# Electrical Design for Part 9 Building Electrification

## Energy Save New West – Breakfast Meeting

**June 18, 2025**

Ben Giudici

Riverside ENERGY SYSTEMS

# Riverside Energy Systems

- Solar PV and storage based electrical energy systems
  - Consulting, feasibility, advising, engineering, and design
  - Installation, maintenance, electrical contracting
- Grid connected, Off-Grid, Micro-grids
- Zero Energy Buildings, Electrification Design and Advising
- Solar Ready, Net-Zero, Net-Zero Ready, LBC
- Residential, commercial, and industrial
- Training for construction professionals and Indigenous communities
- Established in Kamloops since 1995
- Available for work throughout BC.

Ben Giudici
778-220-2496
ben@riversideenergy.ca
www.riversideenergy.ca

Riverside ENERGY SYSTEMS

# Overview

1. Why Electrical Design Matters for Part 9 Buildings
2. Part 9 Building Electrification Challenges
   a) CEC Electrical Service Sizing vs Utility Distribution Standards
   b) CEC Sections 64 and 84 – Renewable Energy and Energy Storage
3. Changing a Home's Electrical Personality (Limiting Service Demand)
   a) Careful ASHP Equipment Selection
   b) Load Limiting, Selection, and Prioritizing
   c) Demonstrated Load
4. Solar PV and Storage
   a) Energy consumption reduction
   b) Grid synergies
5. Case Studies
   a) Contemplated energy retrofit - with classic methods and Demonstrated Load
   b) New Zero-Energy build with solar PV and storage
6. Call to Action – Achieving Best Results

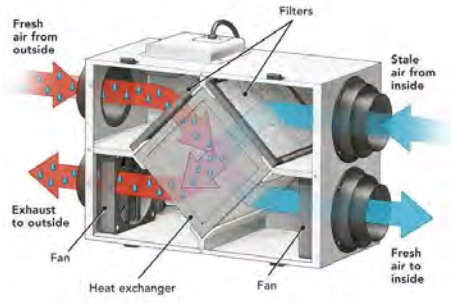
Riverside ENERGY SYSTEMS

# Why Electrical Design Matters for Part 9 Buildings

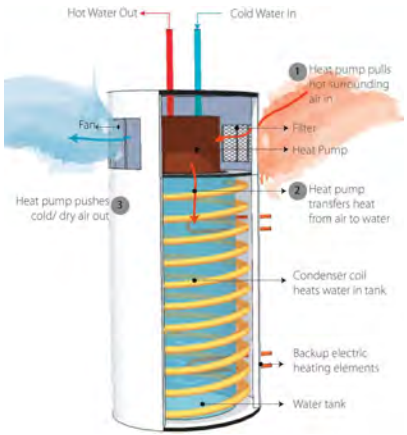
- Electrification can dramatically affect electrical service sizing requirements, and overall retrofit costs.
  - Service upgrades costs $6k - $12k for service panel and supply conductors.
  - Much more if utility transformer or secondary conductor upgrades required.
  - In some instances, service upsizing may not even be possible.
- Electrical service sizing and electrical demand mitigation considerations during design stage can yield significant savings, and improved project outcomes.
- Solar PV and storage (present or future) have significant electrical design impacts to be considered up front for best results.

Riverside ENERGY SYSTEMS

# Part 9 Building Electrification Challenges – Electrical Service




+




+

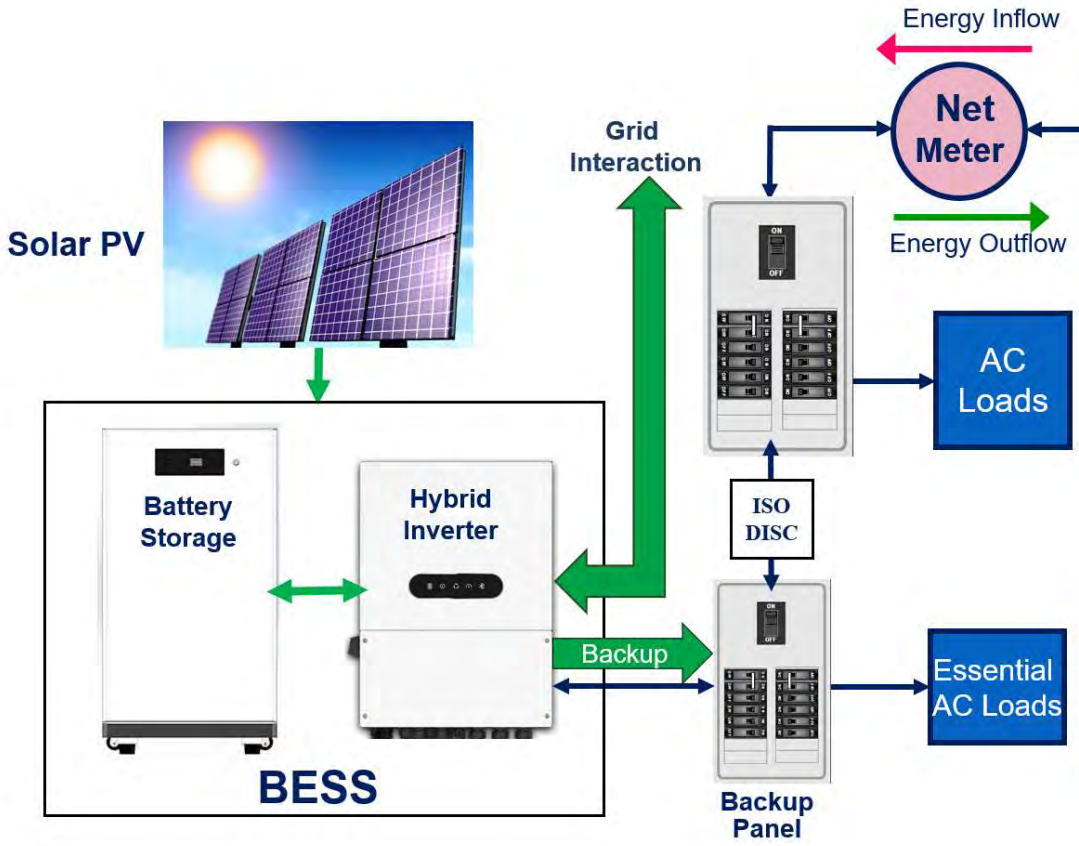
+

=

- Higher load demand.
- Electrical service capacity may need upsizing (CEC Section 8)

Riverside ENERGY SYSTEMS

# Part 9 Building Electrification Challenges – Solar PV and Storage




**Solar PV and Storage**

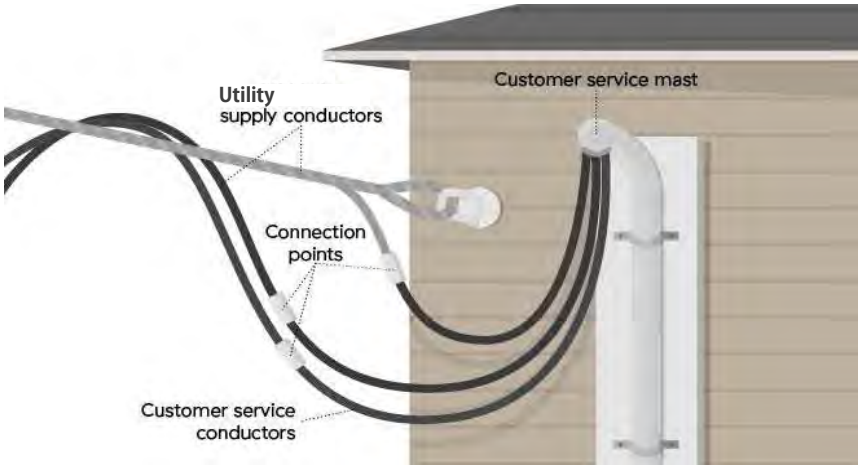
- Reduce grid energy purchase
- Can backup up essential loads
- Can leverage TOU rates
- Impact electrical design significantly
- Are not all-or-nothing decisions.
- Must be considered during design and not left as after-thoughts

Riverside ENERGY SYSTEMS

# Customer Service Constraints

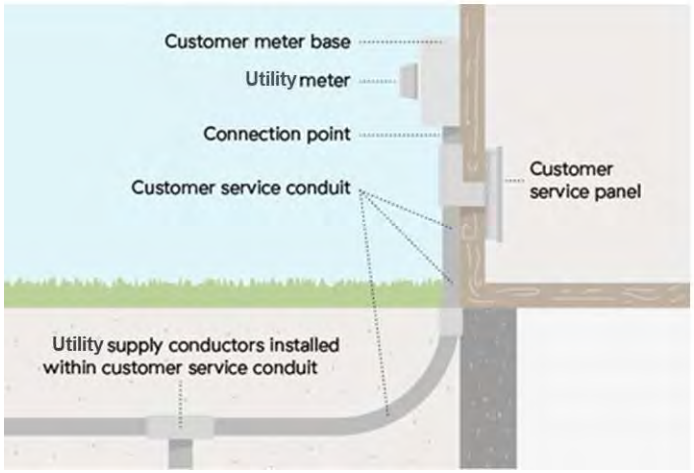
- Upgrading costs vary dependent on customer service type.

Overhead Service




- Supply conductors most easily upsized.

Underground Service




- Supply conductor upsizing requires excavation, driveway cutting/repairs, landscaping disruptions, etc.

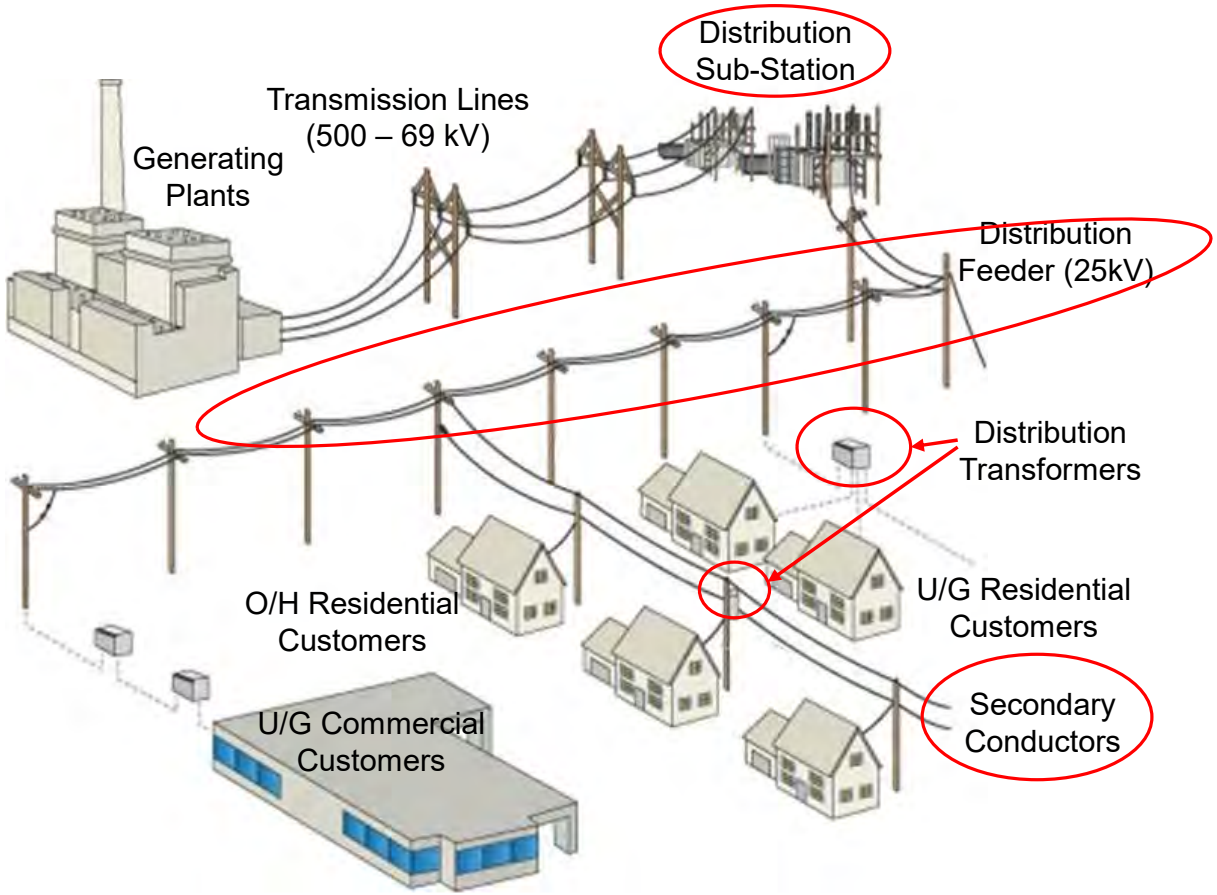
Riverside ENERGY SYSTEMS

# Utility Infrastructure Limitations

Multiple neighborhood or service area service upgrades can require utility infrastructure upgrades including:

- Substation equipment
- Distribution feeders
- Distribution transformers
- Secondary conductors.

Expensive, difficult, or even impossible in some regions.




Riverside ENERGY SYSTEMS

# CEC Section 8 – Service Sizing Requirements

- Safety centered to avoid service overload under worst case scenarios. Loads assumed to be Concurrent
- Founded on 3 principles
  a) Service sizing based on load calculations – Not our choice of service main breaker or fuse (OCPD)
  b) Living area ($m^2$) dictates continuous basic loading (load is never less)
  c) Heavy loads (> 1500W) assumed to all run concurrently.
- Includes permissible load control methods that may lessen service upgrading requirements if carefully applied.

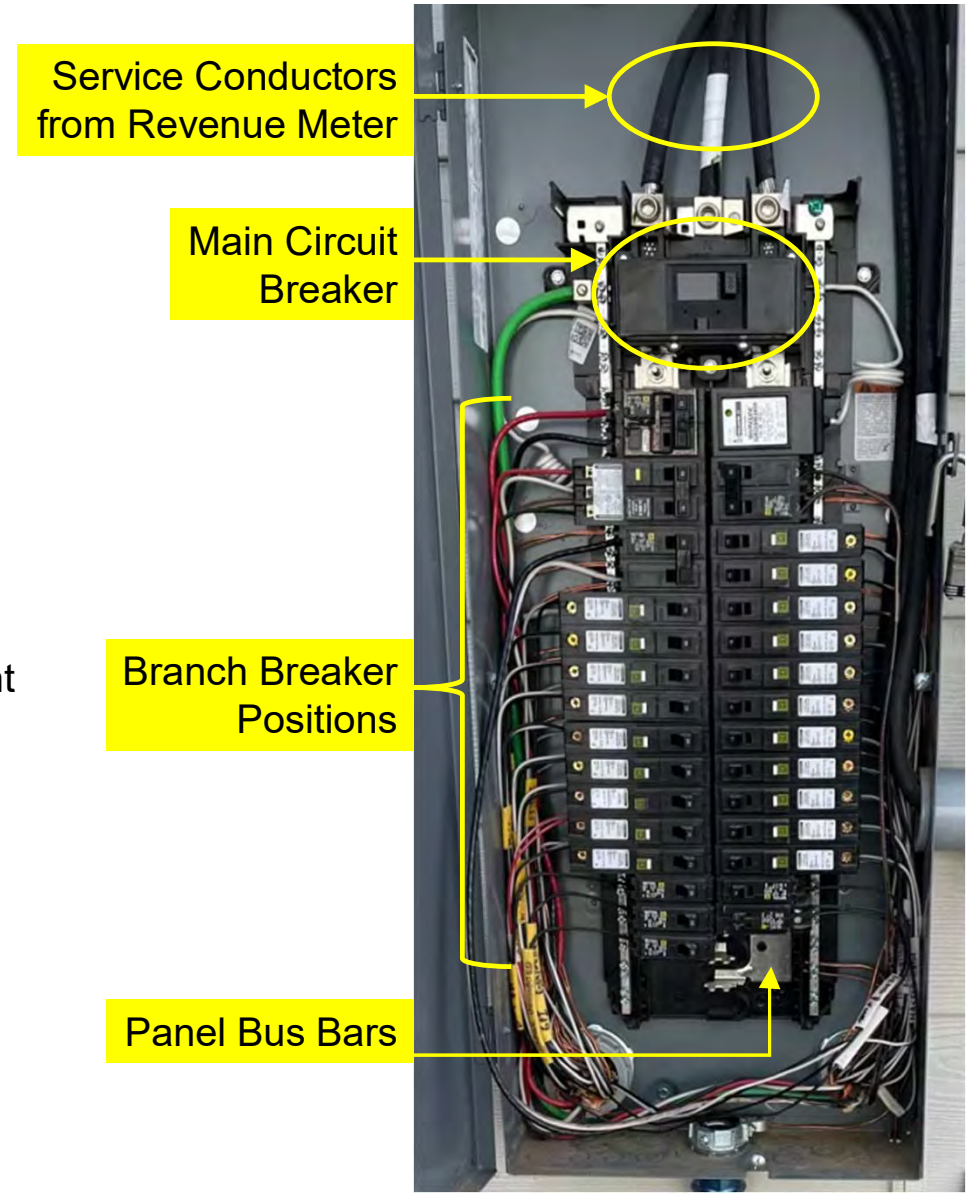
Riverside ENERGY SYSTEMS

# Terminology

1. **Service Size** is the current rating (Amps) of main breaker and service conductors. Eg. 100A, 200A, etc.

2. **Panel Size and Panel Rating** are often interchanged and confused.
   a) **Panel Rating** is the maximum allowable fuse or breaker size for protecting the panel. Eg. 100A, 200A,
   b) **Panel Size** is the number of usable single pole breaker positions. Eg. 42 circuit, 60 circuit, etc.

3. **Bus or Lug Rating** is the maximum continuous current rating of the panel bus bars. **Bus ≥ Main CB rating.**
   - **Eg.** 200A Panel, 200A main CB, 42 circuit, 225A bus.




Riverside ENERGY SYSTEMS

# Utility Distribution Infrastructure Sizing

Engineering Standards based on empirical operating experience.

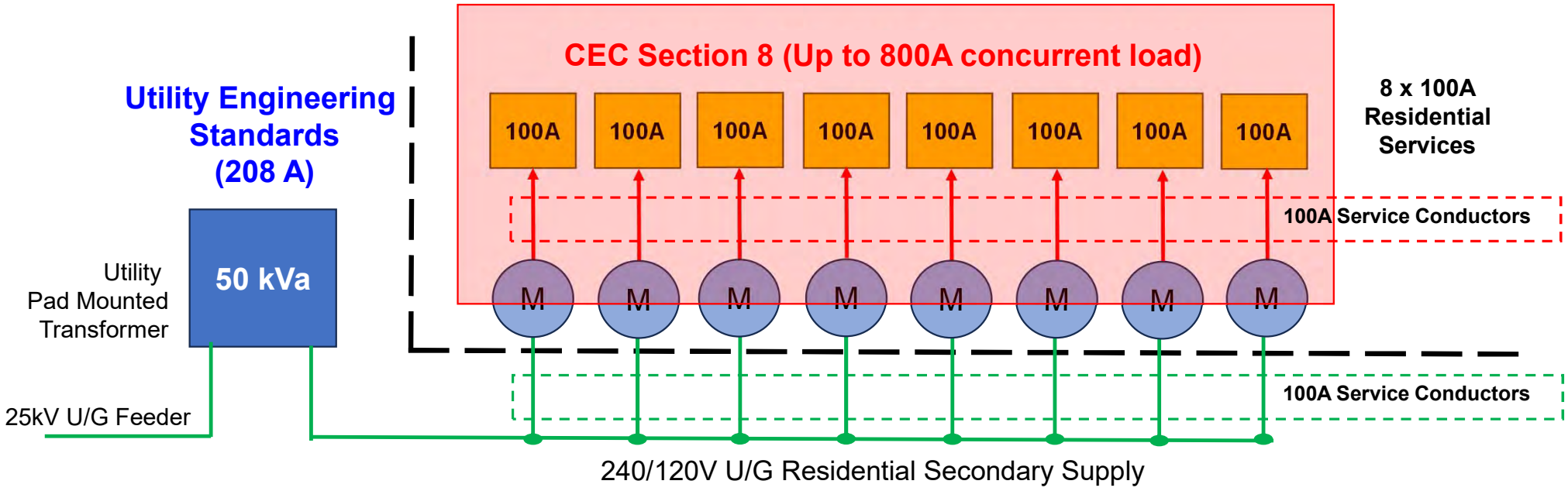
- What is the likely maximum load? vs What is the worst possible loading?
- Loads WILL NOT all run concurrently. Loads assumed to be Diverse
- Utilities are not required to follow CEC design practices.

Residential 50 kVA
Pad-Mounted U/G
Distribution Transformer
(208A Full Load at 120/240V)


Riverside ENERGY SYSTEMS

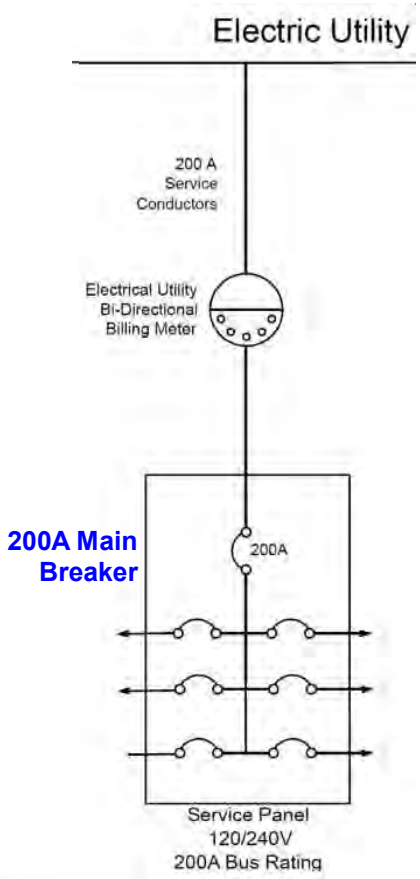
# CEC Service Sizing vs Utility Distribution Capacity

- Utility Engineering Standards – Empirical, Cost effective. Loads Diverse (208A)
- CEC Section 8 – Caution for consumer safety. Loads Concurrent (800A)




Riverside ENERGY SYSTEMS

# Service OCPDs Do Not Limit or Justify Service Size




- Service sizing must be based on the nature and size of Connected Load, and Living Area.
- CEC does not permit the tripping of a 200A main service breaker on sustained overload, to justify connecting more than 200A of calculated service load. Rather, a 400A service is required.

Service Load Calculated
Per CEC Section 8

195A → **200A service OK**

205A → **400A service required**

Riverside ENERGY SYSTEMS

# Living Area ($m^2$) Dictates Continuous Basic Load

| | |
|---|---|
| Ground Floor Area ($m^2$) | 0 |
| Living Area Above Ground Floor (m2) | 147.1 |
| Living Area Below Ground Floor (m2) x 70% | 51.5 |
| | |
| **Effective Living Area (m2) 8-110 a,b,c** | **198.6** |
| | |
| Basic Load (first 90 m2) 5000 W | 5000 |
| Additional (per 90 m2 Increment) 1000 W | 2000 |
| **Effective Base Load (Watts) 8-200, 1a** | **7000** |
| **Effective Base Load (Amps)** | **29.2** |

- **Basic Load** calculated by area
  - 5000 W first 90 $m^2$.
  - 1000 W per additional 90 $m^2$ or portion.
- **Basic Load** considered continuous (i.e. Load never less than this)
- **7000 W (29.2 Amps)** for two story 2375 $ft^2$ case study home
- 29.2% of 100A service capacity used by prescriptive basic load
  - Only 70.8A left to work with.

Riverside ENERGY SYSTEMS

# Continuous Loads (>1500W) Assumed to All Run Concurrently

- Space Heating
- Air Conditioning
- Electric DHW
- Electric Range
- Electric Dryer
- EV Charging
- Others
  - Hot Tub
  - Sauna

**Some derating is permitted but these can quickly use up any remaining service capacity margin**

Riverside ENERGY SYSTEMS

# Burnaby Case Study Home with a 100A Service Before Retrofit

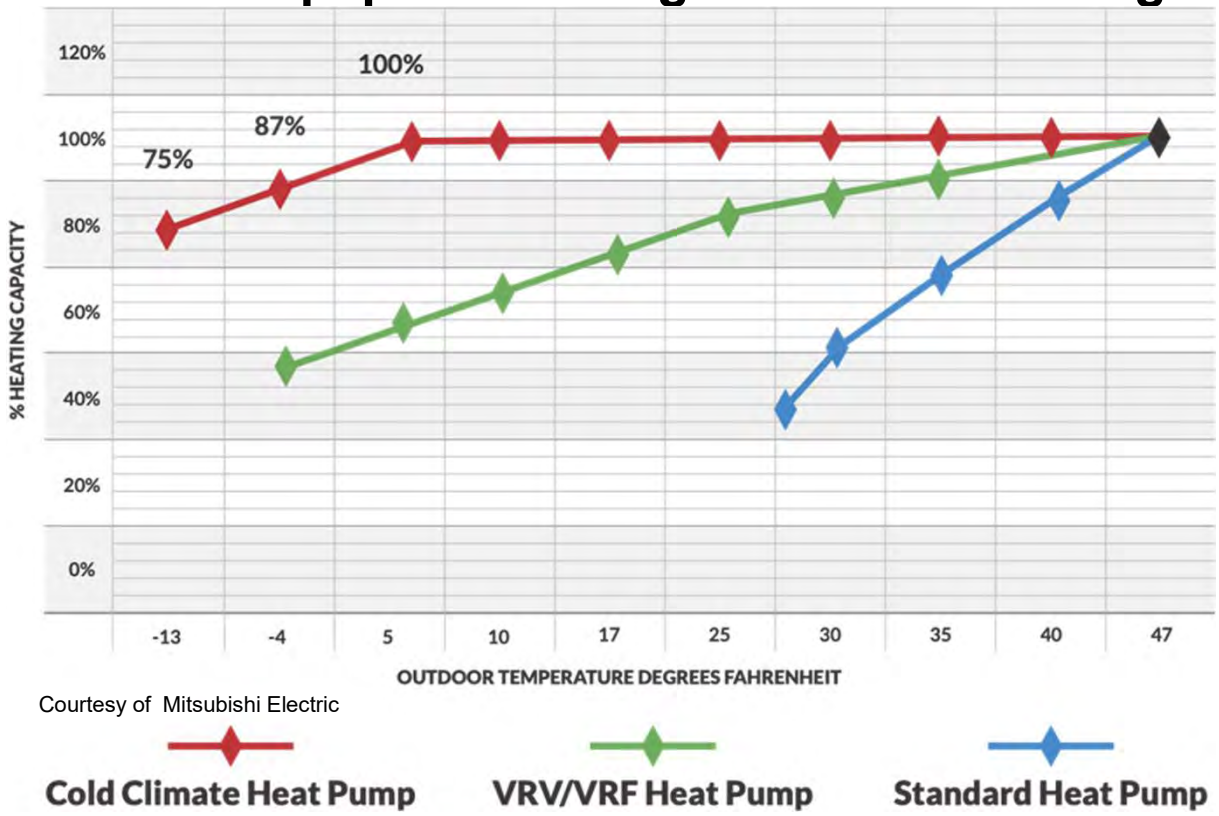
| CEC Section 8 -200 | | | | | |
|---|---|---|---|---|---|
| **Single Dwelling Residential Service Sizing** | | | | | |
| **Continuous Loads** | **Num** | **Rated Watts** | **Rule** | **Eff. Watts** | **Amps** |
| | | | | | |
| Electric Oven Load | 1 | 7500 | 8-200 1a, iv) | 6000 | 25.0 |
| Electric Dryer (30A @ 0.8) | 1 | 5760 | 8-200 1a, vii) | 1440 | 6.0 |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| **Total Effective Loads** | | | | **7440** | **31.0** |
| **Effective Base Loads** | | | | **7000.0** | **29.2** |
| **Continous Current** | **Service Size is OK** | | | | **60.2** |
| | | | | | |
| Main OCB Device Rating (Amps) | 100 | | | | |
| Derating Factor | 80% | | | | |
| **Maximum Demand Current (Amps)** | **80** | | | | |

- 2375 $ft^2$ home
  - NG Furnace - 1975
  - NG DHWT
  - NG Cooktop
  - Electric Oven
  - Electric Dryer
- 100 Amp service suffices before retrofits.
- F280 40,985 BTU heating load.

Riverside ENERGY SYSTEMS

# Changing a Home's Electrical Personality

## 1. Careful Equipment Sizing and Selection – eg. ASHP (HVAC Designer)




Courtesy of Mitsubishi Electric

- Extending cold temp operating range with CCHP may lower or eliminate supplemental heat dependence.
- Alternate supplemental heat to electric can accomplish the same
- eg. NG

Riverside ENERGY SYSTEMS

# Changing a Home's Electrical Personality



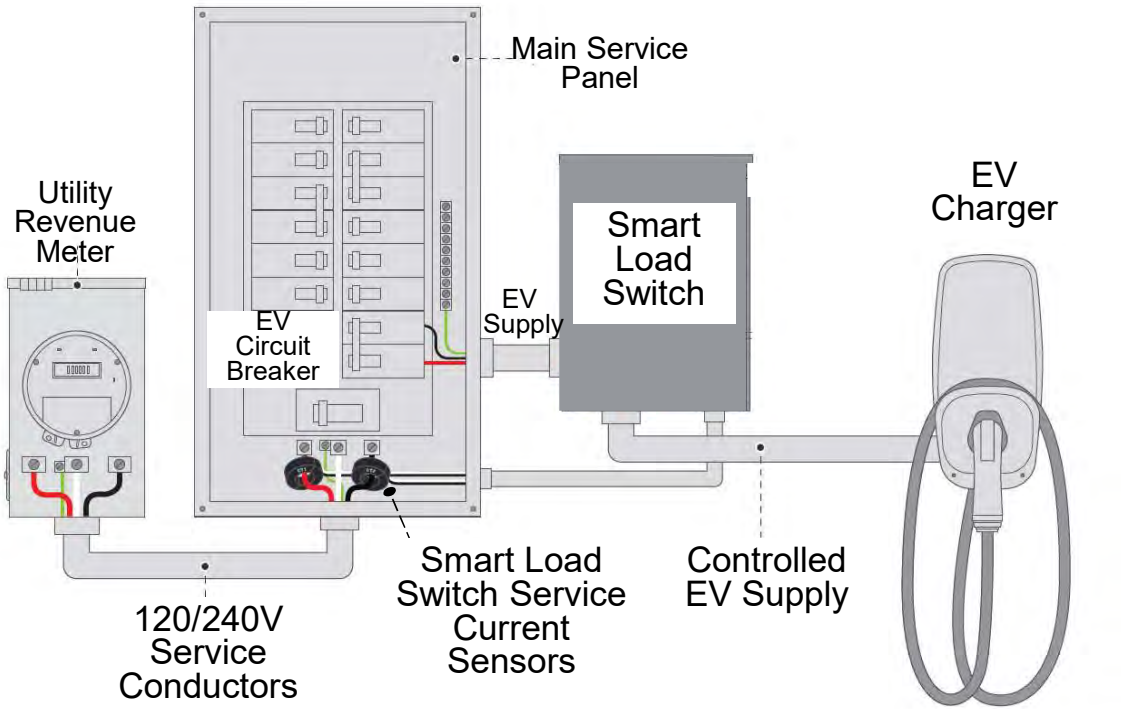
## 2. CEC Section 8 – Allowable Load Demand Limiting Methods

**Electrical Contractor/Designer**

- EV charger load can be eliminated from service sizing calculation if charging is enabled/disabled by service demand current measurement. (Control)
  - **Rule 8-106, 11)**
- If multiple loads are connected such that only one may operate at once, only largest load need be considered in service sizing calculation. (Interlock)
  - **Rule 8-106, 2) and 3)**
- Service sizing calculation for electrical retrofits can be justified based on historical load measurements (Demonstrated Load). Helpful for retrofits. (Measure)
  - **Rule 8-106, 9)**

Riverside ENERGY SYSTEMS

# Load Limiting Methods (Smart Load Switches)




Smart Load Switch measures service currents, and allows load to be powered only if service will not be overloaded

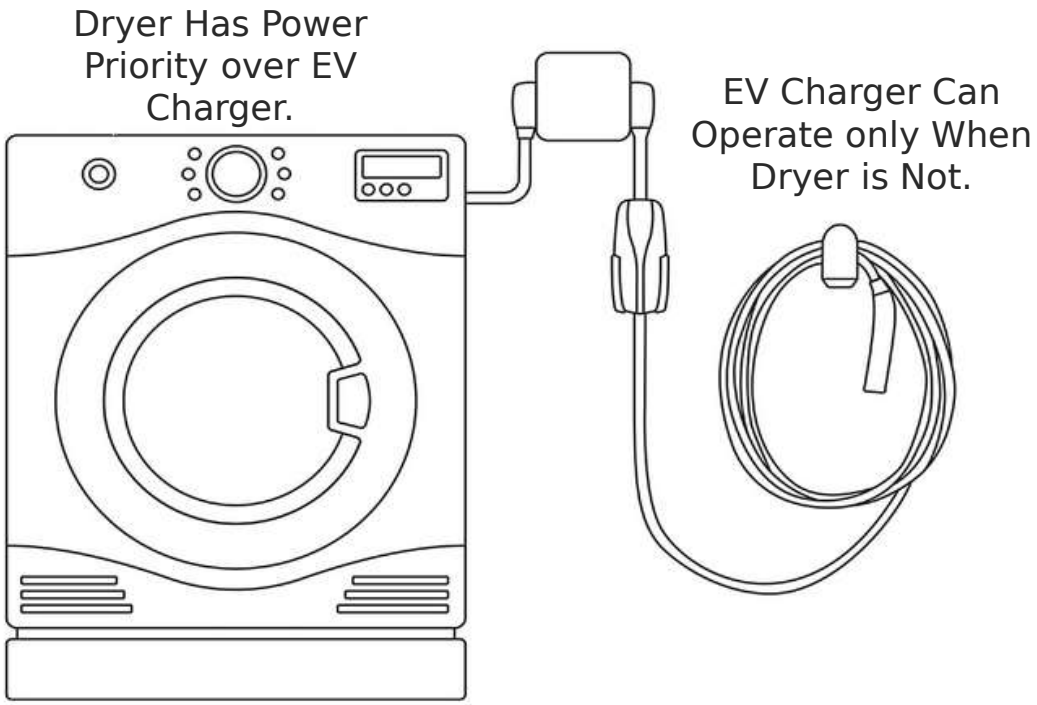
EV charger can operate only when charger operation will not exceed the service size rating.

By **Rule 8-106, 11),** EV charger load can be excluded from service sizing calculations.

Riverside ENERGY SYSTEMS

# Load Limiting (Smart Splitter - Interlocking)

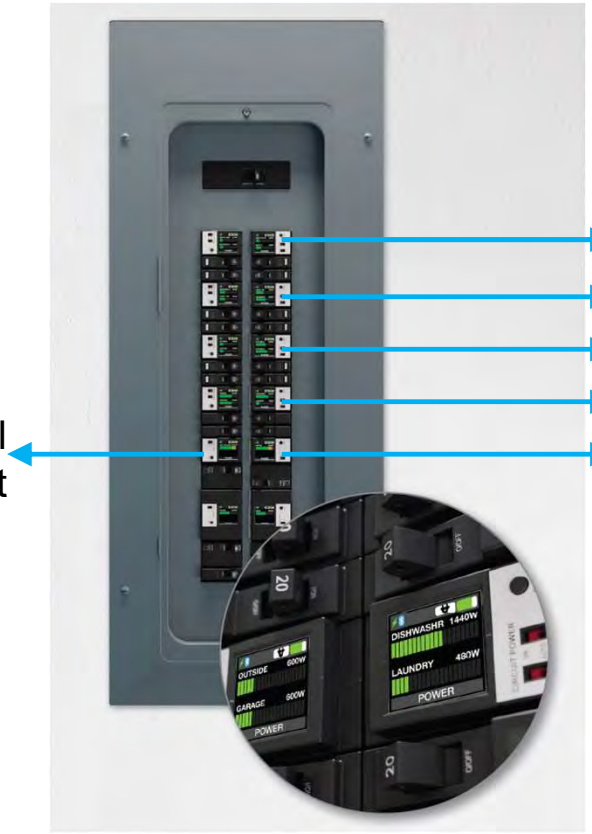
**Plug-in Smart Splitter on 240VAC Outlet**




- Smart Splitter selects one load over another on a single shared supply circuit.
- EV charger can operate only if the electric dryer is not operating.
- **Rule 8-106, 2) 3)** requires only the larger of the two loads to be included in service sizing calculation.

Riverside ENERGY SYSTEMS

# Prioritized Load Enabling/Shedding (Smart Panels)




- Smart Panel selectively enables/disables continuous electrical loads based on real-time service current measurements.
- Sophisticated form of interlocking
- Loads prioritized based on available service current margin and programmed load shedding.
- **Rules 8-106 2) 3)** and **8-106 11)**.
- Not widely endorsed by safety authorities yet …..
  - Recently approved by Ontario electrical safety authorities.

Riverside ENERGY SYSTEMS

## Using the Demonstrated Load Clause Rule 8-106, 9)

- Historical load measurements may be used to justify remaining electrical service capacity for electrical retrofits versus the classic approach.

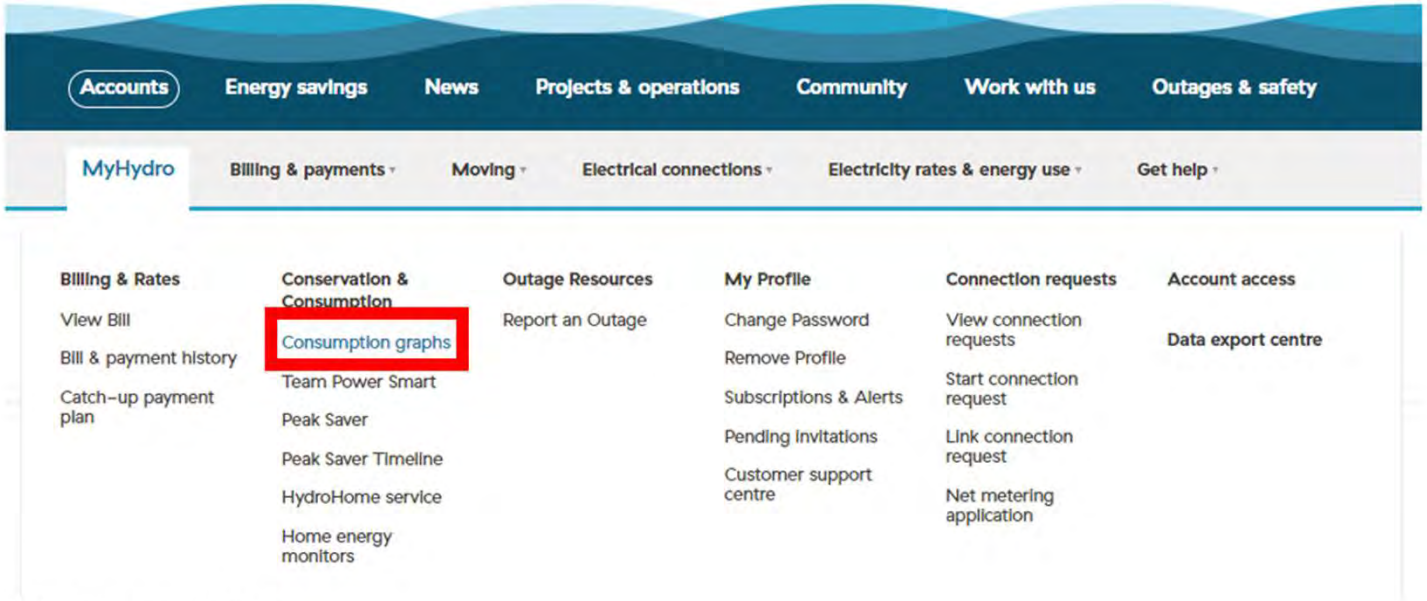
- Historical load measurements may be completed by a qualified professional (Electrical FSR, Electrical Engineer) using one of:
  - 12 month (or more) hourly kWh utility data to estimate maximum load.
  - 12 month (or more) third party power/energy data logger; 1hr or smaller sampling intervals.

- New Westminster smart meter program (AMI) circa Fall 2025. The City may wish to plan for this type of data availability to utility customers.

Riverside ENERGY SYSTEMS

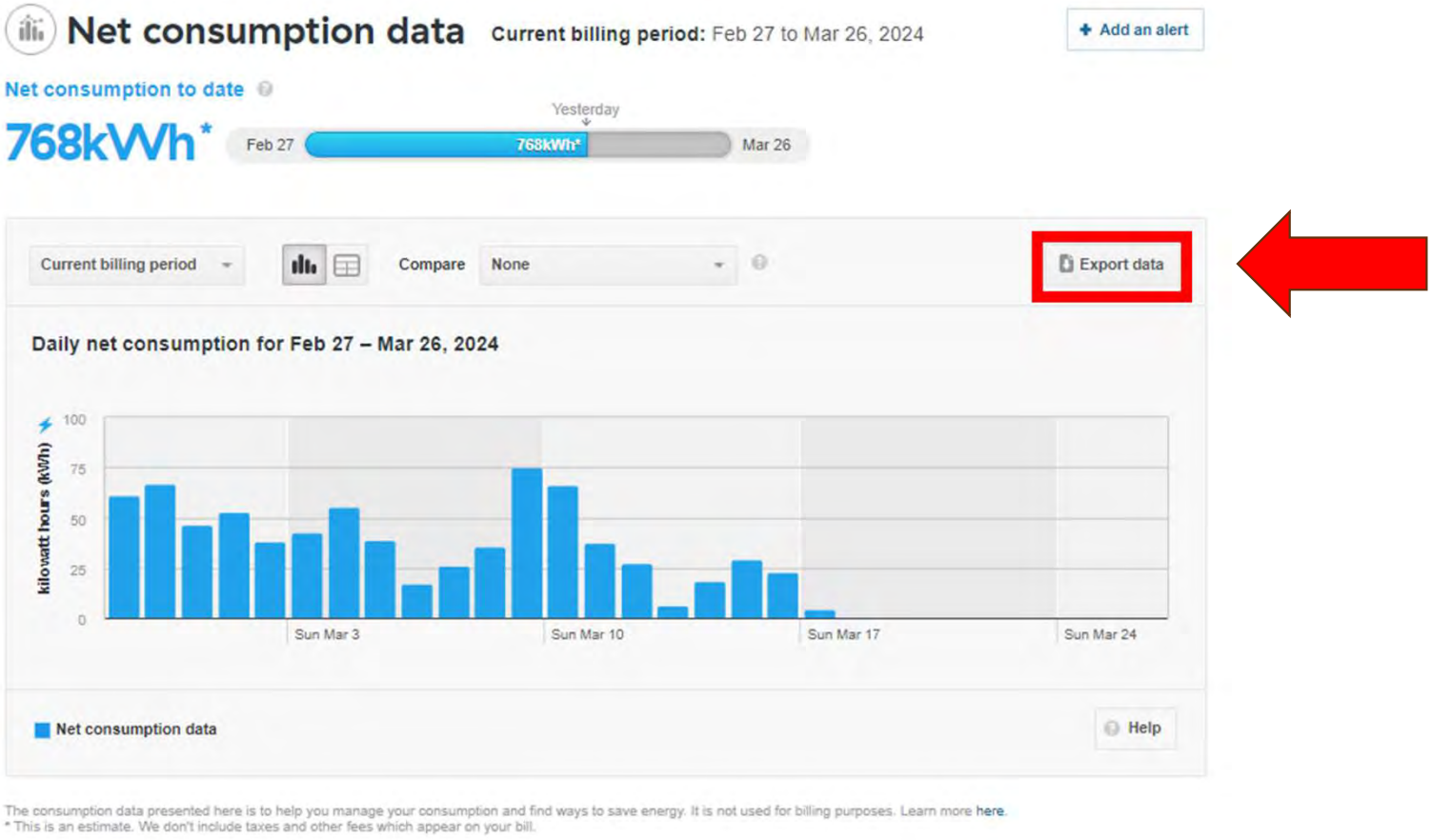
# Acquiring 1 Hr Meter Data via MyHydro Website

1. Sign in to customer's MyHydro Account
2. Navigate to the *Consumption Graphs*




3. Click *Export data*

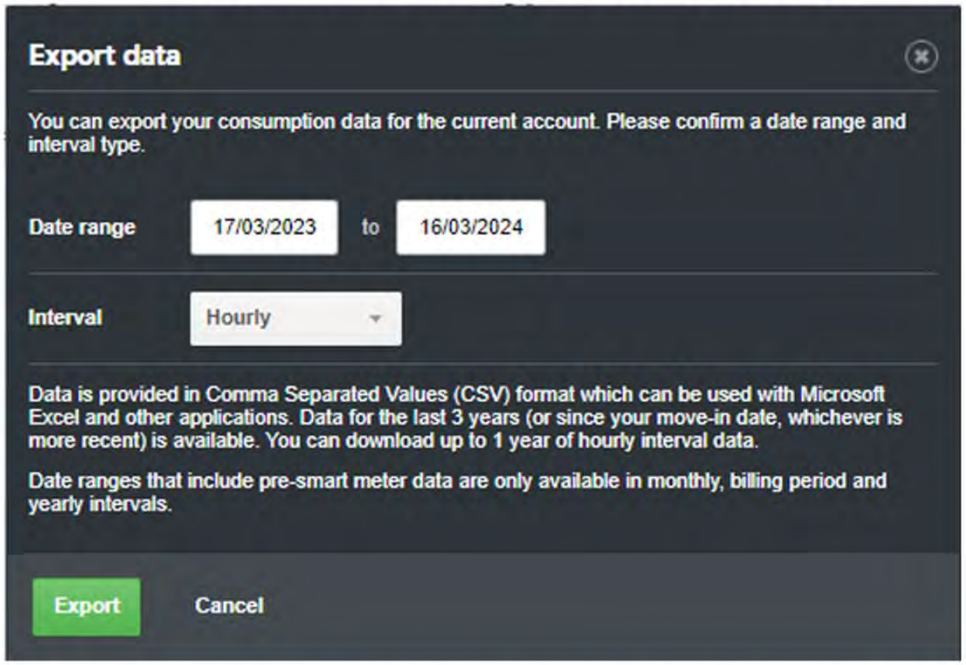
# Acquiring 1 Hr Meter Data via MyHydro Website




Riverside ENERGY SYSTEMS

# Acquiring 1 Hr Meter Data via MyHydro Website

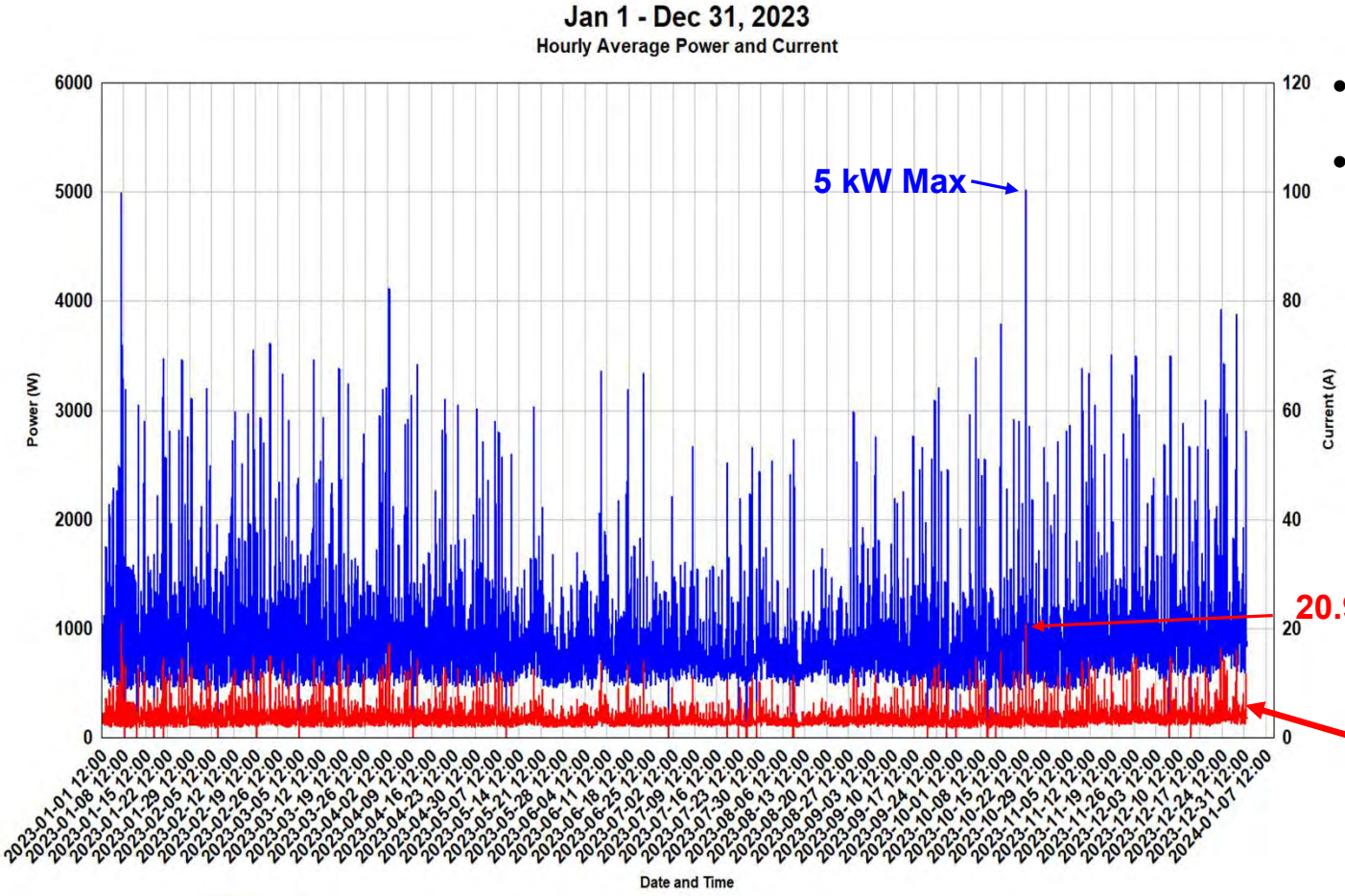
4. Set the date range for the previous 365 days and ensure the *Interval* is set to *Hourly.* If the date range is more than 12 months, hourly data will not be available.




5. Click *Export*. The file will download into your browser as a *.csv type.

Riverside ENERGY SYSTEMS

# Demonstrated Load – Burnaby Case Study Home Before Retrofit




- 20.9 A Max demand in 2023.
- **Demonstrated Load is** less than 35% of CEC calculated load.

Approx 5-6 A Basic Load in contrast to 29.2A prescribed by CEC Section 8 “Living Area” Method

Riverside ENERGY SYSTEMS

# Burnaby Case Study Home with ASHP Retrofit – CEC Classic Method

| CEC Section 8 -200 | | | | | |
|---|---|---|---|---|---|
| **Single Dwelling Residential Service Sizing** | | | | | |
| **Continuous Loads** | **Num** | **Rated Watts** | **Rule** | **Eff. Watts** | **Amps** |
| | | | | | |
| Electric Range Load | 1 | 7500 | 8-200 1a, iv) | 6000 | 25.0 |
| Electric Dryer (30A @ 0.8) | 1 | 5760 | 8-200 1a, vii) | 1440 | 6.0 |
| | | | | | |
| Air Source Heat Pump 3 Ton | 1 | 3500 | | 3500 | 14.6 |
| Supplementary Electric Heat | 1 | 10000 | | 10000 | 41.7 |
| | | | | | |
| | | | | | |
| | | | | | |
| **Total Calculated Load** | | | | **20940** | **87.3** |
| **Effective Basic Load** | | | | **7000** | **29.2** |
| **Continous Calculated Current** | **Larger Service Needed** | | | | **116.4** |
| | | | | | |
| Main OCB Device Rating (Amps) | 100 | | | | |
| Permissible for Calculated Load | 100% | | | | |
| **Maximum Demand Current (Amps)** | **100** | | | | |

- 2375 ft$^2$ home
  - NG DHWT
  - NG Cooktop
  - Electric Oven
  - 3 Ton ASHP Retrofit with 10 kW electric supplemental heat.
- Minimum 125A service upgrade required unless impacts can be mitigated.

Riverside ENERGY SYSTEMS

# Burnaby Case Study Home with ASHP Retrofit – CEC Classic Method

| CEC Section 8 -200 | | | | | |
|---|---|---|---|---|---|
| **Single Dwelling Residential Service Sizing** | | | | | |
| **Continuous Loads** | **Num** | **Rated Watts** | **Rule** | **Eff. Watts** | **Amps** |
| Electric Range Load | 1 | 7500 | 8-200 1a, iv) | 6000 | 25.0 |
| Electric Dryer (30A @ 0.8) | 1 | 5760 | 8-200 1a, vii) | 1440 | 6.0 |
| Cold Climate Heat Pump 3 Ton | 1 | 3500 | | 3500 | 14.6 |
| **Total Calculated Load** | | | | **10940** | **45.6** |
| **Effective Basic Load** | | | | **7000** | **29.2** |
| **Continous Calculated Current** | **Service Size is OK** | | | | **74.8** |
| Main OCB Device Rating (Amps) | 100 | | | | |
| Permissible for Calculated Load | 100% | | | | |
| **Maximum Demand Current (Amps)** | **100** | | | | |

- 2375 ft$^2$ home
  - NG DHWT
  - NG Cooktop
  - Electric Oven
  - 3 Ton CCHP with no supplemental heat
- 100 A service suffices with considerable additional margin

Riverside ENERGY SYSTEMS

# Burnaby Case Study Home with ASHP Retrofit – CEC Classic Method

| CEC Section 8 -200 | | | | | |
|---|---|---|---|---|---|
| **Single Dwelling Residential Service Sizing** | | | | | |
| **Continuous Loads** | **Num** | **Rated Watts** | **Rule** | **Eff. Watts** | **Amps** |
| Electric Range Load | 1 | 7500 | 8-200 1a, iv) | 6000 | 25.0 |
| Electric Dryer (30A @ 0.8) | 1 | 5760 | 8-200 1a, vii) | 1440 | 6.0 |
| Cold Climate Heat Pump 3 Ton | 1 | 3500 | | 3500 | 14.6 |
| Electric DHW | 1 | 4000 | | 4000 | 16.7 |
| **Total Calculated Load** | | | | **14940** | **62.3** |
| **Effective Basic Load** | | | | **7000** | **29.2** |
| **Continous Calculated Current** | **Service Size is OK** | | | | **91.4** |
| Main OCB Device Rating (Amps) | 100 | | | | |
| Permissible for Calculated Load | 100% | | | | |
| **Maximum Demand Current (Amps)** | **100** | | | | |

- 2375 ft$^2$ home
  - NG Cooktop
  - Electric Oven
  - 3 Ton CCHP with no supplemental heat
  - Electric DHW
- 100 A service is sufficient.

Riverside ENERGY SYSTEMS

## TSBC –CEC 8-106 “Demonstrated Load” for Single Family Dwellings
## IB-EL 2022-01

Where loads are to be added, augmented load may be calculated by

- *adding the sum of the additional loads, to the “Maximum Demand Load” of the existing installation as measured over the most recent 12-month period.*
- *“Maximum Demand Load” may be obtained using maximum utility 1 hr interval data for existing demand over the last 12 (or more) months X 125%*
- *The new load (hot tub, electric vehicle charger, etc.) can then be added to the utility supplied load to calculate the new demand.*

Kamloops case study home maximum demand load was 20.9 A for 24 months.
Maximum Historical Utility Data x 125% = 1.25 x 20.9A = 26.1 A

Riverside ENERGY SYSTEMS

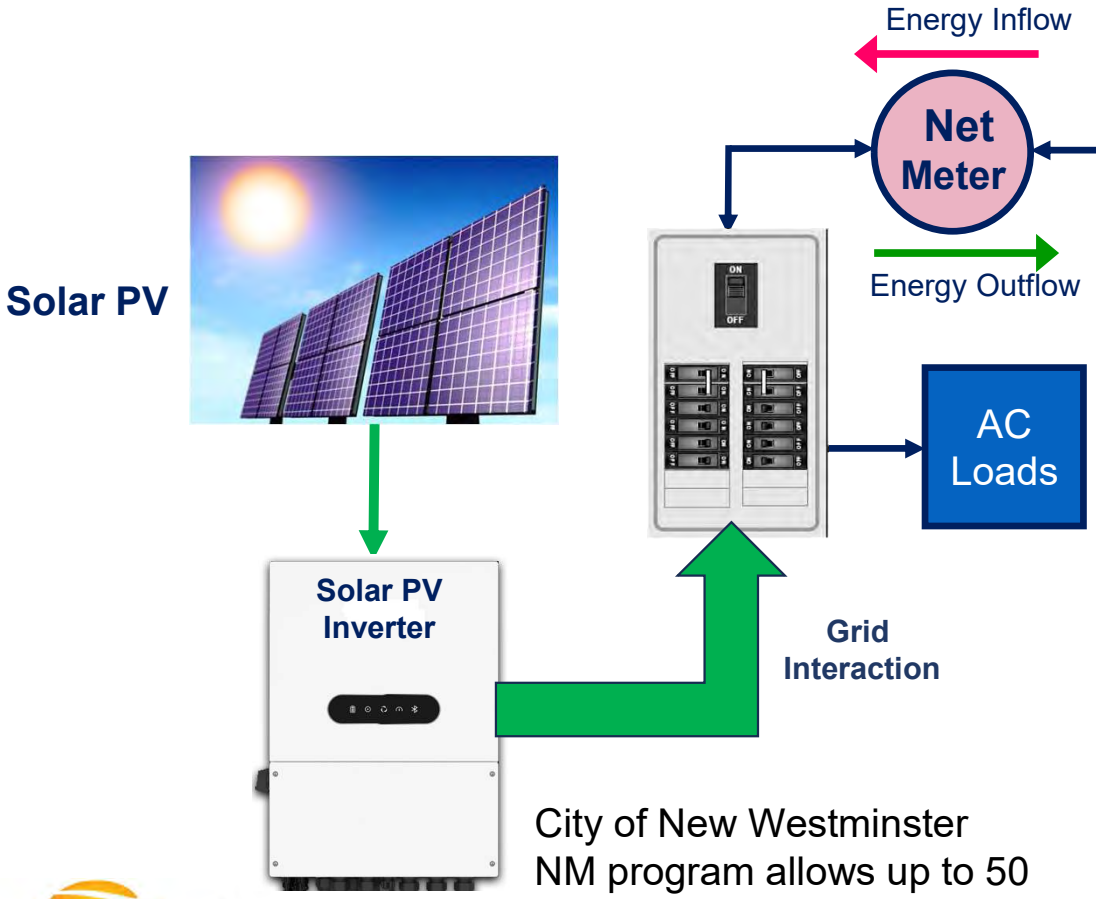
# Burnaby Case Study ASHP Retrofit – Demonstrated Load Method

| CEC Section 8 -200 | | | | | |
|---|---|---|---|---|---|
| **Single Dwelling Residential Service Sizing** | | | | | |
| **Continuous Loads** | **Num** | **Rated Watts** | **Rule** | **Eff. Watts** | **Amps** |
| Maximum Historical Utility Data x 1.25 | | | | 6270 | 26.1 |
| Cold Climate Heat Pump 3 Ton | 1 | 3350 | | 3350 | 14.0 |
| Supplemental Heat | 1 | 10000 | | 10000 | 41.7 |
| Electric DHW | 1 | 4000 | | 4000 | 16.7 |
| **Augmented Continuous Load** | | | | | **98.4** |
| **Continous Calculated Load Current** | **Service Size is OK** | | | | **98.4** |
| Main OCB Device Rating (Amps) | 100 | | | | |
| Permissible for Calculated Load | 100% | | | | |
| **Maximum Demand Current (Amps)** | **100** | | | | |

- 2375 ft$^2$ home
  - NG Cooktop
  - Electric Oven
  - 3 Ton CCHP Retrofit with 10 kW electric supplemental heat.
  - Electric DHW
- 100 A service is sufficient, even with electric DHW and 10 kW electric supp. heat.

Riverside ENERGY SYSTEMS

# Integrating Solar PV under Net-Metering




City of New Westminster NM program allows up to 50 kWac of inverter capacity

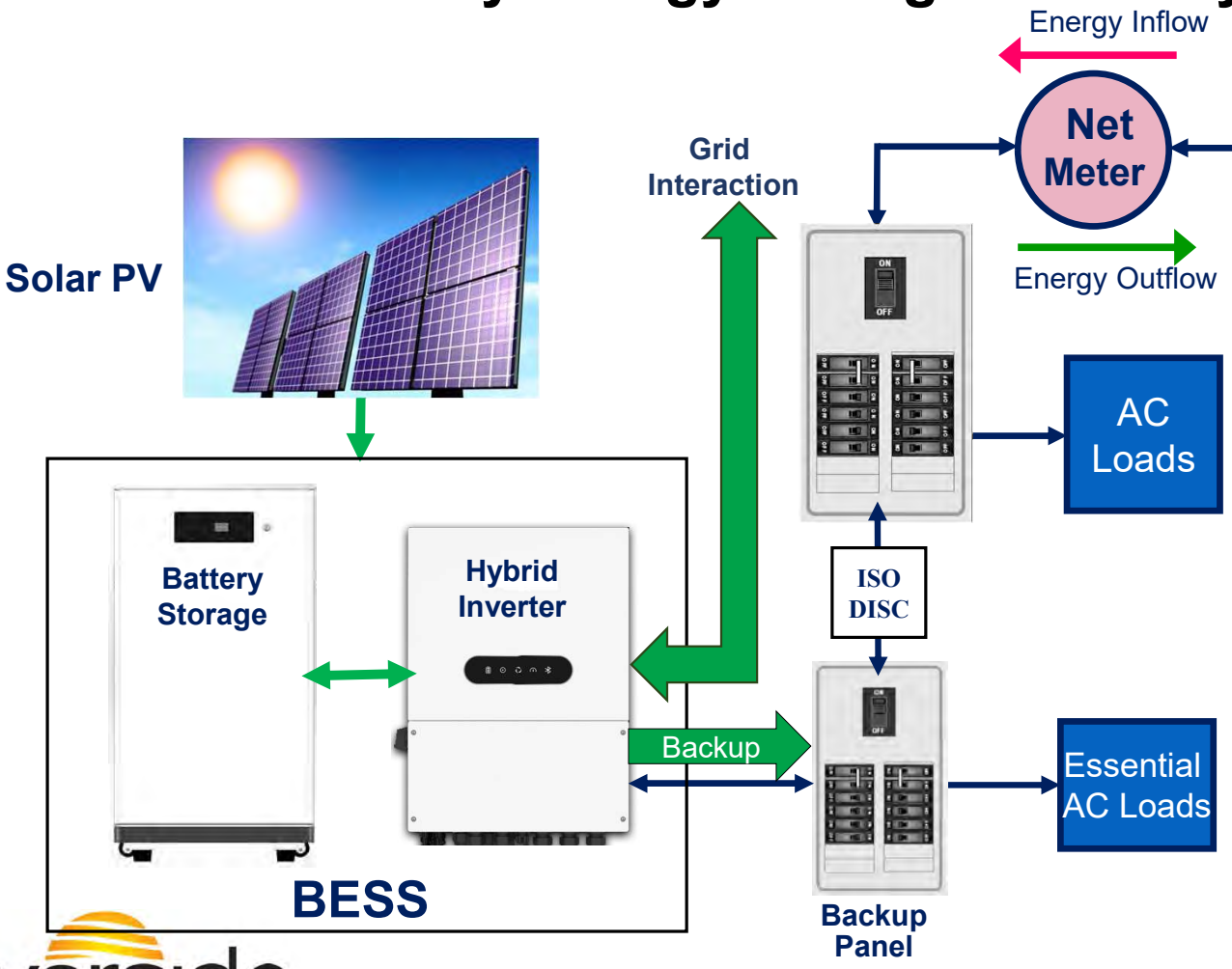
**Solar PV** interacts with the grid to

- Reduce energy inflow required from the grid.
- Solar inverter power output in excess of AC Load demand results in energy outflow to the grid, which is stored for later use.

During grid outages, the solar PV system shuts down.

Riverside ENERGY SYSTEMS

# Solar PV with Battery Energy Storage – Grid Synergies



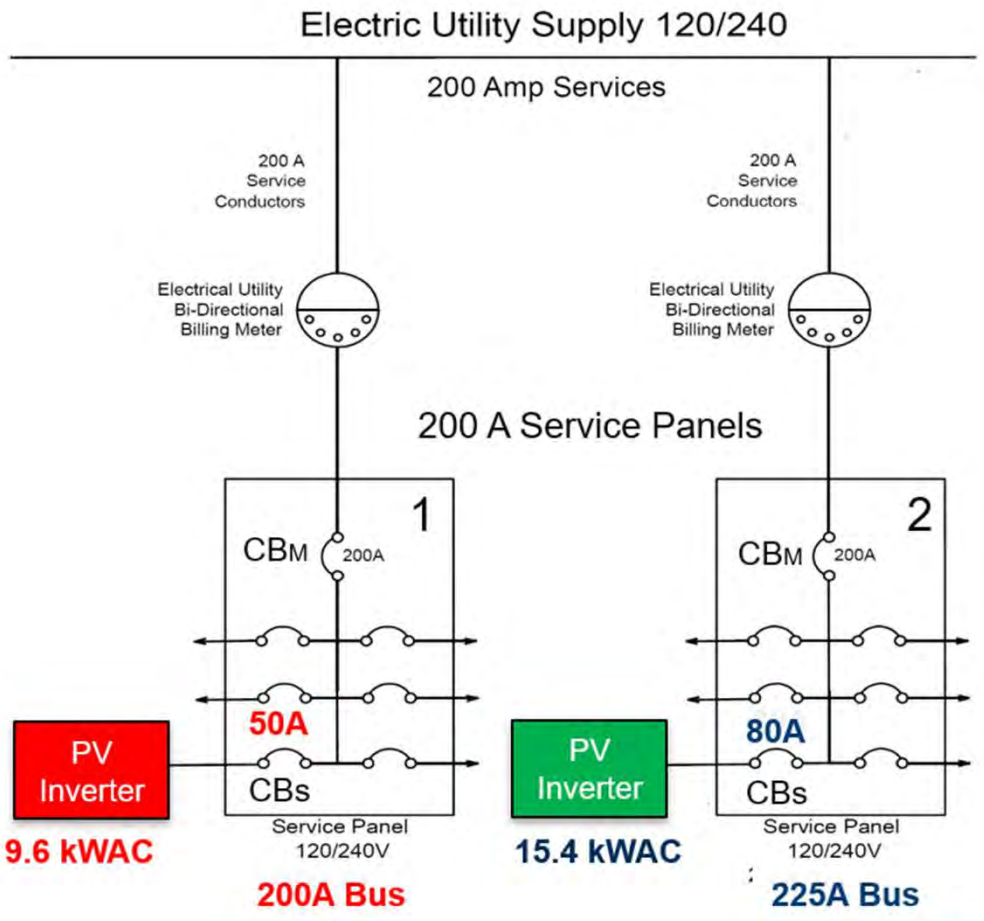

**1. Solar PV and BESS** interact with the grid to reduce grid energy purchase and leverage TOU rates.

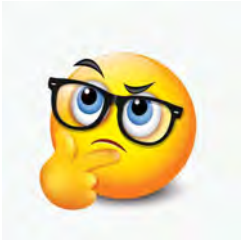
**2. Essential Circuits** in dedicated sub-panel for backup by solar PV and BESS during grid outages.

Riverside ENERGY SYSTEMS

# Solar PV Electrical Design - CEC 64-112 Point of Connection

- PV system generates a service panel via a solar system circuit breaker CBs.
- CEC 64-112 limits PV system inverter size based on bus capacity if multiple sources power the service panel.
- CBs ≤ 1.25 x Bus Capacity – $CB_M$
- Two panels with same rating but differing bus capacity will accommodate different levels of solar PV generation.
- Consider carefully in electrical design to avoid inadvertently limiting PV options.



# Solar PV Electrical Design – Additional Considerations

- Space allocated for
  - lockable solar AC disconnect required by CEC and utility.
  - solar inverters if not on the roof-top
- Routing plan for solar PV cables, conduits, or raceways between PV system equipment and the point-of-connection to the grid.
  - DC circuits must be metal-encased entering the building. Solar module strings up to 600 VDC.
- Provisions for hybrid inverter and storage; now or future.
  - Battery locations and sizing limited by CEC 2021.
  - Hybrid inverter must be near battery storage (within 10 ft).
  - Wire essential loads into a designated sub-panel to simplify future backup.
- **Don’t let solar PV and storage be an after-thought.**

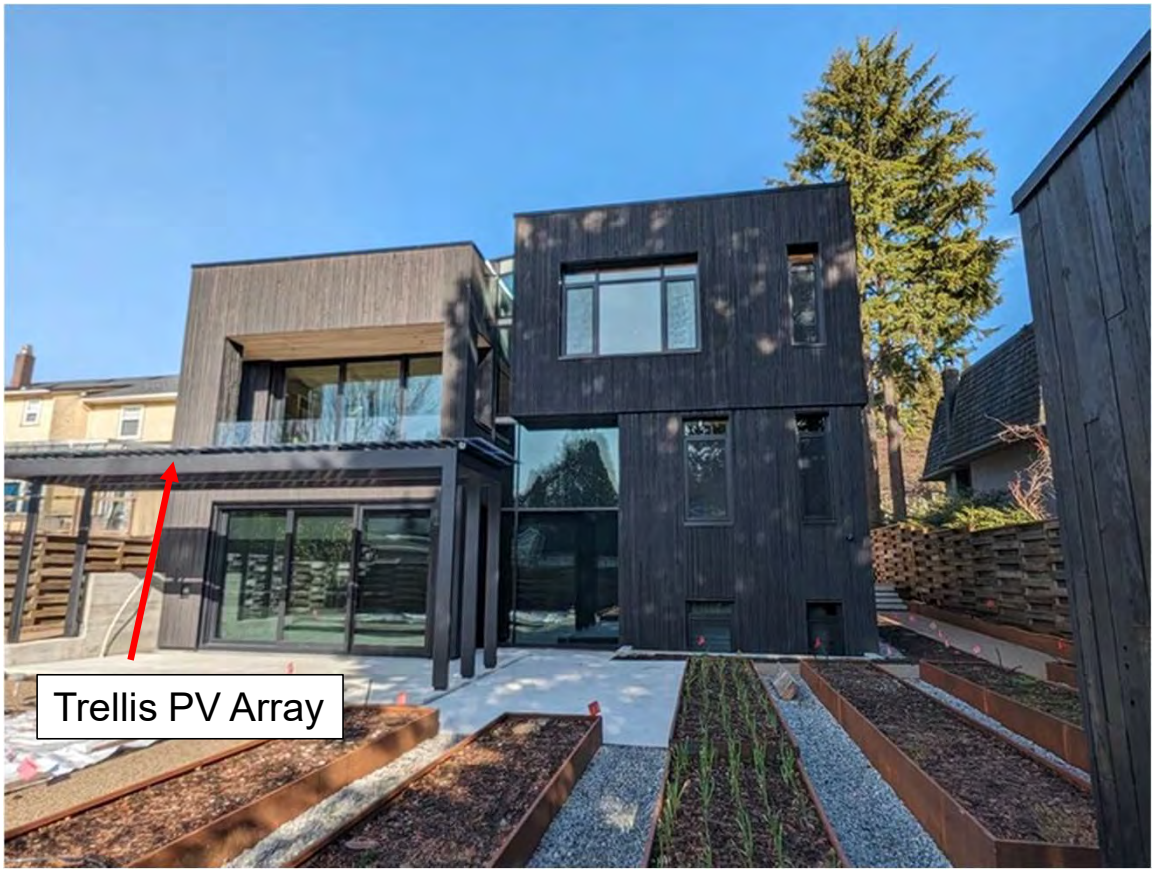
Riverside ENERGY SYSTEMS

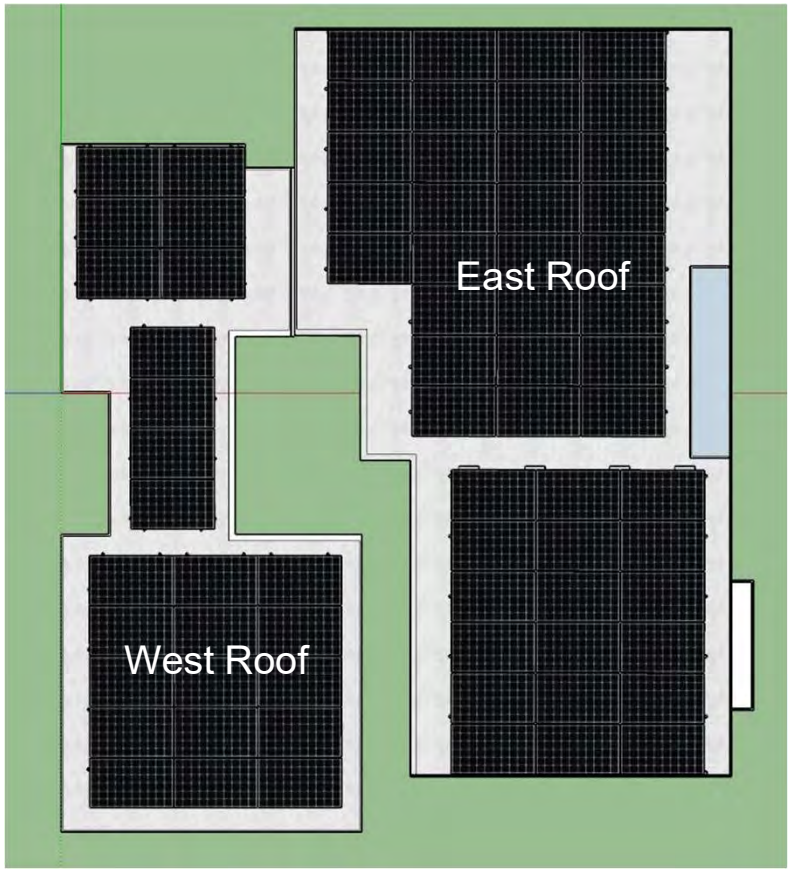
## Case Study – Living Building Challenge - Insightful Healthy Homes, Vancouver BC

LBC goes well beyond Net-Zero energy targets to include grid-resilience and sustainability measures

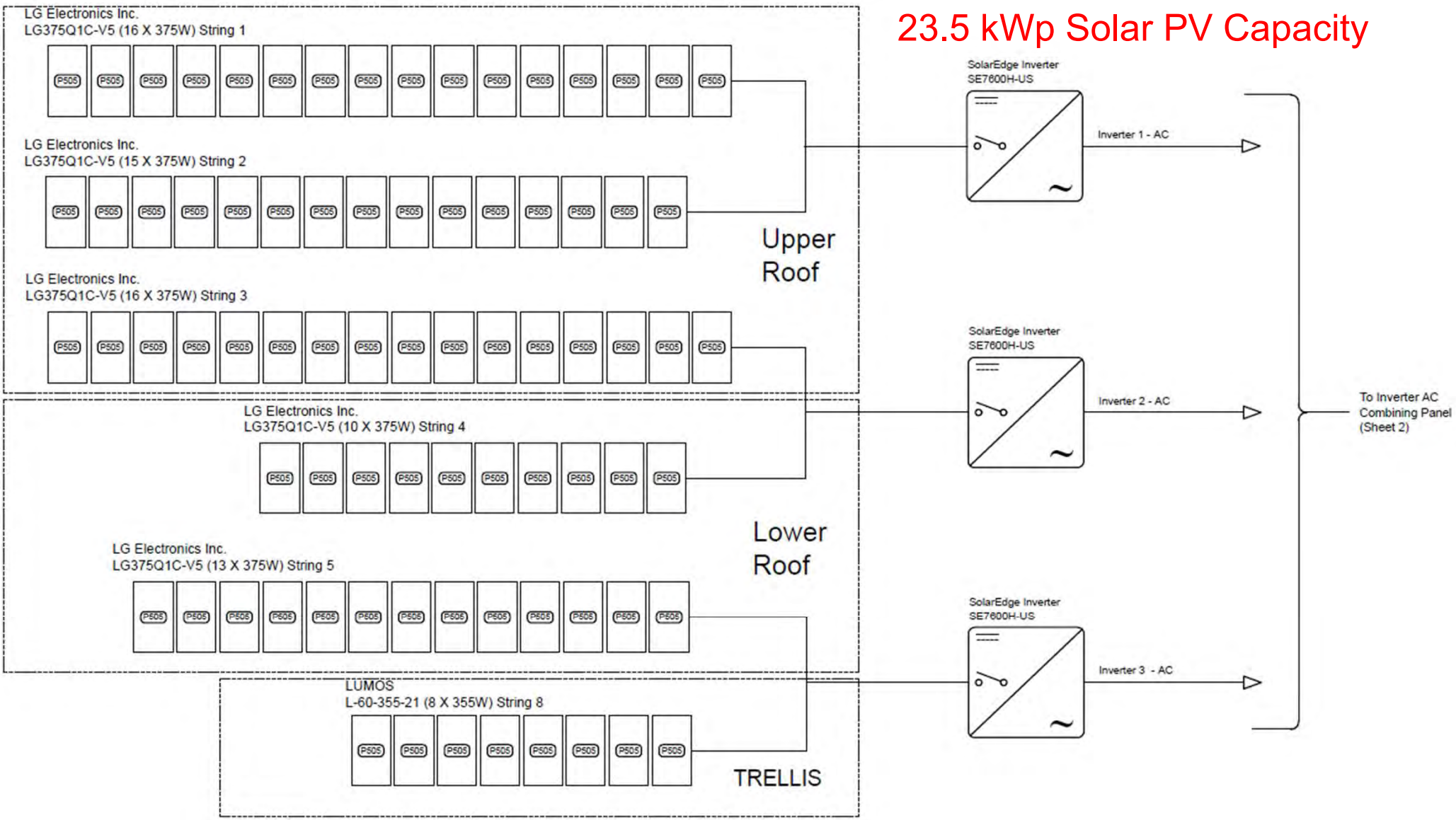
- Fully electrified.
- Grid connected solar PV production ≥105% of annual electrical consumption
- Energy storage sustains essential loads backup for 7- day grid outage
- Rain water collection reduces reliance on domestic water supply
- Restrictions on allowable construction materials

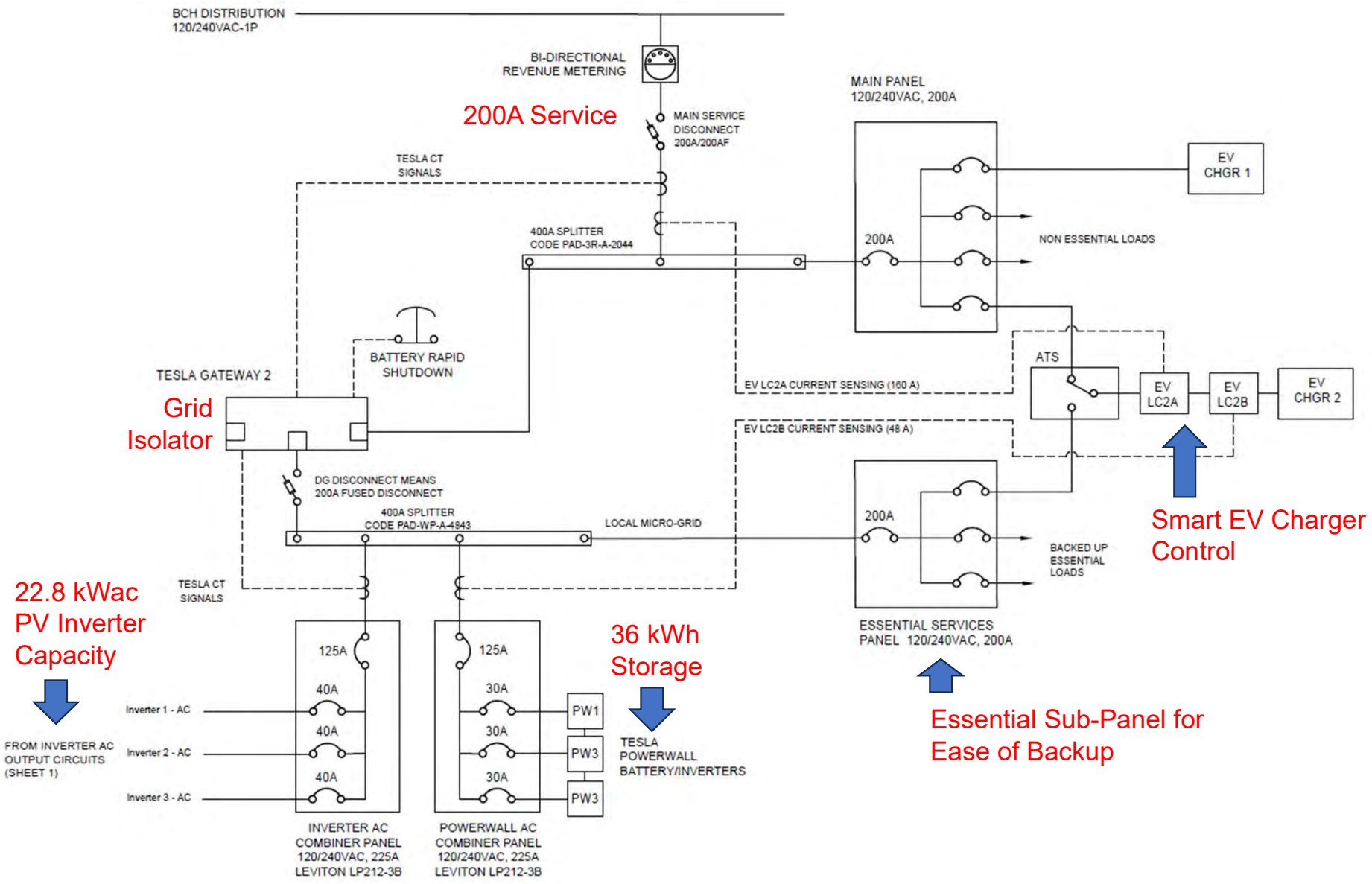
Riverside ENERGY SYSTEMS




Riverside ENERGY SYSTEMS


23.5 kWp Solar PV Capacity
LG Electronics Inc.
LG375Q1C-V5 (16 X 375W) String 1
LG Electronics Inc.
LG375Q1C-V5 (15 X 375W) String 2
Upper Roof
LG Electronics Inc.
LG375Q1C-V5 (16 X 375W) String 3
LG Electronics Inc.
LG375Q1C-V5 (10 X 375W) String 4
Lower Roof
LG Electronics Inc.
LG375Q1C-V5 (13 X 375W) String 5
LUMOS
L-60-355-21 (8 X 355W) String 8
TRELLIS
SolarEdge Inverter
SE7600H-US
Inverter 1 - AC
SolarEdge Inverter
SE7600H-US
Inverter 2 - AC
SolarEdge Inverter
SE7600H-US
Inverter 3 - AC
To Inverter AC
Combining Panel
(Sheet 2)


BCH DISTRIBUTION
120/240VAC-1P
BI-DIRECTIONAL
REVENUE METERING
200A Service
MAIN SERVICE
DISCONNECT
200A/200AF
MAIN PANEL
120/240VAC, 200A
TESLA CT
SIGNALS
EV
CHGR 1
400A SPLITTER
CODE PAD-3R-A-2044
200A
NON ESSENTIAL LOADS
BATTERY RAPID
SHUTDOWN
TESLA GATEWAY 2
Grid
Isolator
ATS
EV LC2A CURRENT SENSING (160 A)
EV
LC2A
EV
LC2B
EV
CHGR 2
EV LC2B CURRENT SENSING (48 A)
DG DISCONNECT MEANS
200A FUSED DISCONNECT
400A SPLITTER
CODE PAD-WP-A-4843
LOCAL MICRO-GRID
200A
Smart EV Charger
Control
BACKED UP
ESSENTIAL
LOADS
TESLA CT
SIGNALS
22.8 kWac
PV Inverter
Capacity
125A
125A
36 kWh
Storage
40A
30A
PW1
Inverter 1 - AC
40A
30A
PW3
TESLA
POWERWALL
BATTERY/INVERTERS
FROM INVERTER AC
OUTPUT CIRCUITS
(SHEET 1)
Inverter 2 - AC
40A
30A
PW3
Inverter 3 - AC
ESSENTIAL SERVICES
PANEL 120/240VAC, 200A
Essential Sub-Panel for
Ease of Backup
INVERTER AC
COMBINER PANEL
120/240VAC, 225A
LEVITON LP212-3B
POWERWALL AC
COMBINER PANEL
120/240VAC, 225A
LEVITON LP212-3B

West Roof

East Roof

Riverside ENERGY SYSTEMS


Riverside ENERGY SYSTEMS

# Call to Action – Achieving Best Electrification Results

1. Be mindful how electrification impacts electrical service sizing.
2. Realize electrical service upgrades are expensive, and may even unavailable in some utility jurisdictions.
3. Classic service sizing calculations can trigger service upsizing that may not always be warranted.
4. CEC section 8 provides methods that mitigate service impacts including:
   - Reducing peak service demand using Smart Load Switches/Splitters, etc
   - "Demonstrated Load" approach to confirm electrical service capacity margin based on historical hourly consumption data.

5. Solar PV and storage (BESS) both impact electrical design significantly, and **MUST BE** considered along with electrical service sizing and load management at design stage. **Don't let solar and storage be an after-thought.**

Riverside ENERGY SYSTEMS

# Questions?

Ben Giudici
778-220-2496
ben@riversideenergy.ca
www.riversideenergy.ca

Riverside ENERGY SYSTEMS