No.09
- CSA 22.2 No.107.1 Inverter Test

PERFORMANCE

- Over/Under Voltage & Frequency
- Anti- Islanding
- Power limiting
- Power Factor Control
- Freq-Watt
- Volt-Var



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PART 2- PRODUCT SAFETY- MODULES

SAFETY

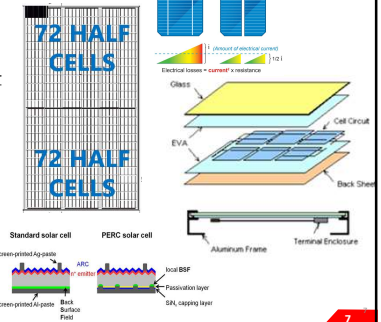
- C22.2 No.61730 or ULC/ORD-C1703
- Withstand ratings and loading
- Electrical Nameplate at STC

PERFORMANCE

- PERC cells
- Busbar quantity and shape
- Half cut cells
- Cell size

ELECTRICAL CHARACTERISTICS	
Max Power (Pmax)	250 W
Tolerance of (Pmax)	[-0; +5 W]
Type of Cell	Poly-Crystalline
Cell Configuration	60 in series
Open Circuit Voltage (Voc)	37.3 V
Maximum Power Voltage (Vpm)	29.9 V
Short Circuit Current (Isc)	8.81 A
Maximum Power Current (Ipm)	8.36 A

PV CIRCUIT
64-202
64-206



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PART 2- PRODUCT SAFETY- INVERTERS

SAFETY

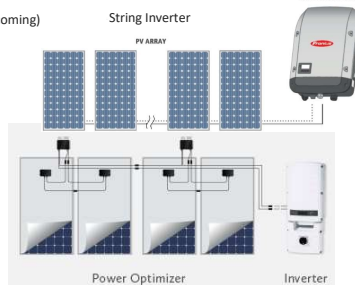
- CSA 22.2 No.107.1 or C22.2 62109-1-2 (Part 3 coming)

PERFORMANCE

- STRING – Traditional 600V, 1000V, 1500V
- OPTIMIZED – DC/DC converter & RSD
- MICRO – AC output circuits



64-218 Rapid Shutdown



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PART 1- ELECTRICAL CODE

Changes/additions to existing rules include:

- 64-112 – Point of connection- Means to limit current

New Rules and requirements:

- 64-800 Installation of Batteries
- 64-900 Energy Storage Systems
- Definitions – Energy storage system — a system capable of supplying electrical energy to local power loads or operating in parallel with a supply authority system or any other power sources.

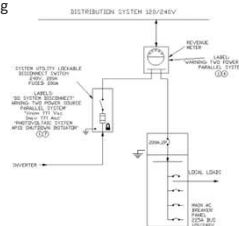
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64-112 INTERACTIVE POINT OF CONNECTION

1) The output of an interactive inverter or power conditioning unit shall be connected to the supply authority system in accordance with Section 84.

2) Except as provided for in Subrule 3), the output of an interactive inverter described in this Section shall be connected to the supply side of the service disconnecting means.

Service entrance rated equipment!



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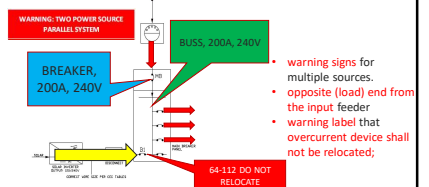
64-112 LOAD SIDE

DWELLING
120/240V SERVICE

- 200A Buss x 1.25 = 250 – 200A Breaker = 50A Solar Breaker

- Approx 9,600W Inverter Power

- ENERGY STORAGE SYSTEM !!



64-112 Busbar Loading

4) d) notwithstanding Section 14, for a dwelling unit, the sum of the ampere ratings of the overcurrent devices in source circuits supplying power to a busbar or conductor shall be permitted to exceed the busbar or conductor rating to a maximum of 125% of the rating of the busbar or conductor;

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64-112 LOAD SIDE COMMERCIAL

64-112 Busbar Loading

4) c) notwithstanding Section 14, the sum of the ampere ratings of the overcurrent devices in source circuits supplying power to a busbar or conductor shall be permitted to exceed the busbar or conductor rating to a maximum of 120% of the rating of the busbar or conductor;

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64-112 EQUIPMENT PROVIDED TO LIMIT THE CURRENT

64-112 Busbar Loading

4) e) notwithstanding (Items c) and d), the sum of the ampere rating of the overcurrent devices shall be permitted to exceed the rating of the busbar or conductor where means are provided to limit the input and output current of the interconnected systems to ensure the busbar or conductor cannot be overloaded; and

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64-900 Energy Storage Regulations

Regulations and Standards	Description
NFPA 855	The Standard for the Installation of Stationary Energy Storage Systems (ESS). For this project we will be looking specifically at the minimum installation requirements of lithium-ion batteries in non-dedicated use buildings.
2021 Canadian Electrical Code	Specifically, section 64-900 in the 2021 Canadian Electrical Code (CE Code). 64-900 outlines the specific requirements for the installation of energy storage systems in Canada. Currently, this section is being revised. The revisions proposed have been sent out for public review and are available on the CSA public review site.
UL 1973	The Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications. The battery management system (BMS) that has been evaluated with the battery is permitted to be part of the thermal runaway protection tested to UL1973 or UL9540.
UL 9540	Energy Storage Systems and Equipment. This standard is used to evaluate the safety and compatibility of energy storage systems and equipment.
UL9540A	Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems. Used in large scale testing in order to get approval to exceed the limitations outlined in NFPA 855 and 2021 Canadian Electrical Code.
NFPA 69	Standard on Explosion Prevention Systems. This standard is used to comply with NFPA 855 Explosion Control Protection Requirements.

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64-900 BATTERY ENERGY STORAGE SYSTEMS

Energy storage system — a system capable of supplying electrical energy to local power loads or operating in parallel with a supply authority system or any other power sources

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Lead-Acid Deviation or Variance from 64-900

Lead-Acid Deviation or Variance from 64-900

No Thermal Runaway
Inappropriately, other battery chemistries have been grouped in the same category as lithium in many of these tests and codes

Whit Paper
109239 Considerations for Lead-Acid Battery Energy Storage Systems

64-800
Lead-acid battery storage systems will still be required to meet all other sections of the code, in particular section 64-800 (Installation of Batteries)

Existing Exemption
Ontario 64-7-1 exempting lead batteries from the UL9540 requirement.

Lead batteries are not harmfully impacted by ambient temperatures when charging or discharging.
Lead batteries charging or discharging process can be easily controlled or "walked" down safely and simply.
Lead batteries use a water-based electrolyte, providing a safe non-flammable medium.
Lead batteries overcharge does not pose a safety hazard like thermal runaway, leads to dry-out and is self-limiting due to the rising resistance.

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What is the issue with Energy Storage Systems

LITHIUM-ION BATTERY

Thermal Runaway

- 500 Degree Temperature
- Gasses Released

LITHIUM-ION

LITHIUM-ION consists of different chemistries

- Thermal Runaway
- Mechanical Failure
- Over-Charging
- Discharge Rate
- Ambient Temperature

LITHIUM-ION cells are typically packet or cylinder type

Battery pack

Combined cells in series or parallel to achieve the desired voltage and capacity. Typically contains a battery management system.

Limit Locations- Living spaces & egress
Physical Protection
Limit Capacity — 20, 40, 80 kWh
Control charge/discharge-UL9540
Fire warning- Smoke detection
Fire containment- 1 hr fire rating
Limit Propagation- UL9540A

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Energy Storage Commercial Warehouse

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- Approved Equipment UL1973 & CSA 22.2 No 107.1
- 64-902 Marking, Directory (Sources & Disconnects)
- 64-904 Voltage - 600V Residential & High Voltage (750-1500Vdc)
- 64-908 Conductors-Red/Black & 90° C
- 64-910 Installation-Mechanical Protection
- 64-912 Overcurrent Protection
- 64-914 Disconnecting Means
- 64-916 Bonding & Grounding

23m Above-Electrical Vault

Egress Path

ENERGY STORAGE SYSTEM DISCONNECT

RENEWABLE ENERGY SYSTEM CONTAINS ELECTRICAL STORAGE DEVICE

Below Egress - Electrical Vault

1m or 3m From Gas - Vehicle Protection

Vault (transformer vault or electrical equipment vault) — an isolated enclosure, either above or below ground, with fire-resistant walls, ceilings, and floors for the purpose of housing transformers and other electrical equipment.

2-308 Working space around electrical equipment (1m clearance)

2-310 Entrance to, and exit from, working space

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Energy Storage Residential GENERAL

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- Approved Equipment-UL9540
- 64-902 Marking, Directory (Sources & Disconnects)
- 64-904 Voltage - 600V Residential
- 64-908 Conductors-Red/Black & 90° C
- 64-910 Installation-Mechanical Protection
- 64-912 Overcurrent Protection
- 64-914 Disconnecting Means
- 64-916 Bonding & Grounding

Residential Use ESS

- Conforms to UL9540
- Capacity less than 20kWh

**SolarEdge
Enphase
Tesla
Simpliphi**

64-910 Mechanical Protection - Subject to impact

ENERGY STORAGE SYSTEM DISCONNECT

RENEWABLE ENERGY SYSTEM CONTAINS ELECTRICAL STORAGE DEVICE

2-308 Working space around electrical equipment (1m clearance)

2-310 Entrance to, and exit from, working space

2-312 Transformer 1m working space

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Energy Storage Residential Garage or Outbuilding or Outside Wall

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- Approved Equipment-UL9540
- 64-902 Marking, Directory (Sources & Disconnects)
- 64-904 Voltage - 600V Residential
- 64-908 Conductors-Red/Black & 90° C
- 64-910 Installation-Mechanical Protection
- 64-912 Overcurrent Protection
- 64-914 Disconnecting Means
- 64-916 Bonding & Grounding

Garage 20kWh/unit up to 80kWh Total 1m apart

Storage Building or free-standing structure 20kWh/unit up to 80kWh Total 1m apart 1m away from Res

Exterior Surface 20kWh/unit up to 80kWh Total 1m apart 1m away from opening

2-308 Working space around electrical equipment (1m clearance)

2-310 Entrance to, and exit from, working space

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Energy Storage Residential Inside Dwelling

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Variance for 64-918 (4) systems >1kWh

- Approved Equipment-UL9540
- 64-902 Marking, Directory (Sources & Disconnects)
- 64-904 Voltage - 600V Residential
- 64-908 Conductors-Red/Black & 90° C
- 64-910 Installation-Mechanical Protection
- 64-912 Overcurrent Protection
- 64-914 Disconnecting Means
- 64-916 Bonding & Grounding

20kWh/unit up to 40kWh Total 1m apart 1m away from opening

Utility Closet/Storage Room 1hr Fire Rating Smoke Detector

Below Grade & Service Room Not Opening to Sleeping Area

ESS certified to UL9540

a) ESS are located in a dedicated storage room, utility closet, service room, or similar area that does not open directly into sleeping areas.

b) The room or area has a fire rating not less than 1 h, deemed to be in compliance with the Ontario Building Code (OBC) by a competent person.

c) The room or area is equipped with an interconnected smoke alarm or detector.

d) Individual ESS capacity does not exceed 20 kWh.

e) Multiple ESS aggregate capacity does not exceed 40 kWh.

f) ESS are spaced not less than 1 m apart from each other (or as per manufacturer's installation instructions), and

g) ESS are spaced not less than 1 m from doors and windows.

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NBCC - One Hour Fire Rated

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- FLOOR- Concrete/ignore?
- DOOR- Fire Rated 1hr
- WALLS
 - Wood or steel
 - 16" or 24" spacing
 - Non or load bearing
 - Fiberglass Insulated
 - Gypsum
 - 1/2" Regular
 - 5/8" Type X
- CEILING
 - Gypsum
 - 1/2" Regular
 - 5/8" Type X

OTHER Smoke Detector Fire Suppression Venting

CEILING 2 Layers 5/8" Type X Gypsum

Fire door 1 Hour Fire Rated

Basement

WALL 16" O.C spacing Insulated 5/8" Type X Gypsum

9.10.3. Ratings

9.10.3.1. Fire-Resistance and Fire-Protection Ratings

1) Where the rating is required, the fire-resistance rating is required in this Section as an element of a building, such rating shall be determined in accordance with:

a) the test methods described in Table 9.10.3.1-A, and

b) the current fire specifications presented in Tables 9.10.3.1-A and 9.10.3.1-B.

CHARGE SOLAR

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Hybrid Microgrids

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The Future of Power Generation

Thank You! QUESTIONS?

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