Bluewater Energy
Renewable Energy Solutions

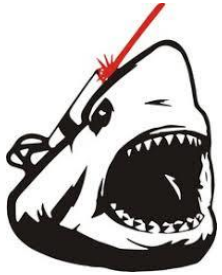
Building Knowledge Advanced Building Science Webinar Series

Wil Beardmore, President

15 December 2022

Outline

- Current and growing barriers to adoption of scaled renewables, storage and increased electrical loads in homes?
- Canadian standards and codes which could be altered to expedite this growth?
- Key considerations for developers, builders, designers, utilities, and municipalities, to build low load communities.



Proud Member of:

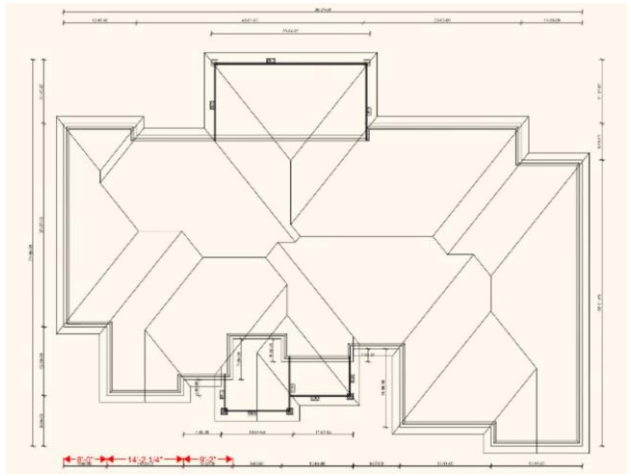
Canadian Home Builders' Association

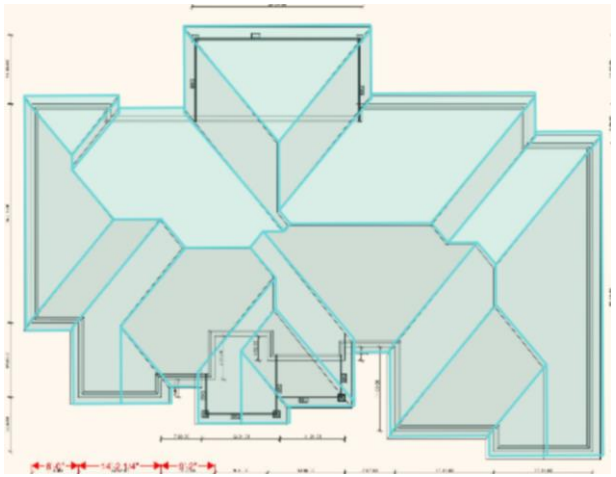
Net Zero Energy Housing Council

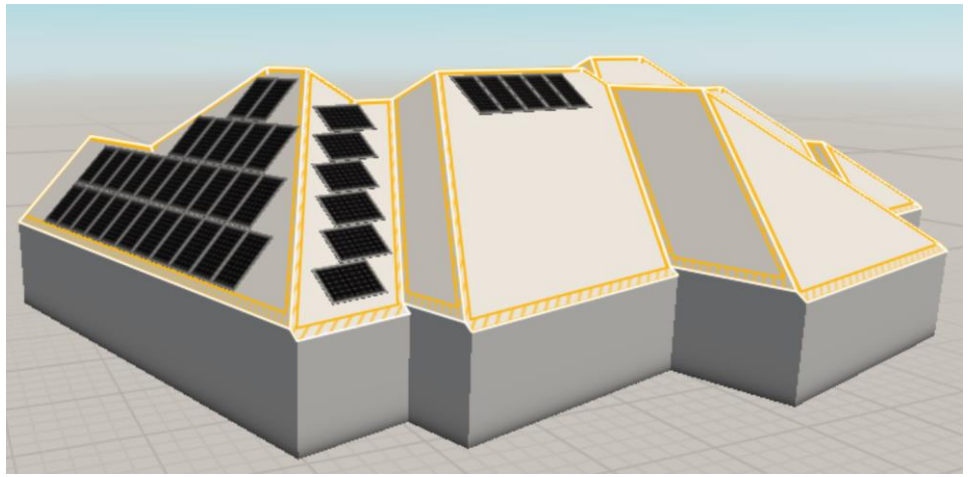
Stages of the Project

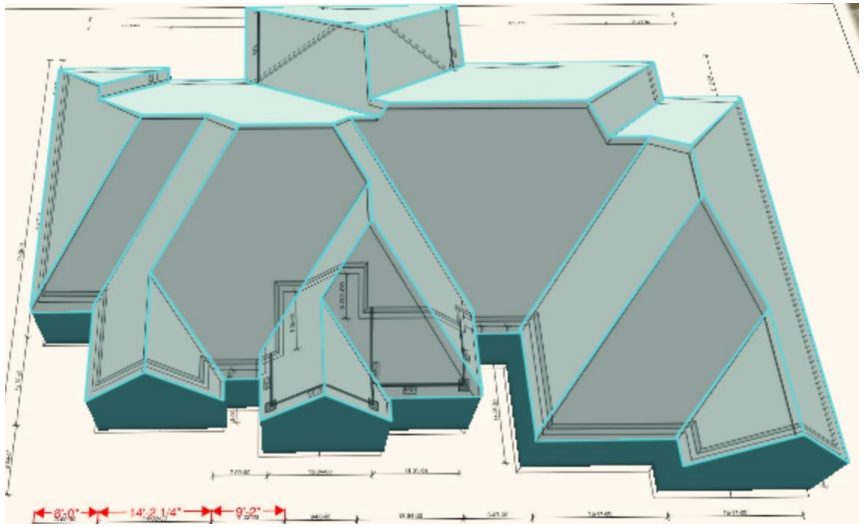
- Review Plans and Energy Modelling
- System Design (iterative) and Generation Modelling
- LDC Application Process
- Engineering Review and Approval
- Building Permit Submission
- Electrical Permit + Plans Review (*>10kW)
- PV/ESS Rough-in
- PV/ESS Installation and Connection
- Electrical Inspection
- Energize and Commissioning
- Set up Monitoring Hardware/Software
- Handover

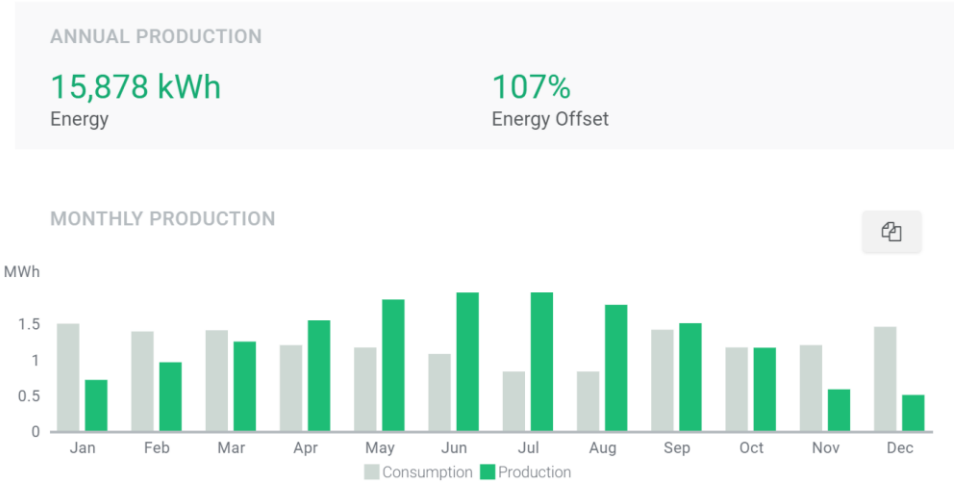
Design Process

1. 

2. 



3. 

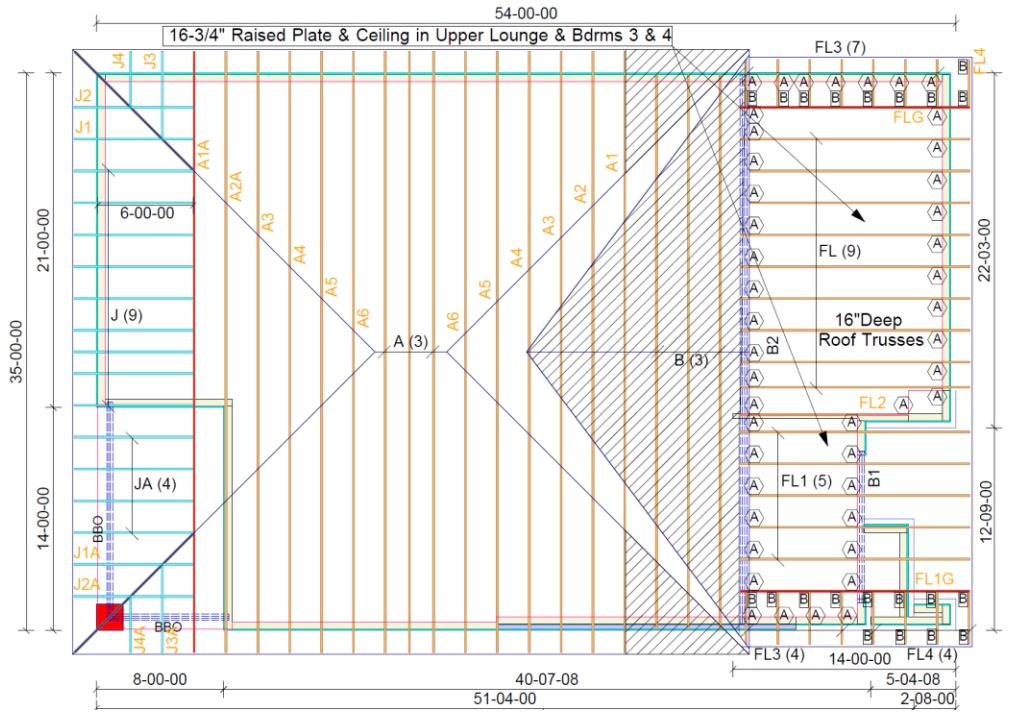


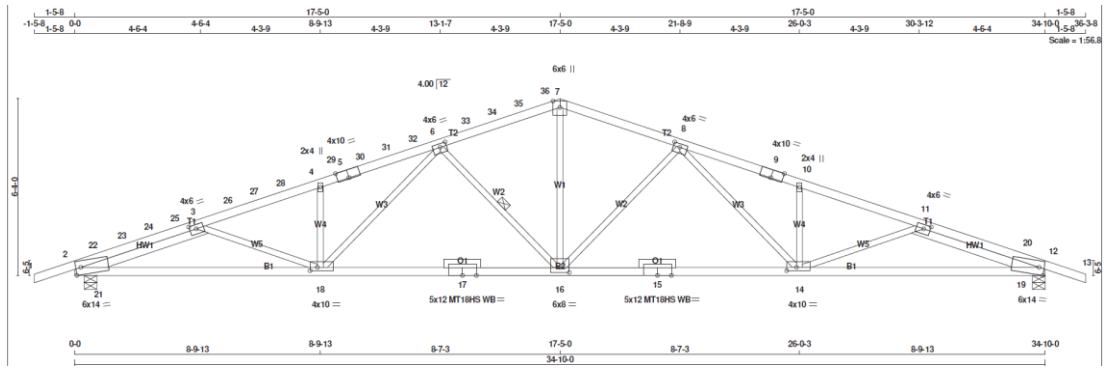
Utility Process

- Application required to secure capacity to connect appropriate amount of generation being constructed
- =<10kW – Form C, quick, easy, no cost application fee, relatively low connection costs, usually 2-5 days
- >10kW – Form B, engineered solution, stamped SLD, $$ application fee, high connection costs, usually 3-4 months
- Utility views PV/ESS as Parallel Generation source interacting with grid

Engineering Review

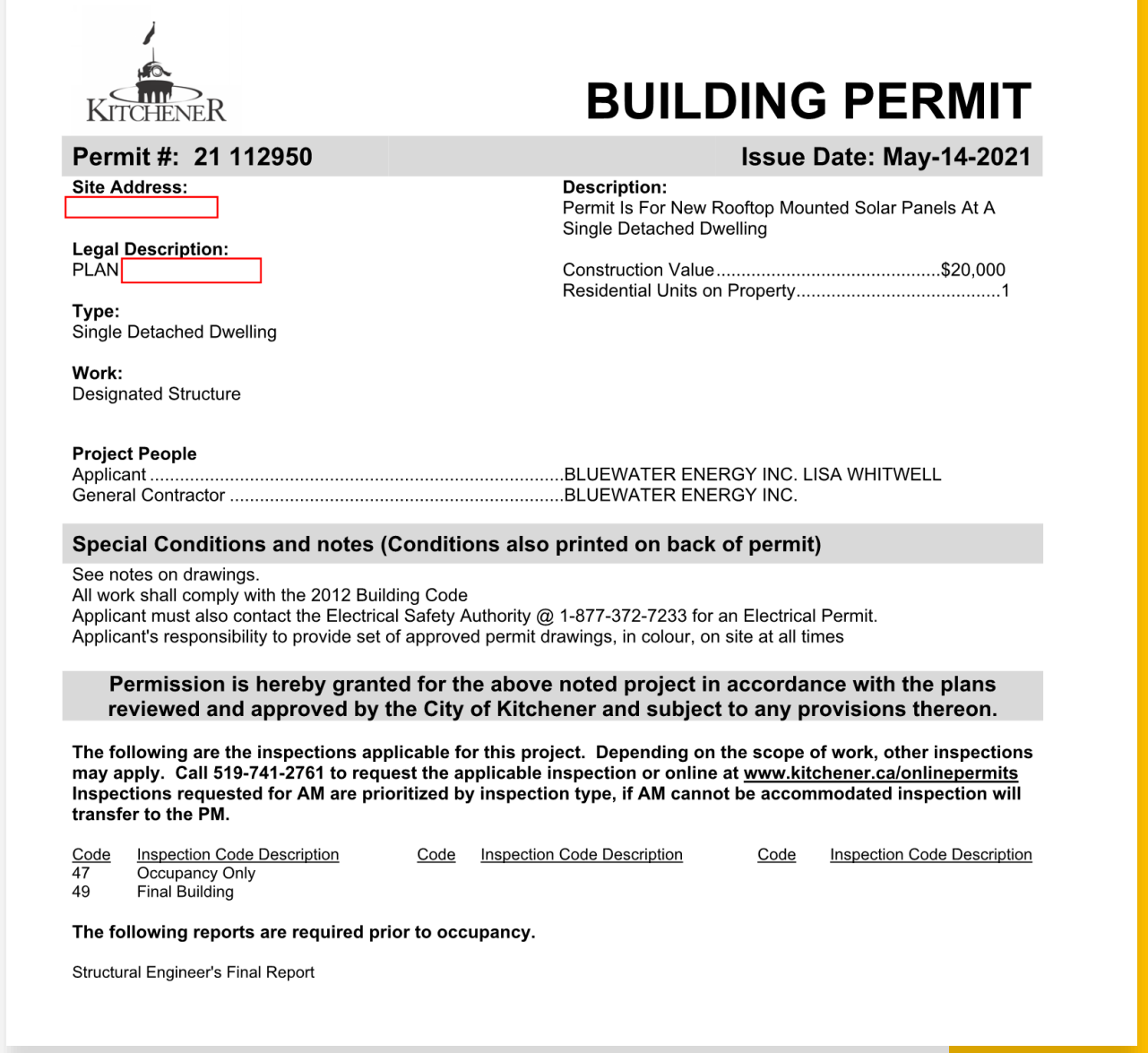
- Review of Roof Truss/Roof Design Dead Load Capacity
- Review of Loads imposed by PV system
- Stamped Letter Confirming Structure will support added weight of PV system
- Signed Commitment to Review
- *Note: PV system typically adds up to 3.5psf on a pitched roof, and up to 9psf on a flat roof





Building Permit

- Requirement varies by municipality, however, most (almost all) require a permit for the addition of a solar PV array greater than 5m^2
- Requires review and certification by structural P.Eng that structure can support added dead load
- Requires mounting details with specific details for attachment method
- Requires P.Eng stamped design layout showing locations of PV modules
- May require site plan and elevation drawings to show location of PV modules in relation to property lines and permitted height of structure



KITCHENER

BUILDING PERMIT

Permit #: 21 112950 **Issue Date: May-14-2021**

Site Address:

Description:
Permit Is For New Rooftop Mounted Solar Panels At A Single Detached Dwelling

Legal Description:
PLAN

Construction Value.....$20,000
Residential Units on Property.....1

Type:
Single Detached Dwelling

Work:
Designated Structure

Project People
Applicant .....BLUEWATER ENERGY INC. LISA WHITWELL
General Contractor .....BLUEWATER ENERGY INC.

Special Conditions and notes (Conditions also printed on back of permit)

See notes on drawings.
All work shall comply with the 2012 Building Code
Applicant must also contact the Electrical Safety Authority @ 1-877-372-7233 for an Electrical Permit.
Applicant's responsibility to provide set of approved permit drawings, in colour, on site at all times

Permission is hereby granted for the above noted project in accordance with the plans reviewed and approved by the City of Kitchener and subject to any provisions thereon.

The following are the inspections applicable for this project. Depending on the scope of work, other inspections may apply. Call 519-741-2761 to request the applicable inspection or online at www.kitchener.ca/onlinepermits Inspections requested for AM are prioritized by inspection type, if AM cannot be accommodated inspection will transfer to the PM.

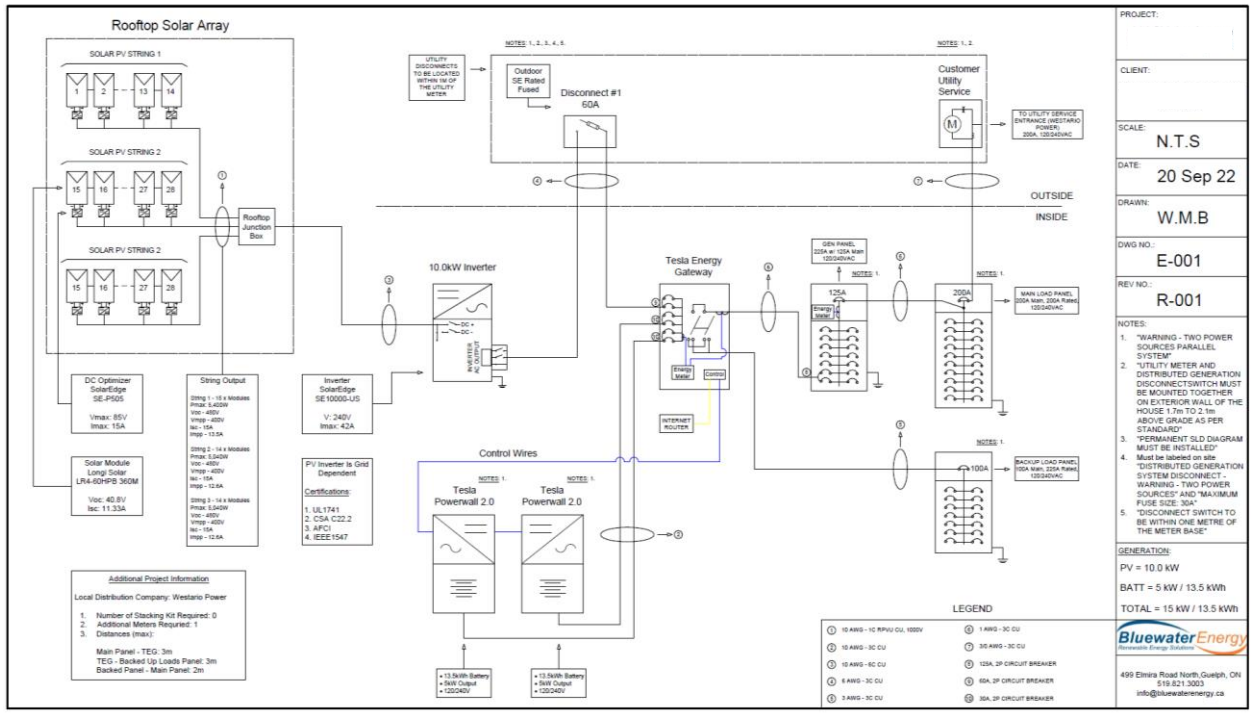
Code	Inspection Code Description	Code	Inspection Code Description	Code	Inspection Code Description
47	Occupancy Only				
49	Final Building				

The following reports are required prior to occupancy.

Structural Engineer's Final Report

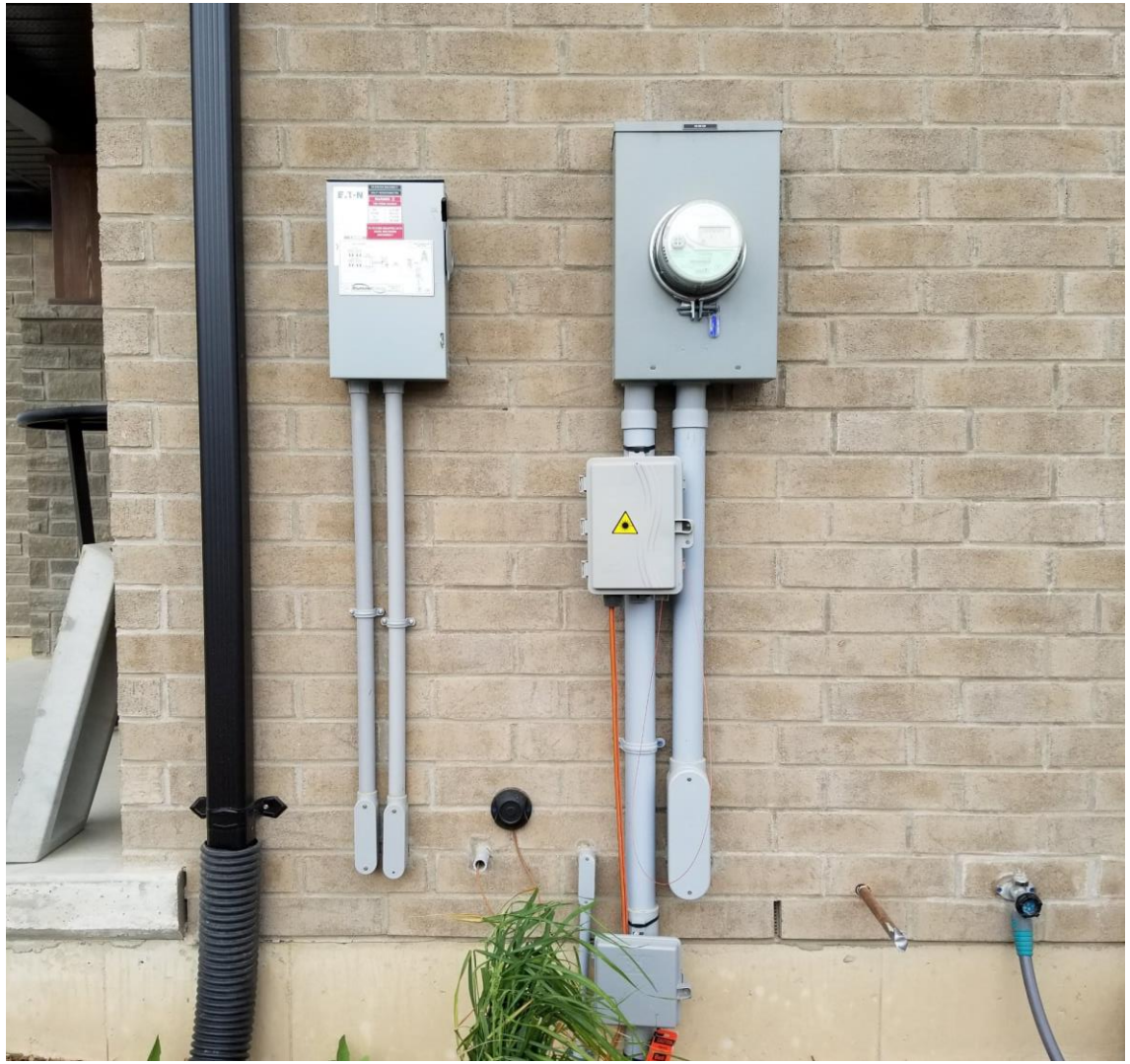
Electrical Authority Having Jurisdiction

- All PV/ESS work requires electrical permit prior to starting work.
- Projects >10kW total AC output capacity require Plans Review.
- Electrical Engineering not required for projects =<10kW AC as electrical work required for PV/ESS installations is prescribed by code.
- Electrical Engineering required for projects with an AC output capacity >10kW



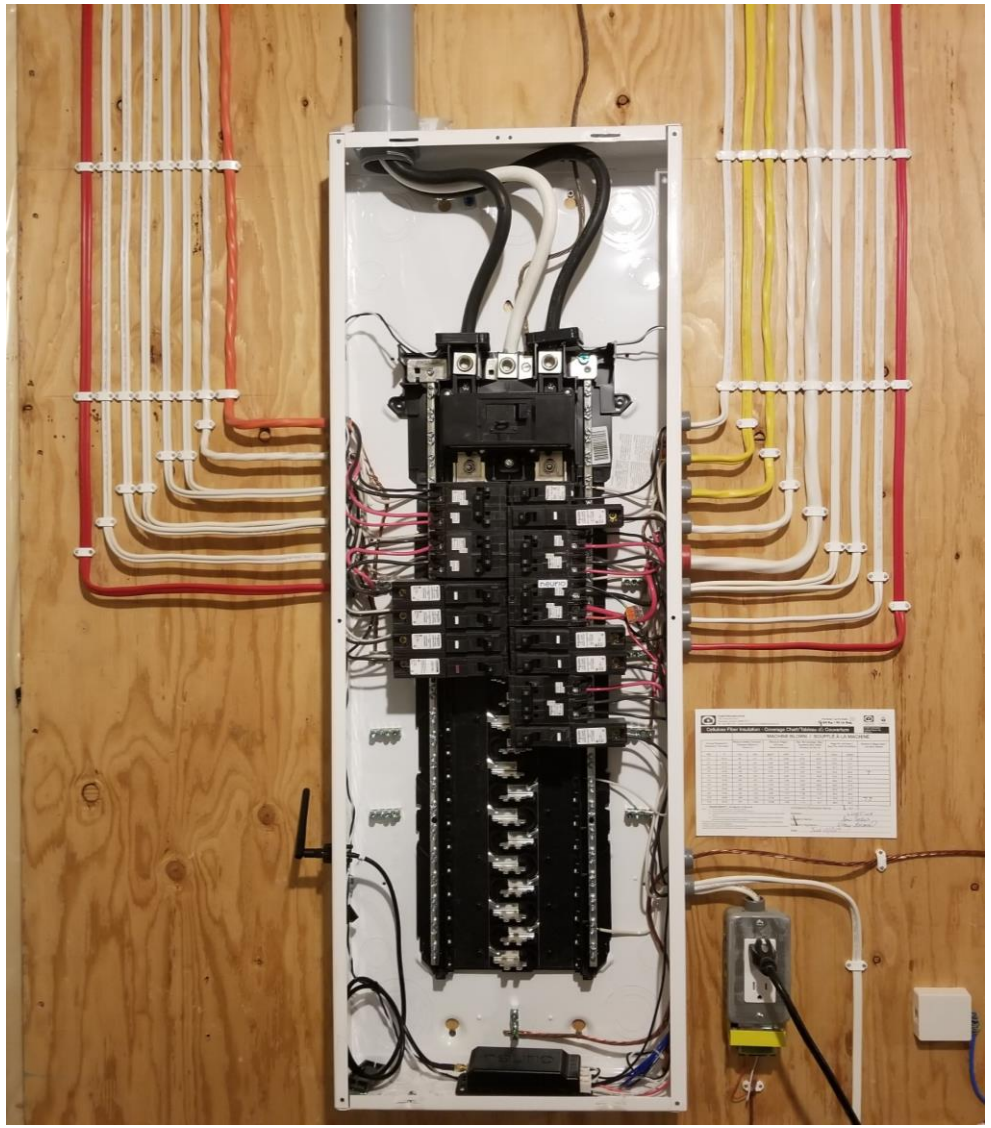
Considerations

- Location of Utility Meter
- Location of Main Electrical Panel
- Location of PV Inverter
- Location of ESS/Batteries
- Location of Transfer/Isolation Switch
- Route from Rooftop (Ground Mount) to PV Inverter
- Route from Inverter/ESS to Point of Connection via Outdoor Utility Disconnect Switch
- Point of Interconnection & How
- **Note: plan this prior to construction so that appropriate underground conduits can be put in place if required



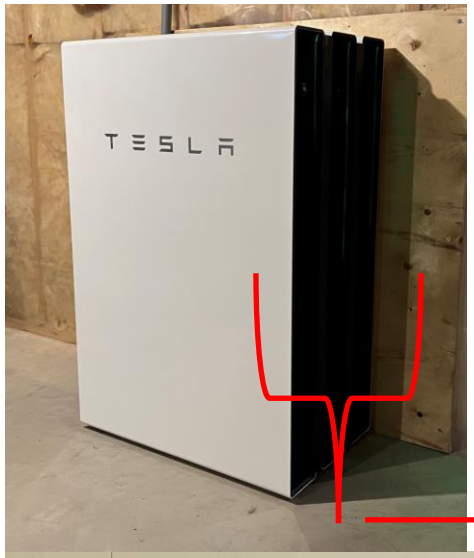
Electrical Code - PV

- ***Limited to 125% of Panel Bus Bar Rating***
- Main Panel Rating = 200A
- Main Breaker Rating = 200A
- 125% x 200A (Panel Rating) = 250A
- 250A – 200A (Main Breaker Rating) = 50A Max
- 10kW Solar PV Max Output = 42A… However:
  - Breakers can only be loaded to 80% of rating
  - 80% of 50A = 40A < 42A
  - Must use 60A Breaker
  - 60A > 50A Max Generation Calc
- Solutions – Use panel with 225A Bus/200A main, or clear with ESA beforehand based on actual load vs. breaker rating. Otherwise, Line Side Tap required



Electrical Code - ESS

- Limited to maximum 40kWh total storage capacity in attached garage of residential dwelling
- Limited to maximum 80kWh total storage capacity in detached garage
- Maximum storage per single storage unit is 20kWh
- Minimum spacing between units is 1m
- 1 x Tesla Powerwall = 13.5kWh
- 3 x Tesla Powerwall = 40.5kWh
- 1 x Tesla Model S P100D has **100kWh** battery bank, can be parked in garage no permit, no restriction.
- Output capacity of Powerwall = 5kW
- Maximum available backup power from 3 x Powerwall = 15kW



Tesla Certified Stacking Kit
Now requires Deviation Request

Now minimum 1m Separation required

Project Summary

- Project Review
- Iterative Design and Generation Modelling
- Final Design
- LDC Application Process and Connection Fee
- Structural Engineering Review and Approval
- Building Permit Submission
- Electrical Permit and Plans Review if Required
- PV/ESS Rough-in
- PV/ESS Installation and Connection
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- Set up Monitoring Hardware/Software
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=<10kW

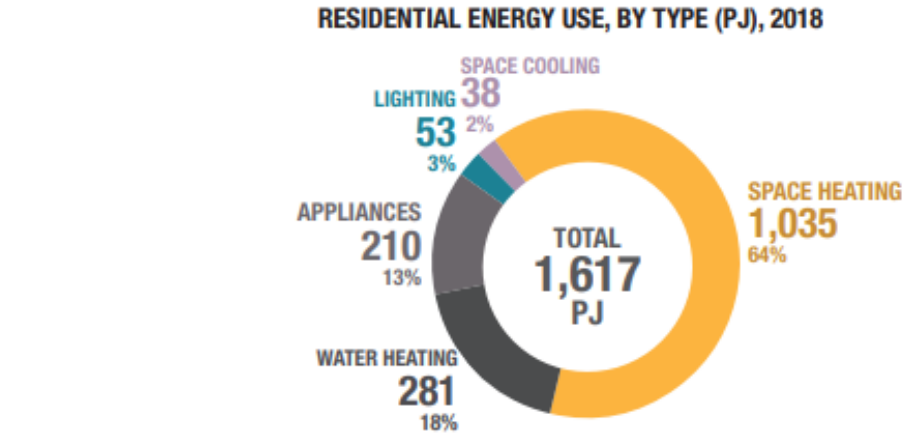
$2,000 - $5,000 Before any equipment is procured or anyone shows up on site to install

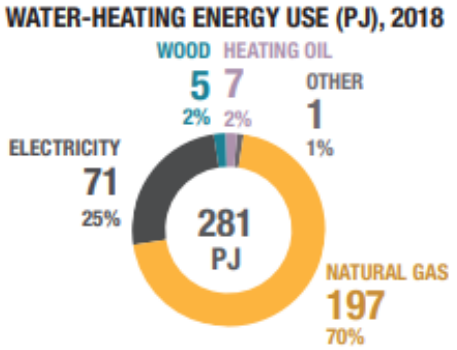
>10kW

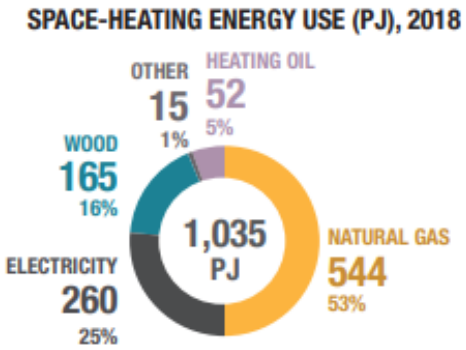
$15k - $250k+ Before any equipment is procured or anyone shows up on site to install

Increasing Electrical Demand

- Space Heating - ASHP
- Geo-Thermal
- Hot Water - Tankless or HWASHP
- HRV/ERV
- A/C
- In-Floor Heating
- EV Charger
- Operational Loads
  - Appliances
  - Lighting
  - Communications
  - Charging phones, laptops, other electronics
- Lifestyle Loads
  - Work/Business – Home Offices
  - Entertainment – AV equipment, gaming, etc.
  - Pool/Hot Tub
  - Fitness
  - Other – crypto mining?







Source: Natural Resources Canada – Energy Fact Book 2021-2022

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What Can Renewables Do?

- Solar PV:
  - On site generation to off-set or eliminate annual electricity cost
  - Provide clean, stable power to the grid
  - Reduce the need for other carbon-based forms of generation
  - Charge Energy Storage Systems (ESS)
  - Charge Electric Vehicles
  - Limited to daytime hours, subject to available sunlight

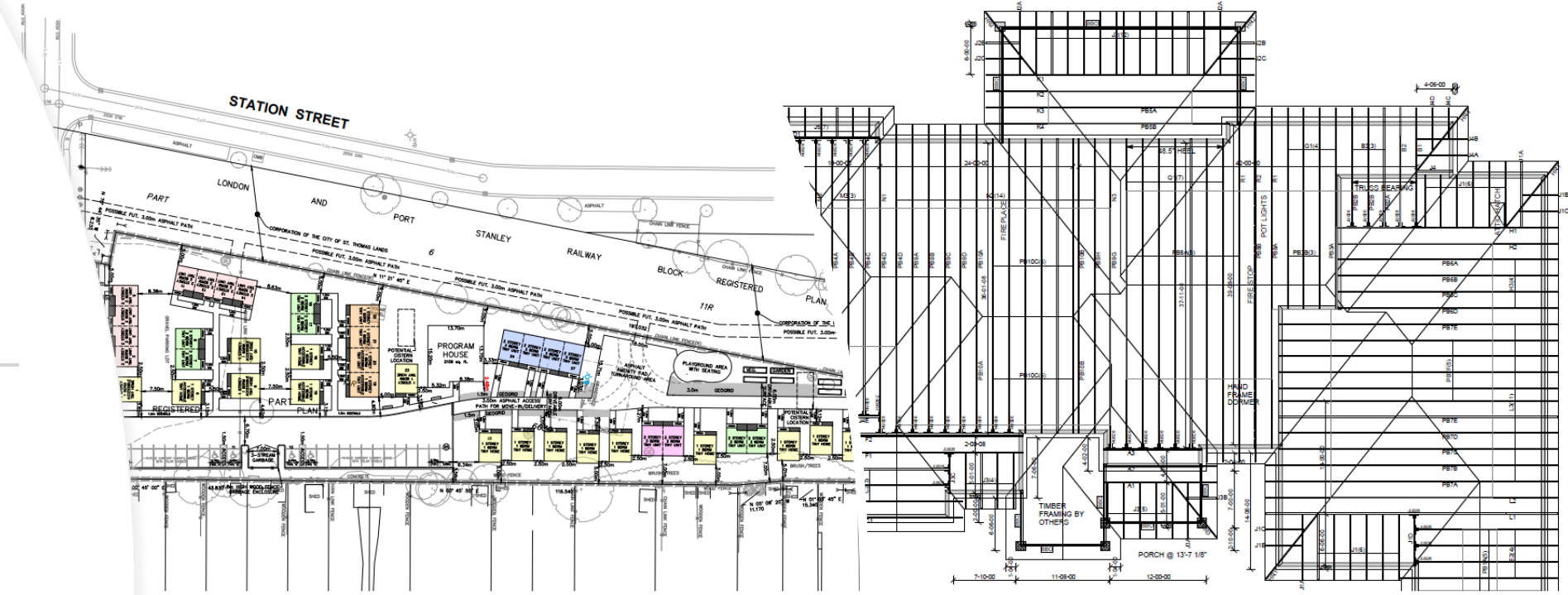
- ESS:
  - Store excess PV generated energy during day
  - Supply energy during peak periods to reduce utility costs
  - Supply energy during peak periods to reduce peak grid demand
  - Reducing peak grid demand reduces need for carbon-based Peaker Plants
  - Provide back up power during grid outages
  - Enables personal level control and automation of energy in home

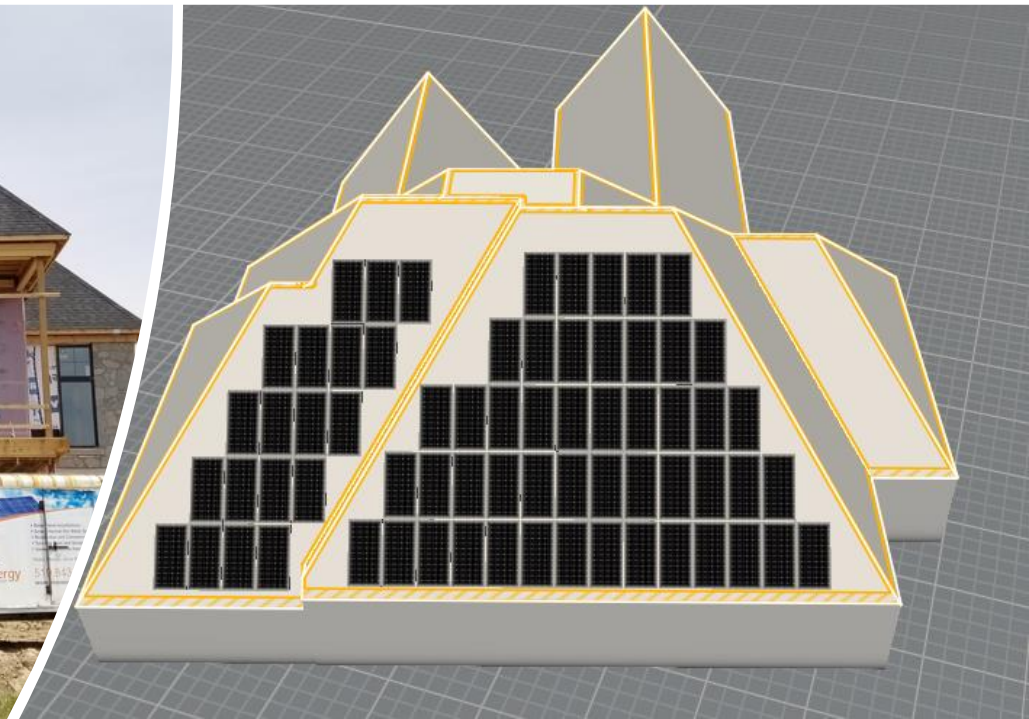
Load Control

- The next step…
- Individual circuit level control and monitoring
- Remote access
- Automated or manual power management
- Scene settings – Home, Away, Off-Grid, etc.
- No need for sub-panel
- Back up entire home and select individual loads to remain powered
- Set maximum power threshold
- Actively pursuing ability to employ as means to avoid service size increases with Electrical AHJ in Ontario, i.e. 200A to 400A

Builder Process

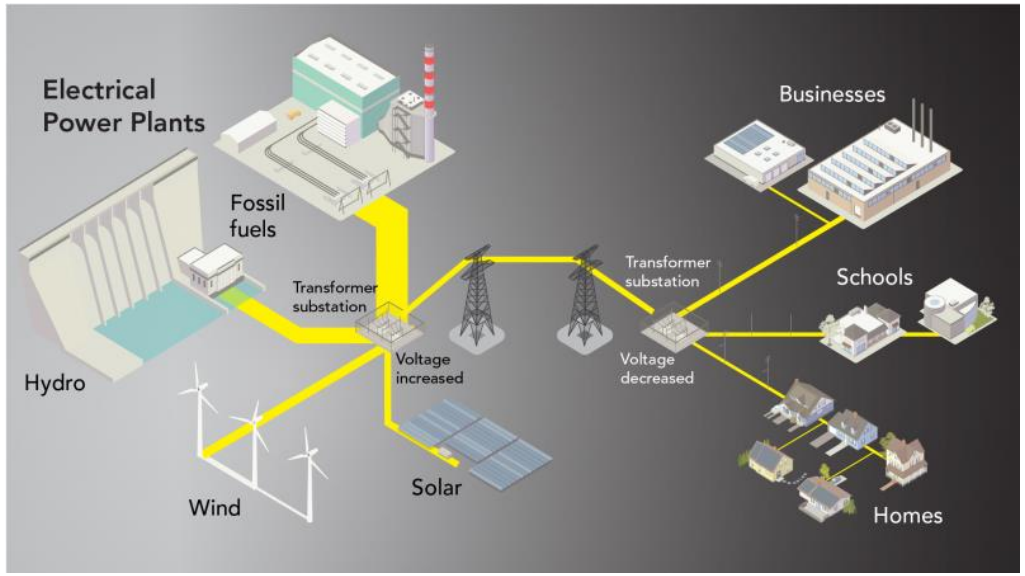
- Engage early
- Site Plan Review
- Architectural Drawings Reviewed
- Each Elevation Reviewed
- Each Orientation, Each Model, Each Elevation Assessed for PV capacity and generation modelling





Challenges at Community Scale – Utility Connection

- Distribution System Limitations
- Short Circuit Capacity - *The maximum acceptable generation limit for connection to the feeder has already been reached. The total current shall not exceed either 200A (for those feeders operating below 13.8 kV) or 400A (for those feeders operating at or above 13.8 kV)*
- Thermal Capacity - *Generation at the upstream distribution or transformer station shall not exceed 60% of the maximum MVA rating of the Hydro One single transformer and minimum station load*
- Total Generation Capacity Already Connected - *total generation must not exceed 7% of the annual line section peak load on F-class feeders or 10% for M Class feeders.*
    - *It is possible that a micro-embedded generator may fail this test, while a larger project may pass upon CIA.*



Generator Classification	Rating
Micro	≤ 10 kW ****System AC Capacity****
Small	(a) ≤ 500 kW connected on distribution system voltage < 15 kV (b) ≤ 1 MW connected on distribution system voltage ≥ 15 kV
Mid-Sized	(a) ≤10 MW but > 500 kW connected on distribution system voltage < 15 kV (b) > 1 MW but ≤ 10 MW connected on distribution system voltage ≥ 15 kV
Large	> 10 MW

Codes and Standards

- Evolving
- Electrical Safety
- Fire Safety
- PV Equipment matured and satisfies arc fault, rapid shut-down, anti-islanding, etc.
- Energy Storage is becoming difficult. This is a critical piece that needs attention
    - Maximum storage capacity allowable limits what is possible
    - Spacing requirements are prohibitive
- Net-metering Regulation needs review
- Code writers need to get into the field and witness the impact of what is being prescribed or bring the actual people who are designing and building projects into the discussion

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Builder Piece of Mind

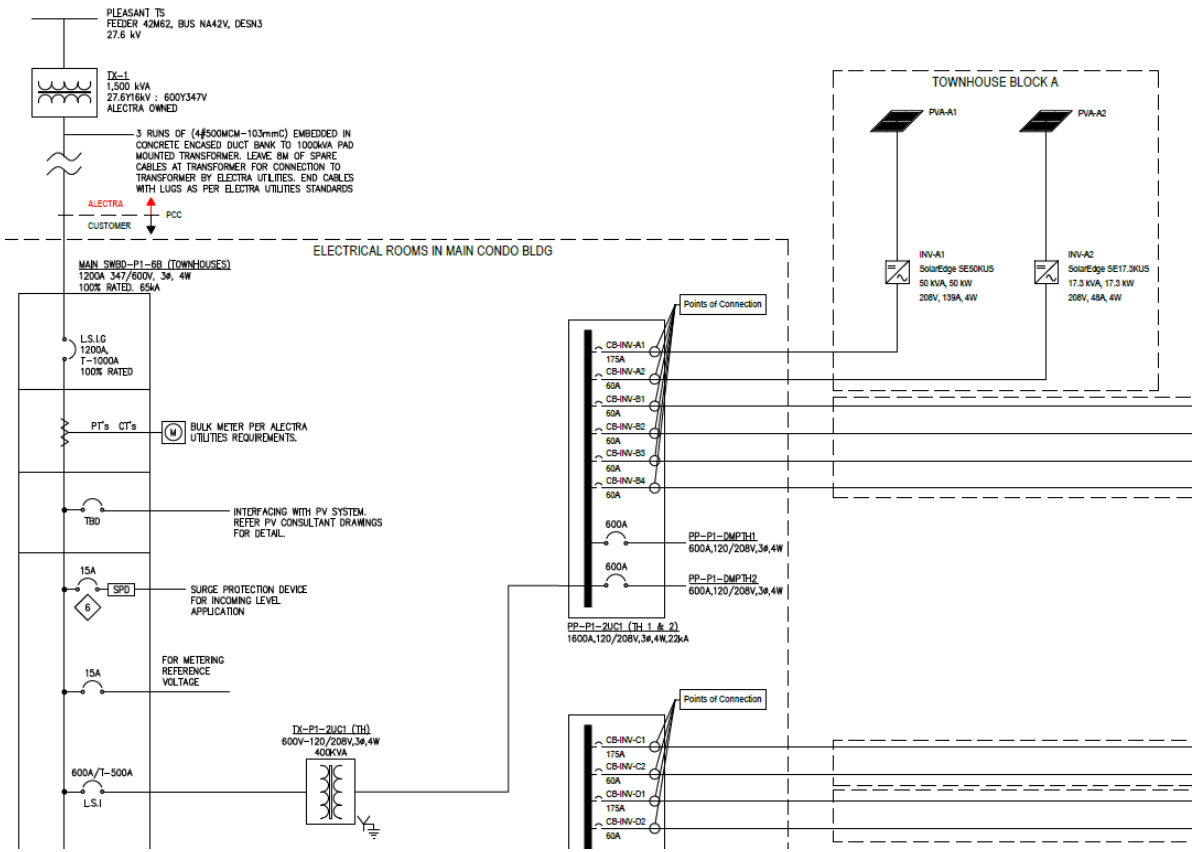
- Roof Protection
- Weather Proofing
- Equipment Warranties
- Tarion
- Homeowner Benefit
- Real Payback

Key Considerations

- Plan Early
- Iterative Design
- Engage Everyone
  - Designers
  - Architects
  - Engineers
  - Purchasing
  - Finance
  - Construction Managers
- Power Generation Analysis
- Utility Connection Impact Assessment
- ESA Plans Review
- Ownership Structure
- Metering and Credit Allocation
- Who Benefits and How

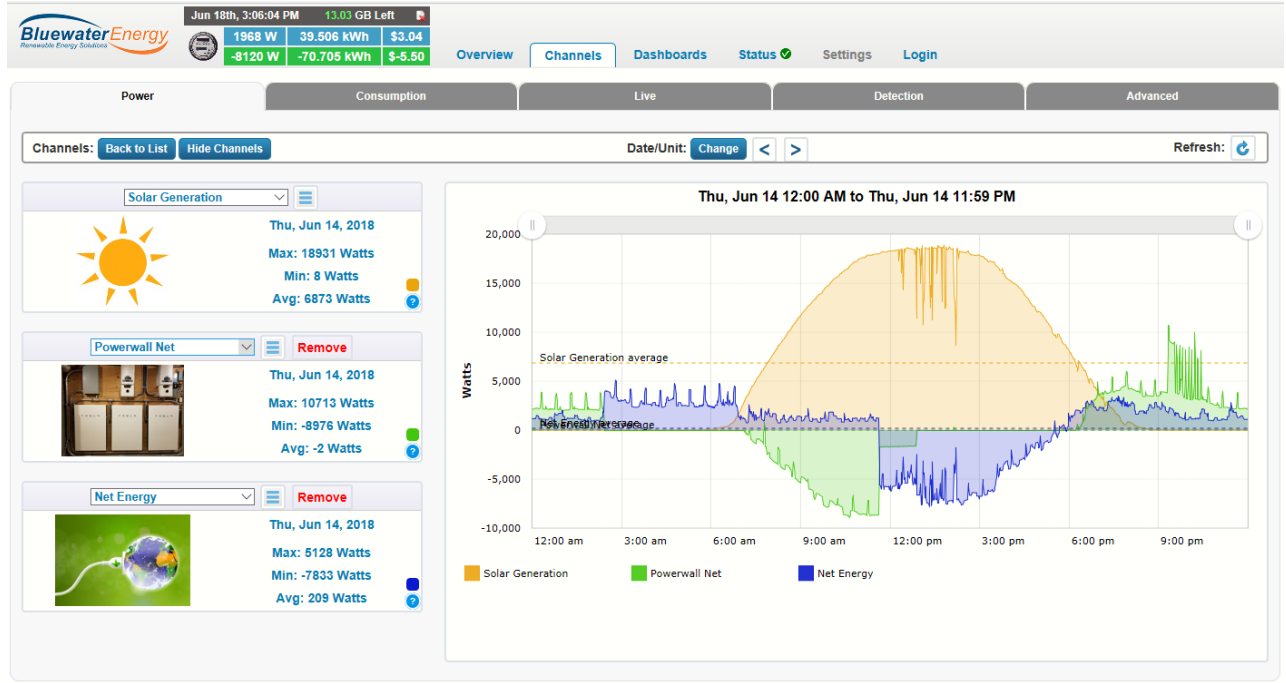
Electrical Design

- Critical to success of project
- Make/model and technical specifications of:
  - PV Modules
  - Inverters
  - Energy Storage Components
- String Level Power
- System Aggregate Power
- Point(s) of Connection
- Conductor Sizing
- Over Current Protection
- Grid Protection
- Disconnect Sizing and Locations



Energy Monitoring

- Critical to verify performance of PV and ESS components
- Understand performance of home vs. design
- Understand nature and impact of occupant loads
- Evaluate performance of smart energy technologies
- Improve homeowner perceptions
- Real-time information
- Accounting and Financial clarity



Questions