

Reframed Tech Series

Solar panels & deep retrofits



#Reframed

June 24, 2020

PEMBINA
institute

Leading Canada's transition to clean energy

The Pembina Institute is a non-profit think-tank that advances a prosperous clean energy future for Canada through credible policy solutions.



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Canada

Canada



FEDERATION
OF CANADIAN
MUNICIPALITIES

FÉDÉRATION
CANADIENNE DES
MUNICIPALITÉS

Supporting partners





Reframed Tech Series

Moderator

Betsy Agar

Senior analyst, Pembina Institute

Agenda

1. Introductions
2. Presentations
3. Q&A
4. Upcoming opportunity

Note to attendees

This webinar is being recorded.
The video will be published
online and shared with all
registrants.

Introducing the Reframed Initiative

The Reframed Initiative is working with designers, builders, owners, financiers, and policy-makers to scale up deep retrofits.

Together, we can address the housing crunch and climate emergency.

LEARN MORE: pembina.org/reframed

Deep retrofits are:

- **Healthy:** cleaner air, improved comfort
- **Resilient:** ready for extreme weather and earthquakes
- **Low-carbon:** use renewable energy and carbon smart materials

Let's scale up solutions that:

- Keep rent affordable
- Minimize disruption to tenants
- Return value to owners and investors

New primer

DOWNLOAD:

pembina.org/pub/solar-powered-retrofits

PEMBINA
institute

Solar panels and deep retrofits

To achieve our climate and housing goals, we need to streamline how we retrofit existing homes and buildings and identify additional sources of capital to pay for these upgrades. Solar photovoltaic (PV) panels generate clean electricity and could free up future cash flows, thereby helping finance more comprehensive retrofits. This primer examines key factors affecting this business case, with a focus on the B.C. context.

The photovoltaic picture in B.C.

The B.C. government's CleanBC climate plan prioritizes shifting buildings, transportation, and industry from fossil fuels to clean electricity and other renewable energy sources. Electrifying the transportation sector alone will require 60% more generation capacity than is available today.¹ On-site generation (e.g. rooftop solar panels) can provide additional electricity without requiring more land and added transmission and distribution costs. Combined with energy storage, it can improve resilience to power failures.

As of 2018, 1,770 solar PV systems were installed in B.C. for a combined capacity of 14 megawatts (MW) — less than 1% of Canada's 3,095 MW of total installed capacity. B.C.'s only utility-scale installation is the 1.1-MW SunMine in Kimberley, though two more are in development.

The business case for commercial and residential solar PV is rapidly improving, and the cost becomes more attractive as the scale of the system increases (see Table 1). Since 2010, the cost of installing solar has decreased by more than 60%,² while BC Hydro rates have increased by more than 70%.³



Solar PV can be installed as part of building retrofits.

Business case for integrating solar in deep retrofits

BC Hydro's residential and commercial customers are permitted to connect a solar PV system to the electricity grid through the net metering program. Each system must be sized to meet no more than the previous 12 months' worth of demand, and 100 kilowatts (kW) is the maximum allowable capacity. Solar PV systems have lifespans of about 30 years. In B.C., well-designed systems can pay for themselves in 8–12 years, potentially freeing up 20 years' worth of utility savings that could be reinvested in the building.

The potential for solar PV to contribute to a net positive business case depends on:

- The site-specific solar potential, based on the building location, shading, orientation, structural load capacity, roof characteristics, and distance to the electrical room.
- Whether enough generation capacity can be installed to justify the system's costs without breaching BC Hydro's net metering cap.
- Whether on-site generation will displace electricity covered by the Step 1 or Step 2 rate. (Typically, energy studies are based on a blended utility rate, which can underestimate the savings.)
- Securing the panels so as to not compromise the integrity of the roof assembly, which could invalidate the warranty (e.g. using ballast rather than fixed anchor systems).
- Prompt grid connection and system commissioning to avoid opportunity costs of lost generation.
- Ongoing system maintenance and monitoring to ensure optimal operation.

Panellist

Ed Knaggs

Vice president, HES PV



Panellist

Ben Mills

Founding principal, Impact
Engineering





Reframed Tech Series

Panellist

Ken Creighton

Solar business development
manager, Penfolds Roofing & Solar

Pembina Webinar Series

Solar Deep Retrofits

Multi Unit Residential Buildings

Ed Knaggs P.Eng
eknaggs@hespv.com





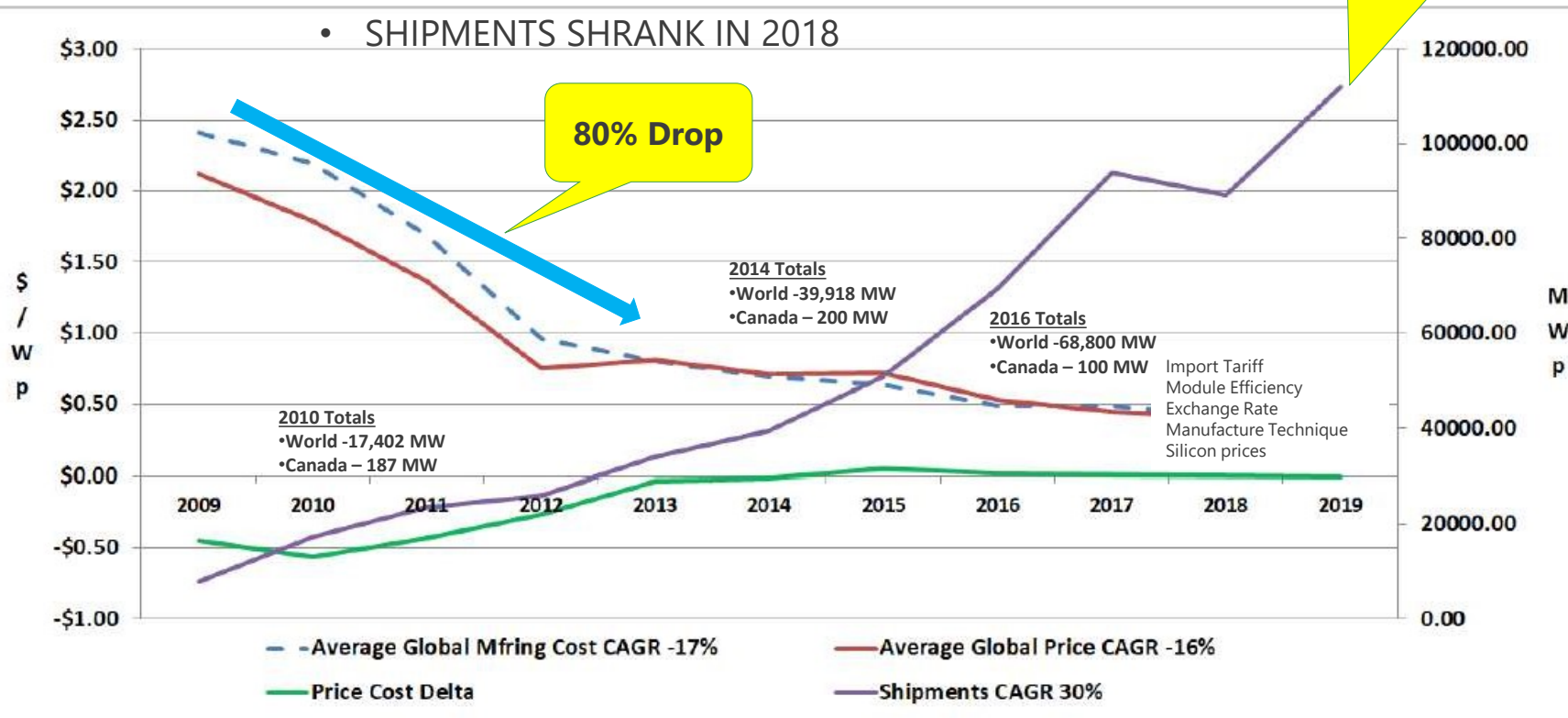
- ✓ Canada's largest PV Equipment Distributor
- ✓ Barrie, Montreal, Edmonton and Victoria Offices
- ✓ Edmonton, Calgary, Victoria, Vancouver, Toronto, Barrie warehouses

2019 Global PV Market



**2019 Total
107.8 GW**

• SHIPMENTS SHRANK IN 2018



Source: SPV MARKETING & IEA PVPS

QUANTITY PRICING
AND NO
INFRASTRUCTURE

ELECTRICAL
PERMIT
COMMERCIAL-
\$221
RESIDENTIAL-
\$172

BC HYDRO NET
METER FEE IS
TYPICALLY \$0

ABOUT MURB Installed Costs



- ▶ Hardware costs
- ▶ Module, Inverters, Racking
- ▶ Soft costs
- ▶ Installation Labour
- ▶ Permitting & Interconnection

Customer Acquisition

\$2.55/w - \$1.88/w

Modules watt (72 cell)	# of modules	Total Watts DC	Installed Cost (Retail)	\$/watt (Retail)
400	68	27200	\$69,380.24	\$2.55
400	112	44800	\$98,906.80	\$2.21
400	224	89600	\$174,527.74	\$1.95
400	338	135200	\$255,102.49	\$1.89
400	375	150000	\$281,612.02	\$1.88

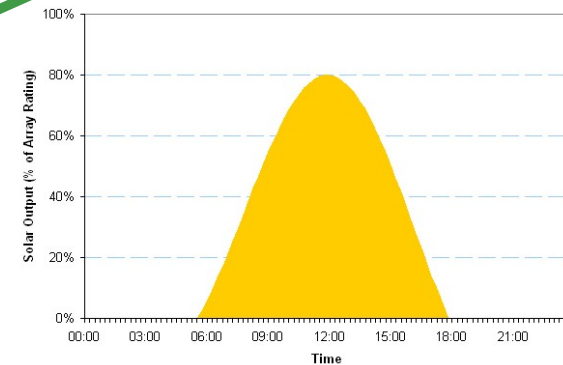
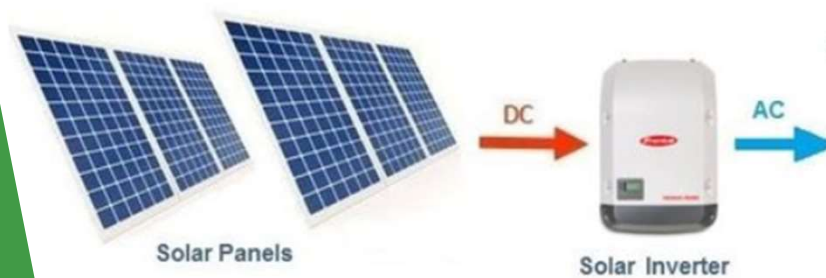
Assumed low permit and interconnection fees, rectangular layout, module level electronics (SolarEdge) , no accessories for additional functionality, ballasted roof mount

ABOUT

LCOE – LEVELIZED COST OF ENERGY



INSTALLED COST



kWh

LIFETIME ENERGY

25 YEAR
WARRANTY
PERIOD

HIGH MODULE
TO INVERTER
RATIO

LOW TILT WITH
NO TRACKING
BALASTED MOUNT

STANDARD MODULE
NOT BIFACIAL

MODULE LEVEL
ELECTRONICS

ABOUT

LCOE - UTILITY PRICING



SOLAR PV SYSTEMS

Modules watt (72 cell)	# of modules	Total Watts DC	\$/watt (Retail)	LCOE \$/kWh
400	68	27200	\$2.55	\$0.0977
400	112	44800	\$2.21	\$0.0846
400	224	89600	\$1.95	\$0.0746
400	338	135200	\$1.89	\$0.0723
400	375	150000	\$1.88	\$0.0723

BC HYDRO

SMALL GENERAL SERVICE

\$0.1240 per kWh.

RESIDENTIAL

Step 1

\$0.0935 per kWh for first 1,350 in
an average two month billing
period (22.1918 kWh per day).

Step 2

\$0.1403 per kWh over the 1,350
Step 1 threshold.

NOVA SCOTIA POWER

SMALL GENERAL SERVICE

\$0.16350 per kilowatt hour for the first 200
kilowatt hours per month

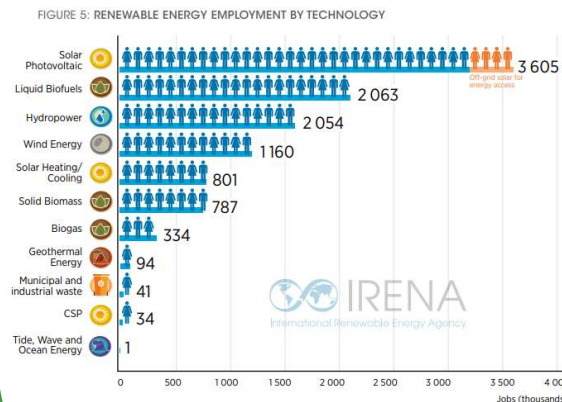
\$0.14536 per kilowatt hour for all additional
kilowatt hours

RESIDENTIAL

\$0.15805 per kWh.

THINGS TO REMEMBER

35 Green Jobs per MW
25 of those jobs are installers



PV CONTRIBUTION TO ELECTRICITY DEMAND

- Utility-scale solar power purchase agreement (PPA) pricing fell by 4.7% in 2019 – settling in at an **average** of **2.74¢/kWh**, according to LevelTen Energy



2,9%

Share of PV in the
global electricity
demand in 2018



Source: IRENA & IEA
VPS & LevelTen Energy



THANK-
YOU



Aspirational Ideas, Practical Implementation.



TOC

Reframed Objective

About Impact

Market Trends

Case Study

Next Steps



Reframed Objective



“Working in partnership, we will demonstrate the technical and economic feasibility of whole-building retrofit solutions that integrate seismic and fire safety, energy efficiency, decarbonization, and climate adaptation upgrades.”

<https://www.pembina.org/reframed>

A decorative horizontal bar with a teal segment on the left and an orange segment on the right, positioned above the title.

Overview

We Provide High Performance Building Solutions that:

- Reduce Operating Costs
- Improve Comfort
- Decarbonize Building Operations





Services



Study

- Passive House & Net Zero Feasibility Studies
- Building Condition Assessments
- Energy Studies



Design

- Mechanical Engineering
- PHPP Energy Modelling
- PH & Net Zero Design
- CaGBC Zero Carbon Certification



Plan

- High Performance Building & Net Zero Design Consulting
- Air Barrier Planning
- Strategic Energy Planning



Optimize

- Building Recommissioning
- Measurement & Verification
- Blower Door Testing
- Thermal Imaging & Flow Metering



Team

We have assembled a team of Energy & Engineering Professionals that are passionate about making a positive impact for our clients and the environment.



Founding Principal
Ben Mills



Principal
Kenneth McNamee



Senior Engineer
Jason Le



Sustainability Specialist
Natasha Samson



Lead Energy Engineer
Steve Fetterly



Project Coordinator
Dilara Omur



Energy Engineer
Zaina Abdul



Energy Operations Manager
Jeff Clarke-Janzen

Deep Experience

MURB, Passive, Net Zero,
Commercial, Health Care,
Recreation, Institutional.

Deep Retrofits +
New Construction.

All electrification projects.



Large MURB: EnerPHit



MURB: Passive House



Part 9: Passive House



Part 9: Passive House



Comm NC: Geothermal



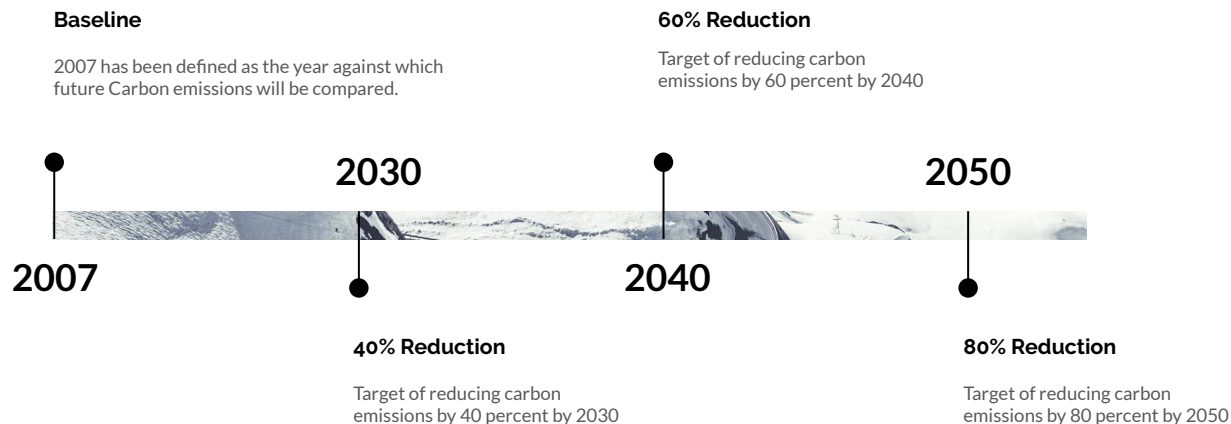
Comm NC: VRF





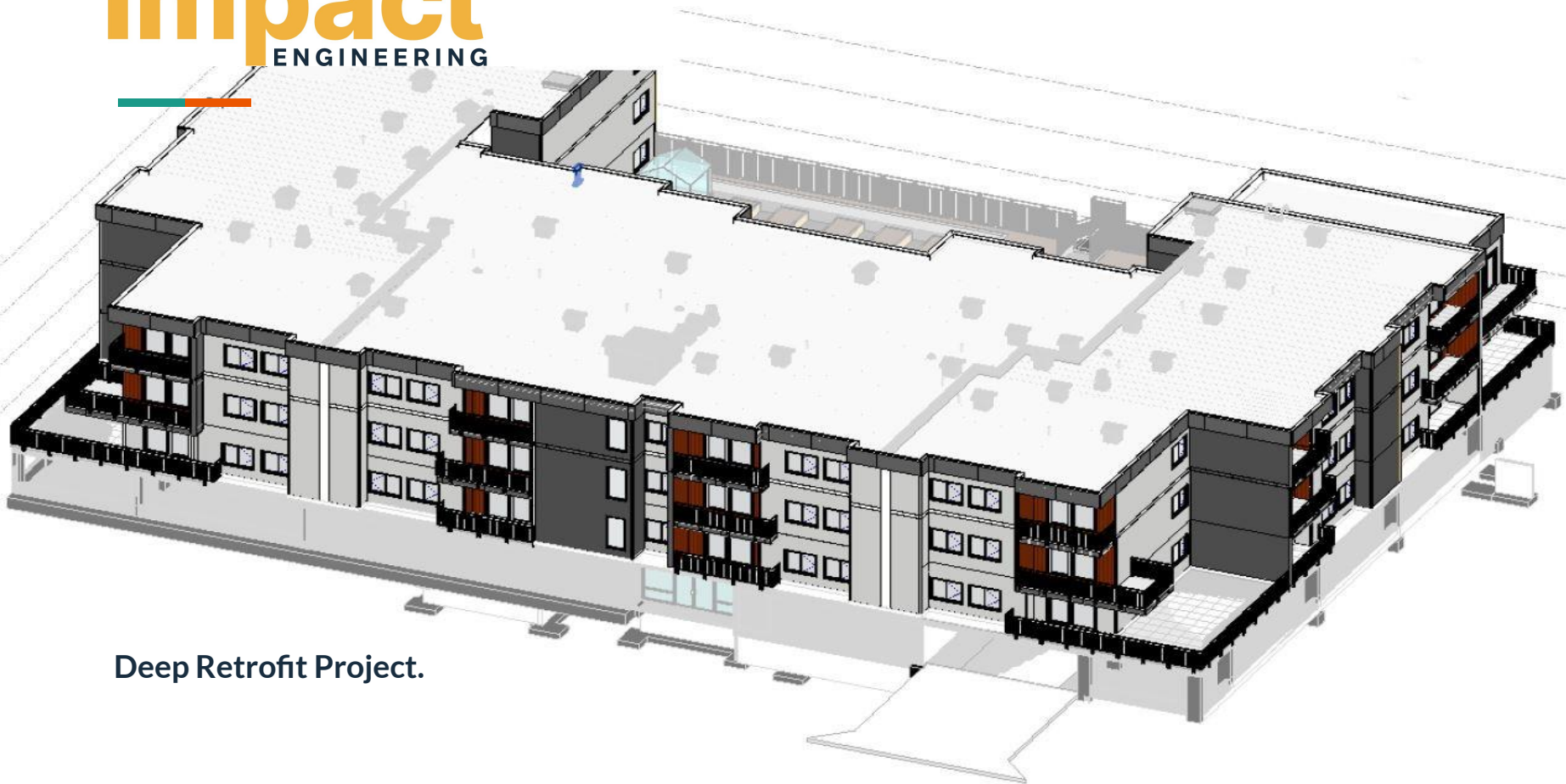
Decarbonization

The Government of British Columbia has defined the following key carbon reduction targets:





Deep Retrofit Project.



Deep Retrofit Project.

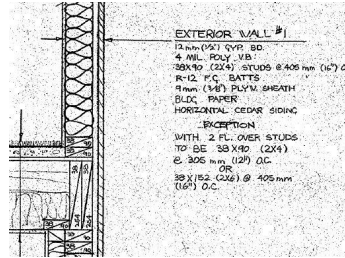
Deep Retrofit / Electrification

Ladner MURB



Existing Conditions

Typical for the vintage.



2x4 Exterior Walls
R-12 Batt Insulation



Tar & Gravel to Torch On
R-28 Batt Insulation



Double Glazed
Aluminum Windows



Unheated Rooftop Fans
Corridor Ventilation



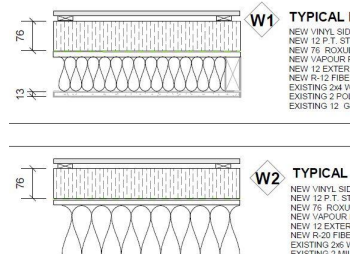
Washroom Exhaust Fans
Door Undercuts



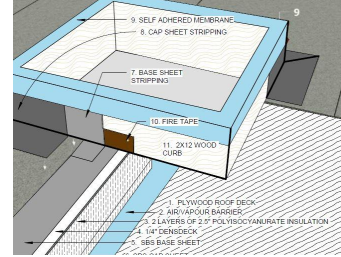
Natural Gas DHW Boiler
Storage Tanks

Proposed Retrofit

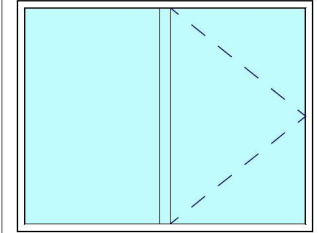
Step 2. Full Electrification.



New R-12 Batt Insulation
+3" Roxul + Vinyl Siding



2 x 2.5" PolyIso (R-31+)
New Air/Vapour Barrier



Double Glazed
Vinyl Windows



Rooftop Heat Pump MUAs
Corridor Ventilation



Continuous WC Exhaust
Door Undercuts



DHW Heat Pump (CO₂)
Storage Tanks

Equipment

Ventilation

Key Characteristics:

- Heat Pump MUA annual COP of 3.5
- Electric resistance backup below -1C
- 3 MUAs (Total of 4,700 cfm)
- Ability for heating + cooling + scheduling
- 38 Continuous WC Exhaust Fans
- Baseline comparison vs. Gas Rooftop MUAs

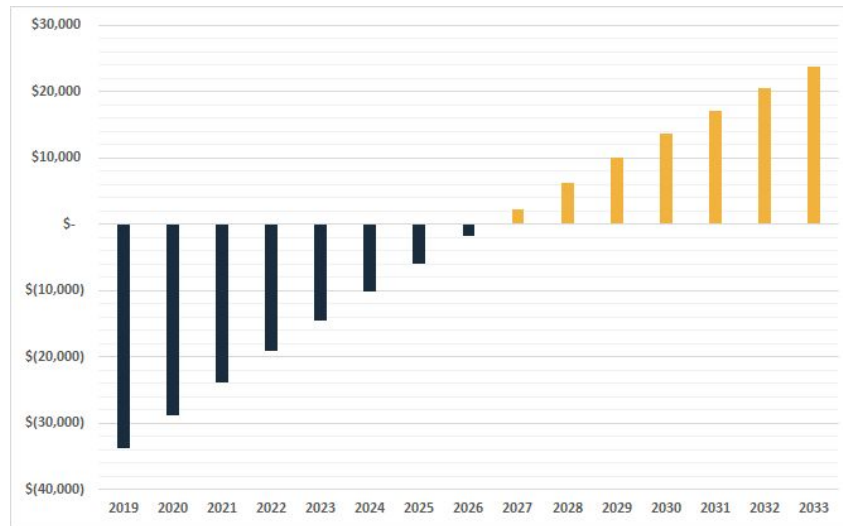




Ventilation

Key Characteristics:

- \$266,850 (Project)
- \$38,991 (Incremental)
- 565 GJ/yr (Gas Savings)
- 25,560 kWh/yr (Elec Increase)
- 28 t CO₂e (Carbon “Comparison”)
- 7.5 years (Simple Payback)
- \$23,764 (Net Present Value)
- 13% (IRR)



Domestic Hot Water

Key Characteristics:

- Heat Pump MUA annual COP of 4
- 6 x 14.5 MBH heat pumps installed in L1 Parkade
- 4 x 120 gal tanks installed in L1 Mech Room
- Ensure cold entering water to maximize COP
- Baseline comparison vs. 2 new storage tanks
- Incentives via CleanBC / SHRSP

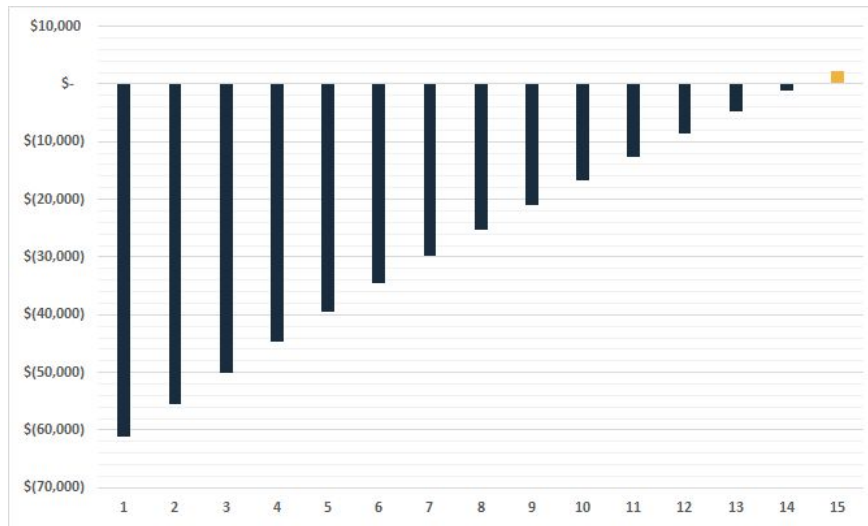




Domestic Hot Water

Key Characteristics:

- \$131,260 (Project)
- \$67,053 (Incremental)
- 753 GJ/yr (Gas Savings)
- 41,833 kWh/yr (Elec Increase)
- 37 t CO₂e (Carbon Reduction)
- 11.5 years (Simple Payback)
- \$2,178 (Net Present Value)
- 4% (IRR)

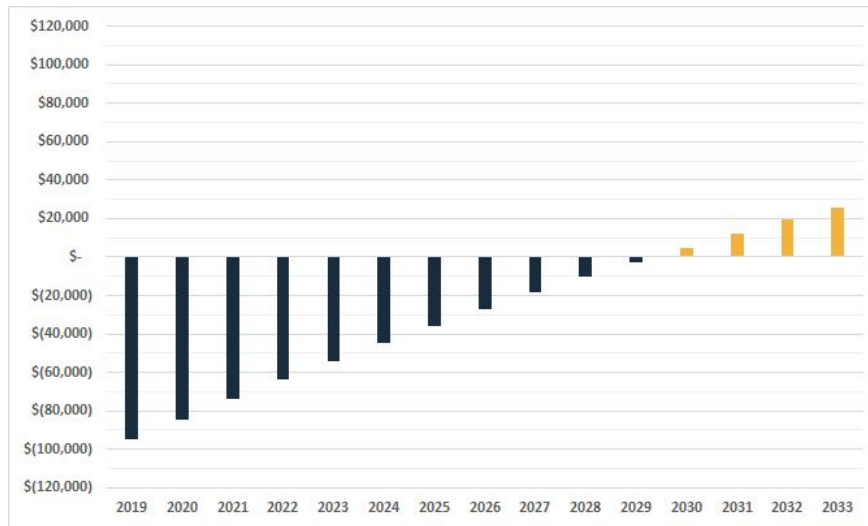




Retrofit Bundle

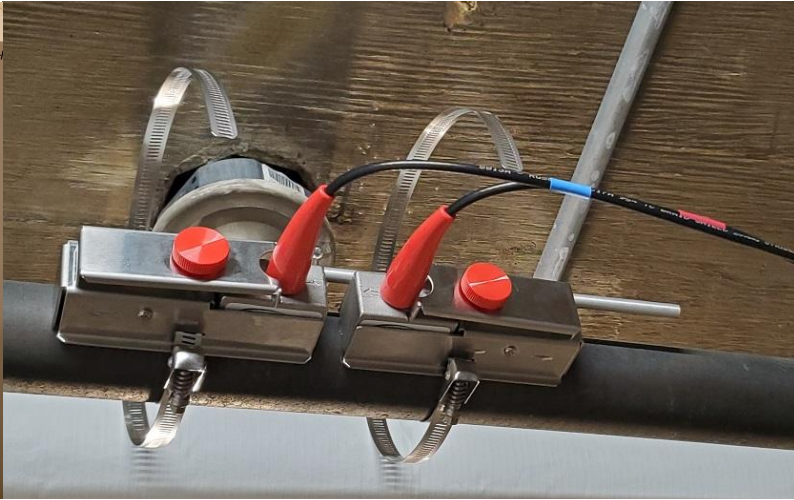
Key Characteristics:

- \$398,110 (Project)
- \$106,044 (Incremental)
- 1,318 GJ/yr (Gas Savings)
- 67,393 kWh/yr (Elec Increase)
- 65 t CO₂e (Carbon Reduction)
- 9.7 years (Simple Payback)
- \$25,943 (Net Present Value)
- 7% (IRR)



Metering / Structural

Critical Next Steps

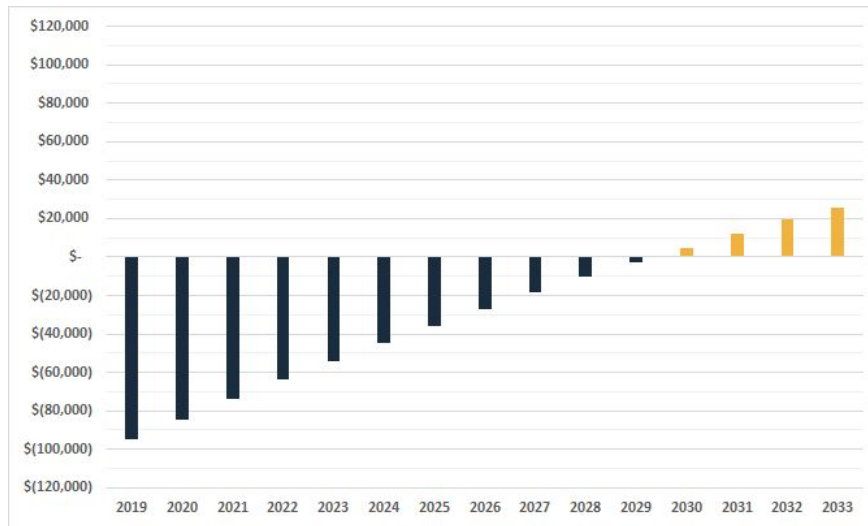




Retrofit Bundle

Key Characteristics:

- \$398,110 (Project)
- \$106,044 (Incremental)
- 1,318 GJ/yr (Gas Savings)
- 67,393 kWh/yr (Elec Increase)
- 65 t CO₂e (Carbon Reduction)
- 9.7 years (Simple Payback)
- \$25,943 (Net Present Value)
- 7% (IRR)

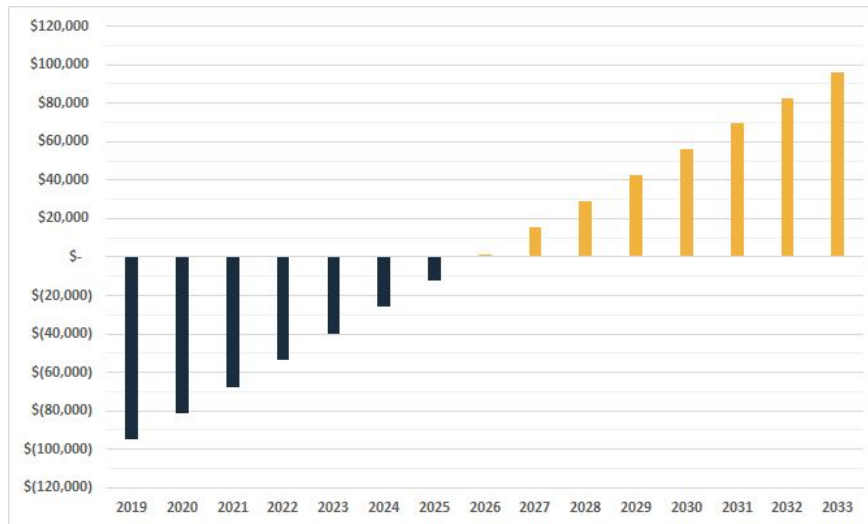




Retrofit Bundle with Solar

Key Characteristics:

- \$398,110 (Project)
- \$106,044 (Incremental)
- \$3,115 (Positive Cash Flow Year 1)
- 1,318 GJ/yr (Gas Savings)
- 67,393 kWh/yr (Elec Increase)
- 137,314 kWh/yr (Elec Production)
- 65 t CO₂e (Carbon Reduction)
- \$95,731 (Net Present Value)
- 15% (IRR)





Thank you.

bmills@impacteng.ca | 778.233.7978



Solar Solutions





About Penfolds

Penfolds Roofing and Solar is the **largest** solar installer in Metro Vancouver of complete solar solutions for residential homes and commercial buildings.

Not all solar systems are created equal. Penfolds uses the most advanced commercially viable components to build solar systems optimized for our BC climate.

Our systems have no moving parts and require very little maintenance over their 30+ year life, all while maximizing power production per dollar invested.

Solar Solutions

- Solar Myths
- Case Study
- Financial Savings

Solar Myths



Metro Vancouver Weather

80 Years

PENFOLDS
ROOFING & SOLAR



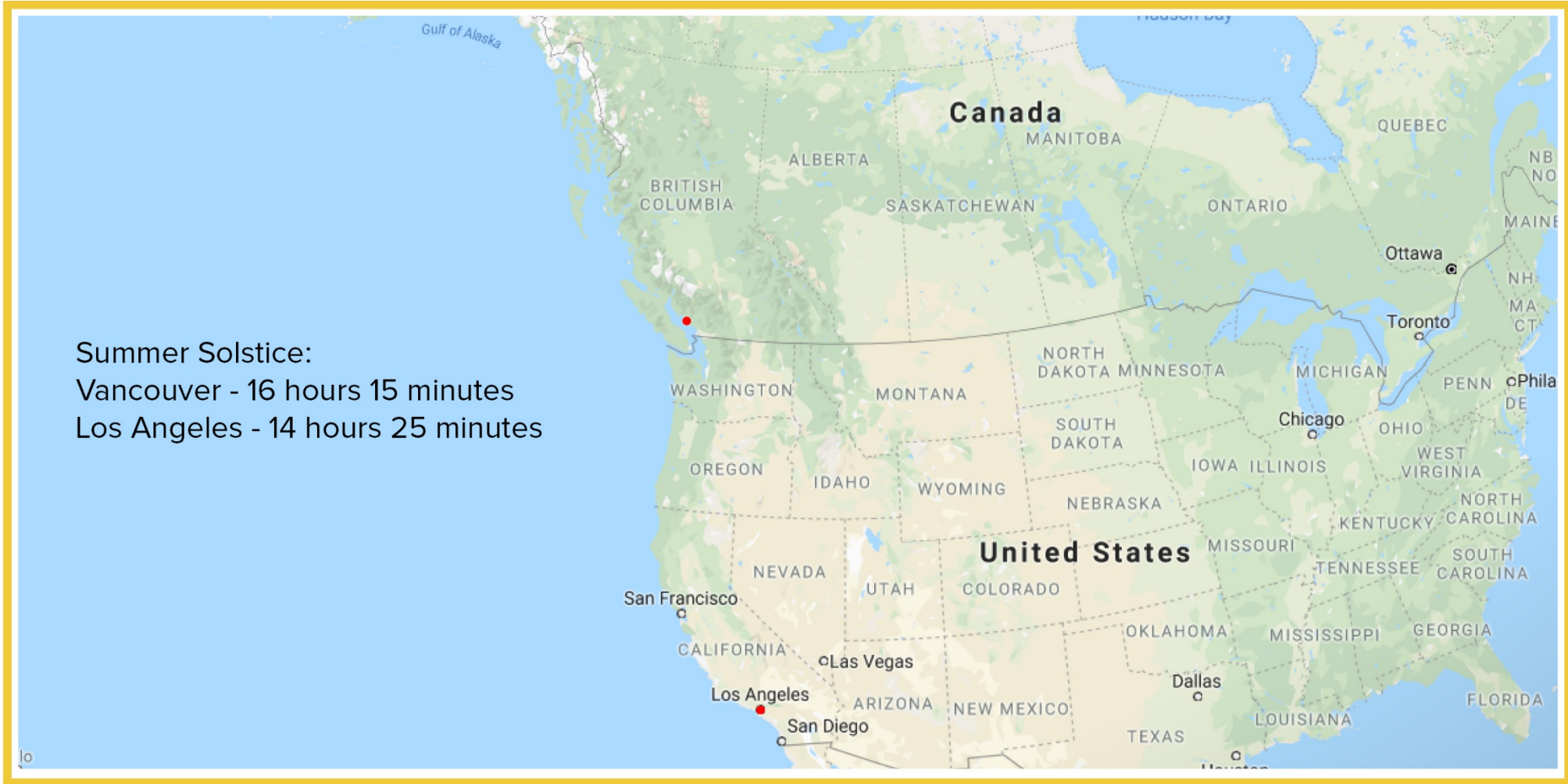
Temperate Climate

80 Years

PENFOLDS
ROOFING & SOLAR

Long Summer Days

Summer Solstice:
Vancouver - 16 hours 15 minutes
Los Angeles - 14 hours 25 minutes



Outperforming a World Leader: **Germany**

Berlin: 912kWh

Vancouver: 1140 kWh

25% more power produced

No Need for Direct Sunlight

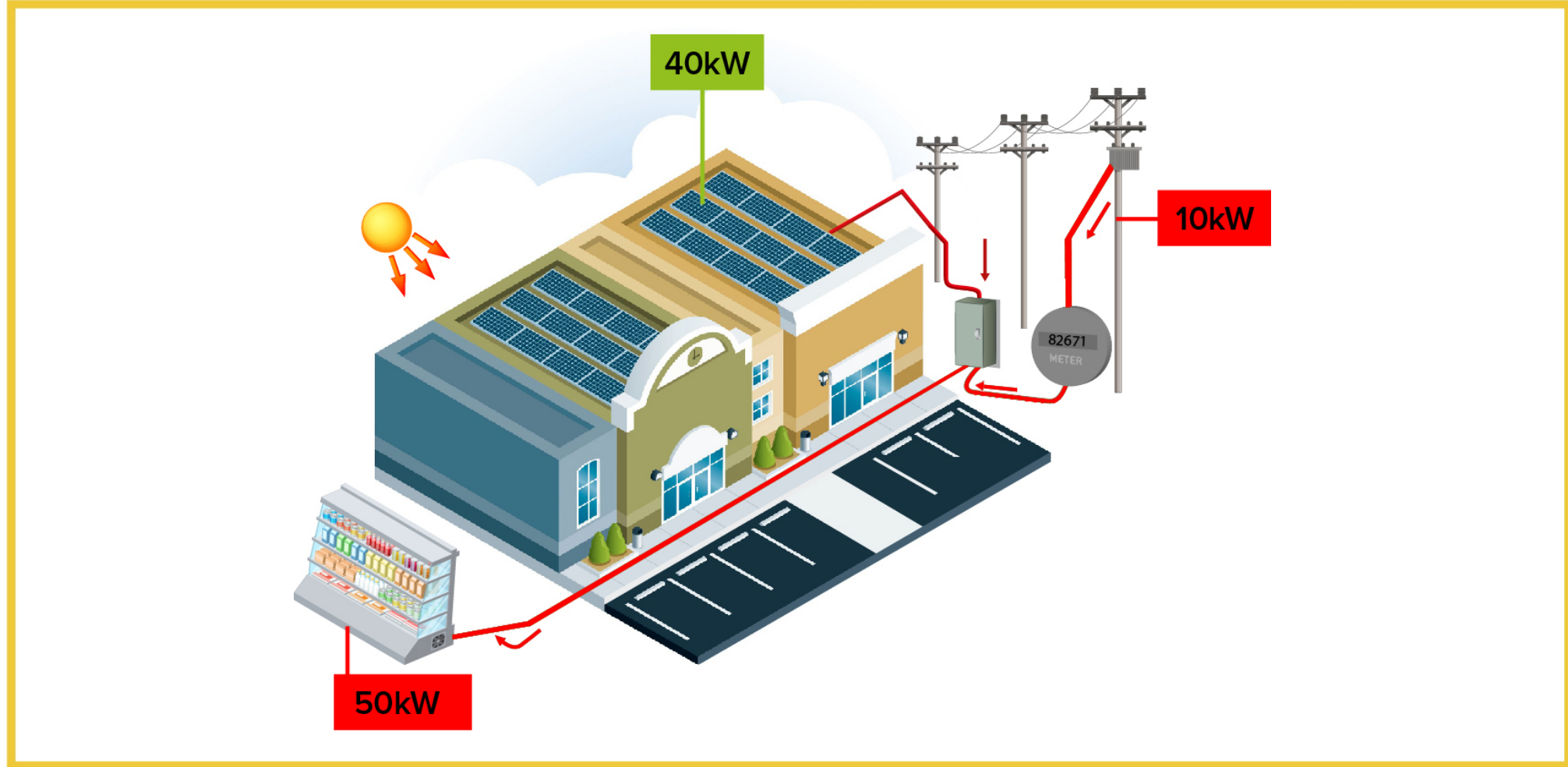
- Direct sun is best, but...
- Solar PV panels generate power from ambient or diffused light
- Even on a dark, rainy December day, solar panels in Vancouver will generate power
- Every minute of every day, solar PV produces power



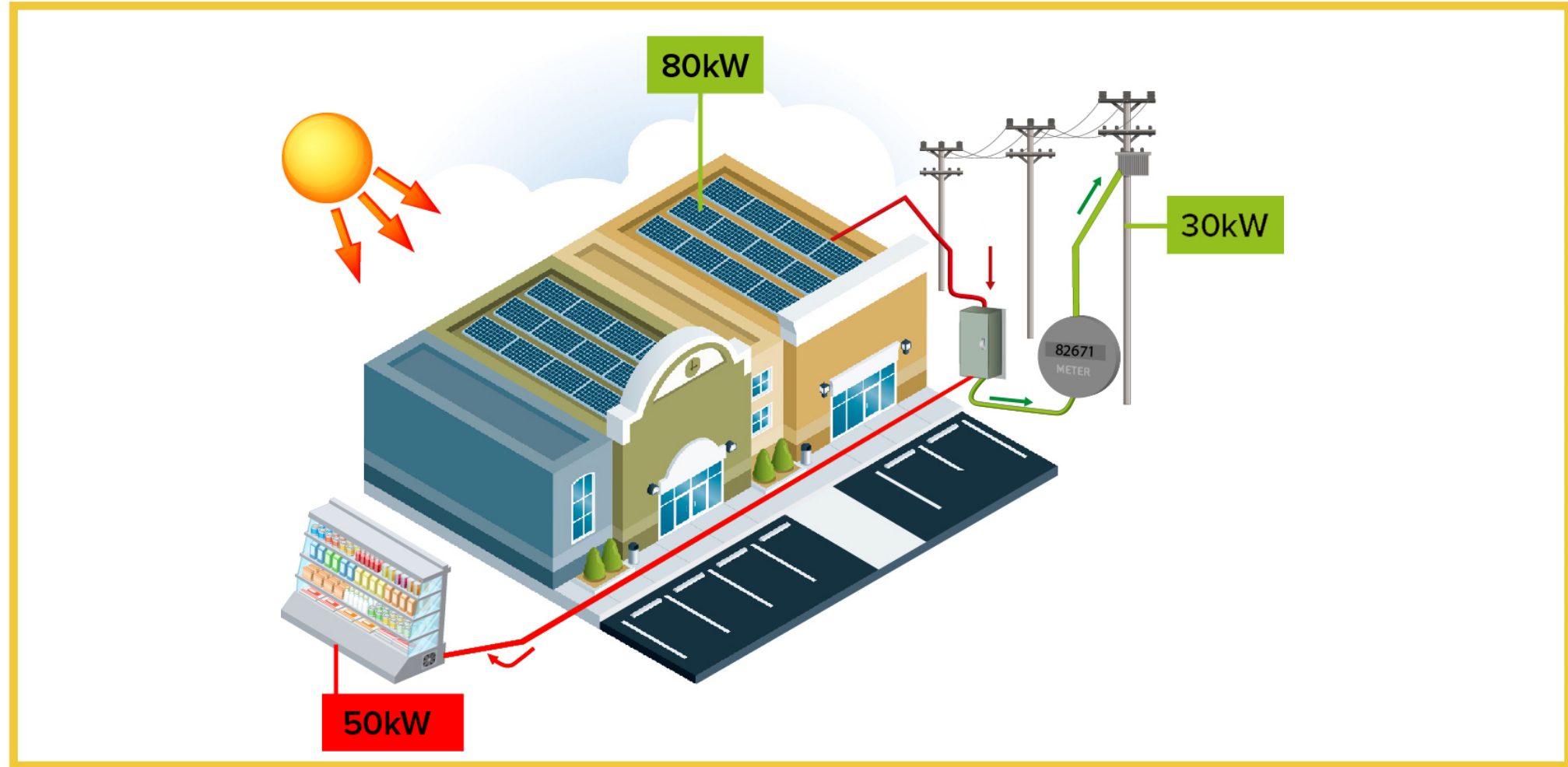
No Batteries Required



Net Metering Reducing Your Bill



Net Metering Credit for Excess



Free Real-Time Monitoring



Incentives

SAVE 7%

+

SAVE 28%

+

Net Metering

PST Exempt

Federal Solar Tax Incentive:
Write Off 100% in Year Installed

Free Program

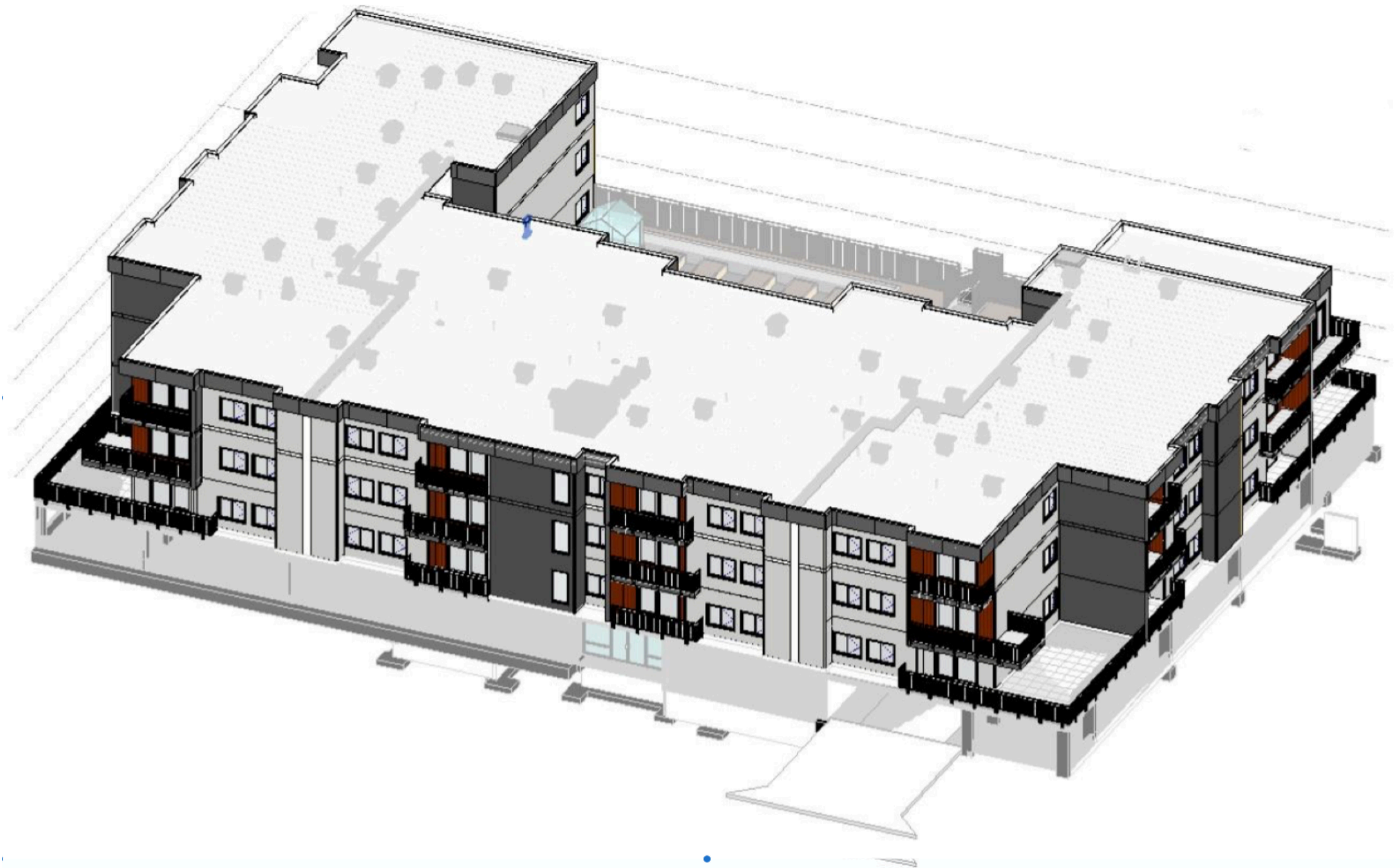
Financing

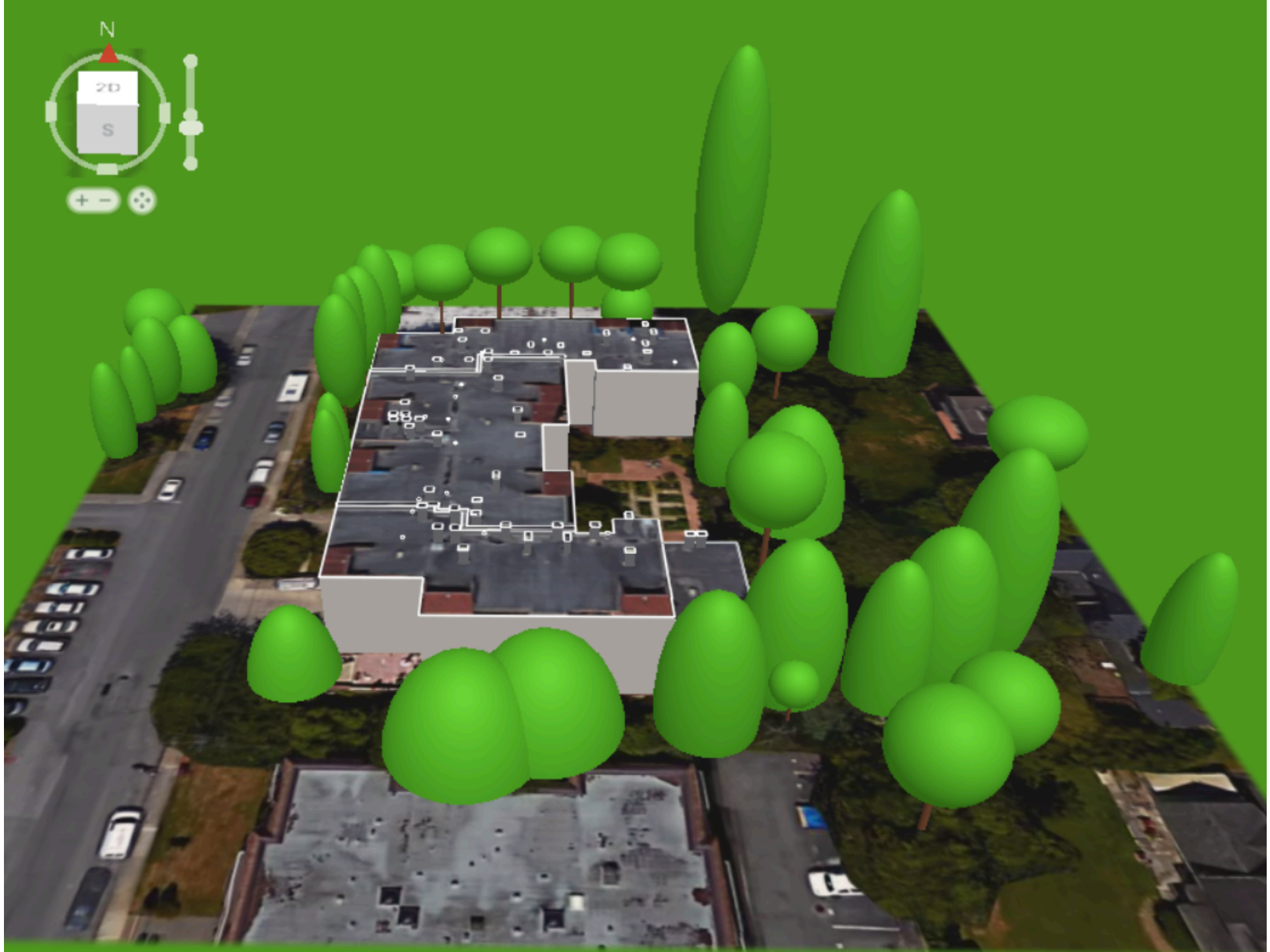
Vancity Home Energy[®] Loan

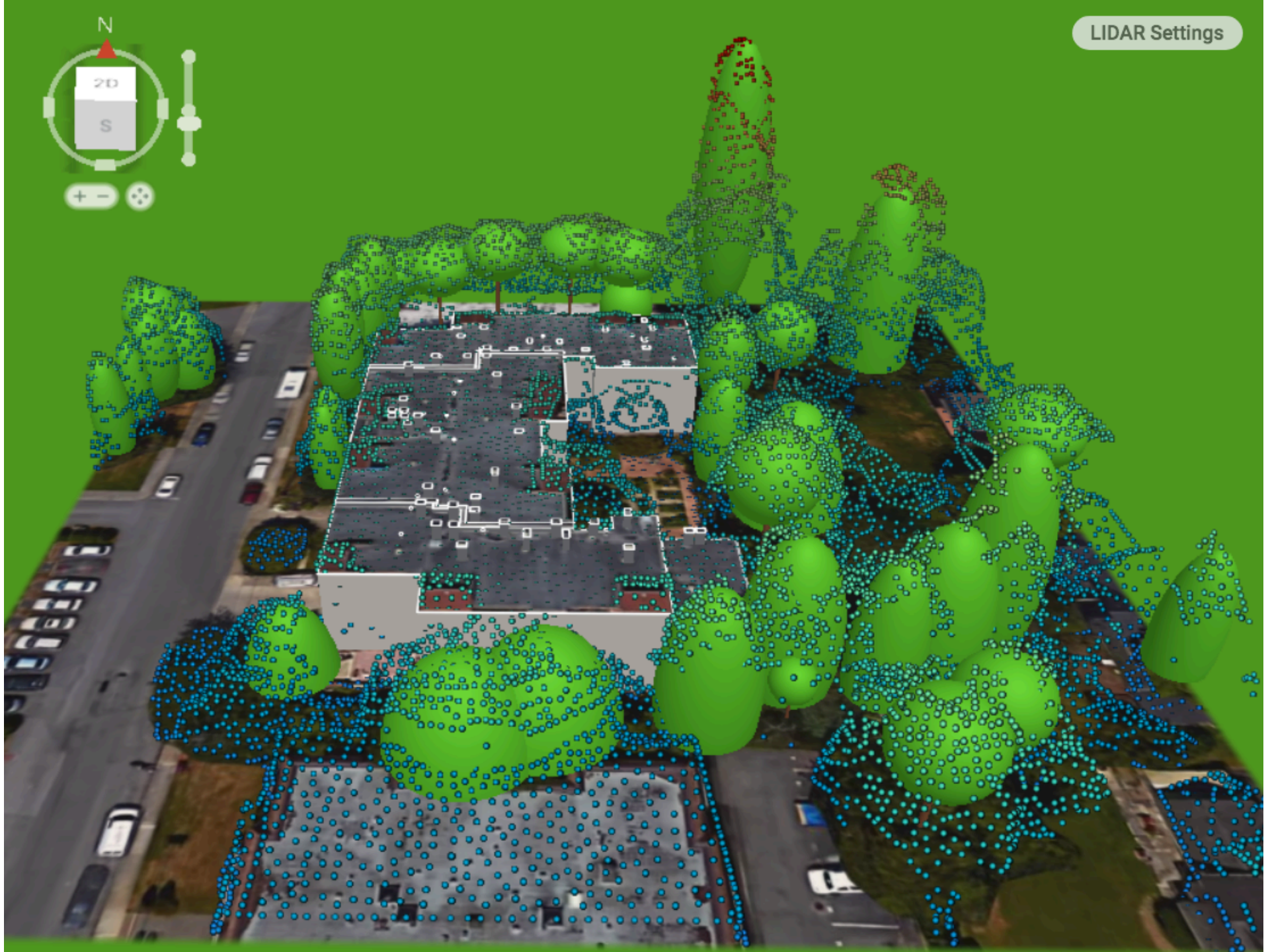
- Prime plus 1 for up to 15 years

Add to Mortgage

- Be cashflow positive very soon

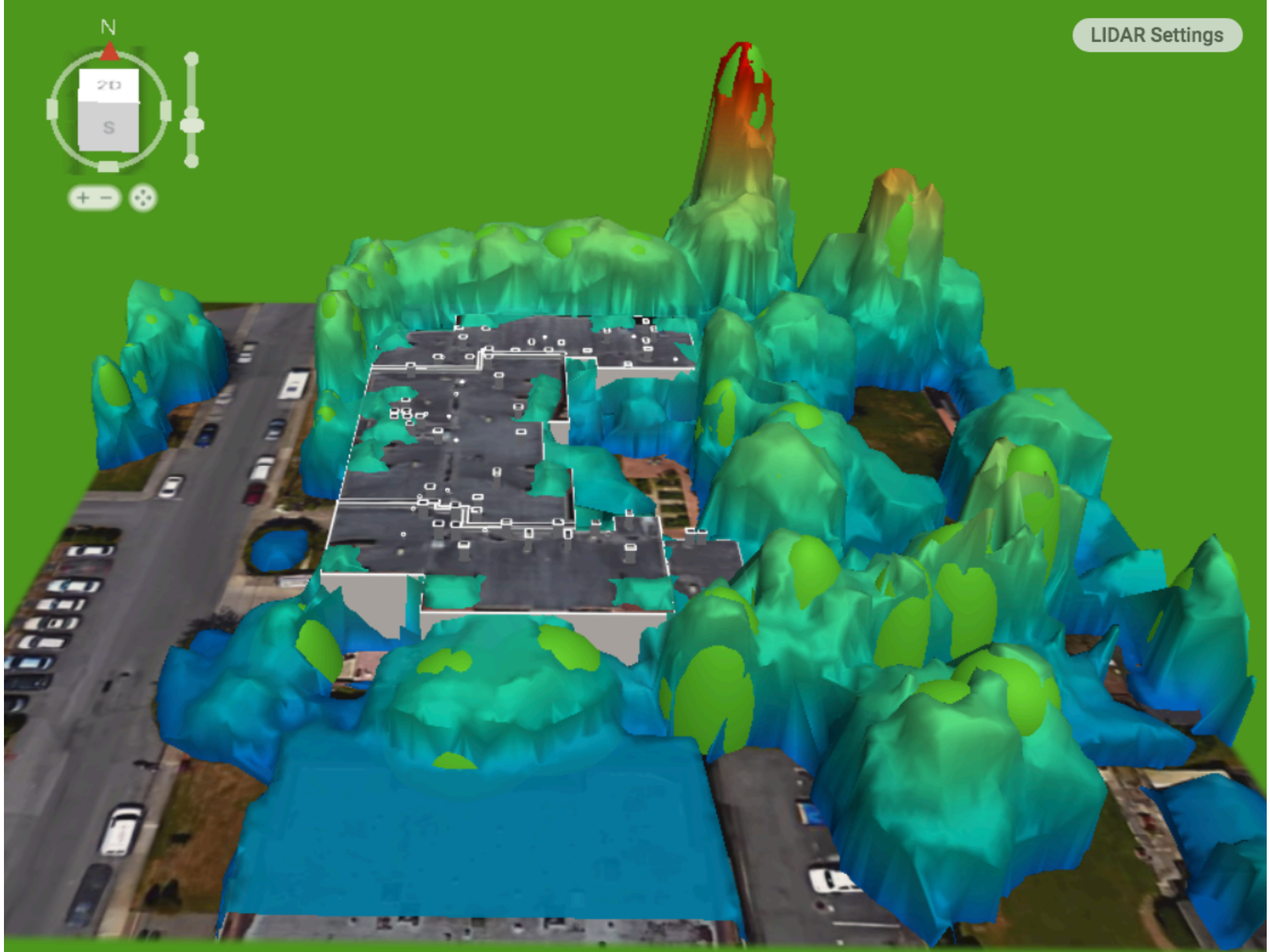


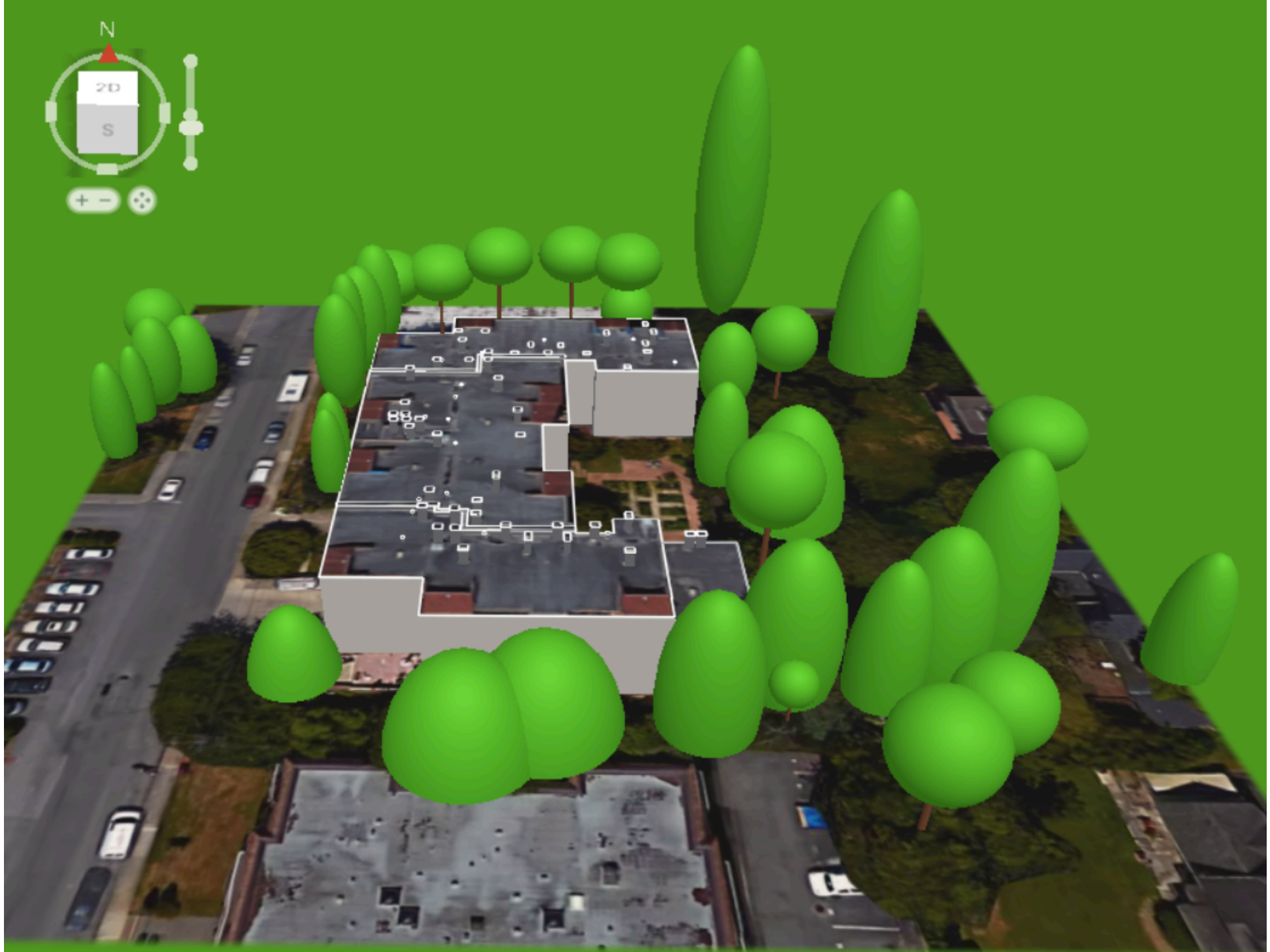






LIDAR Settings



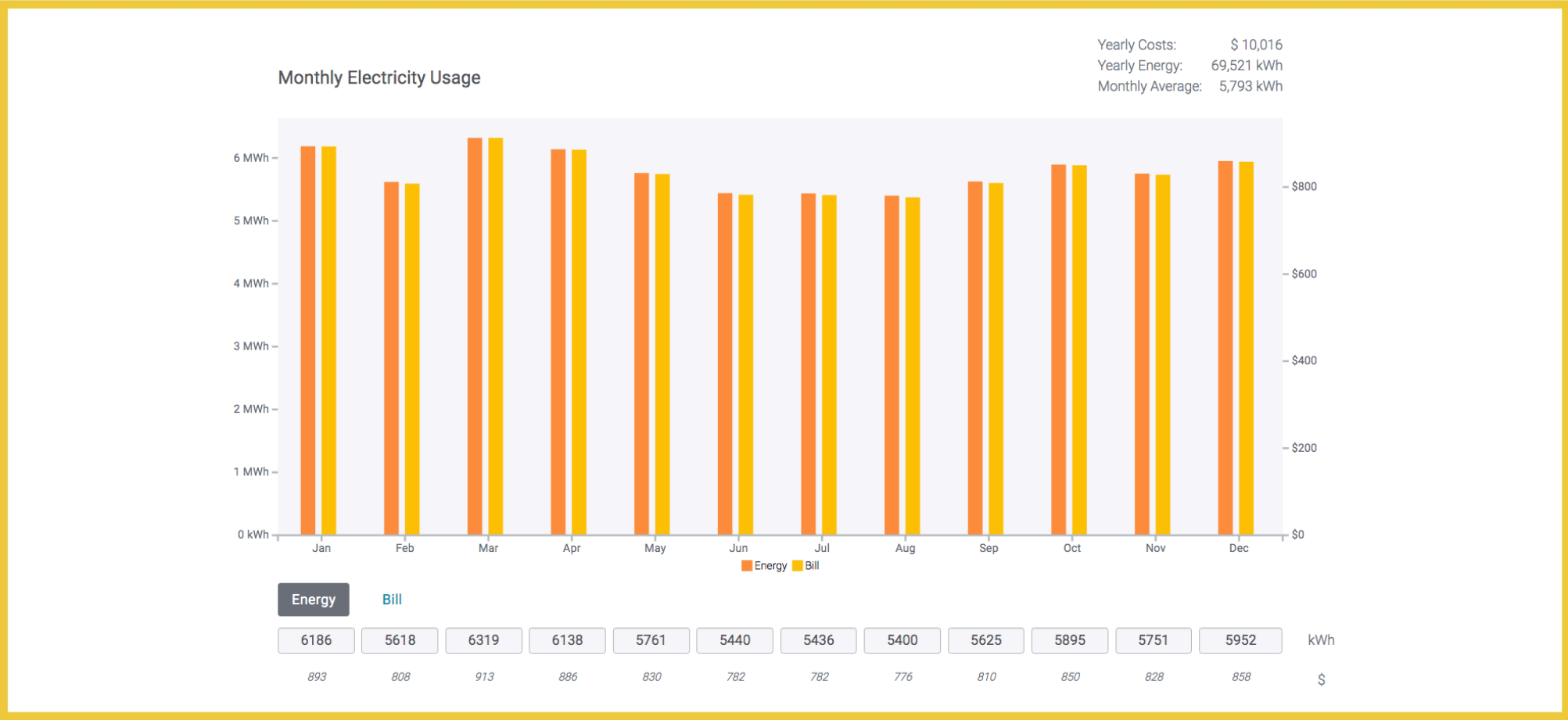






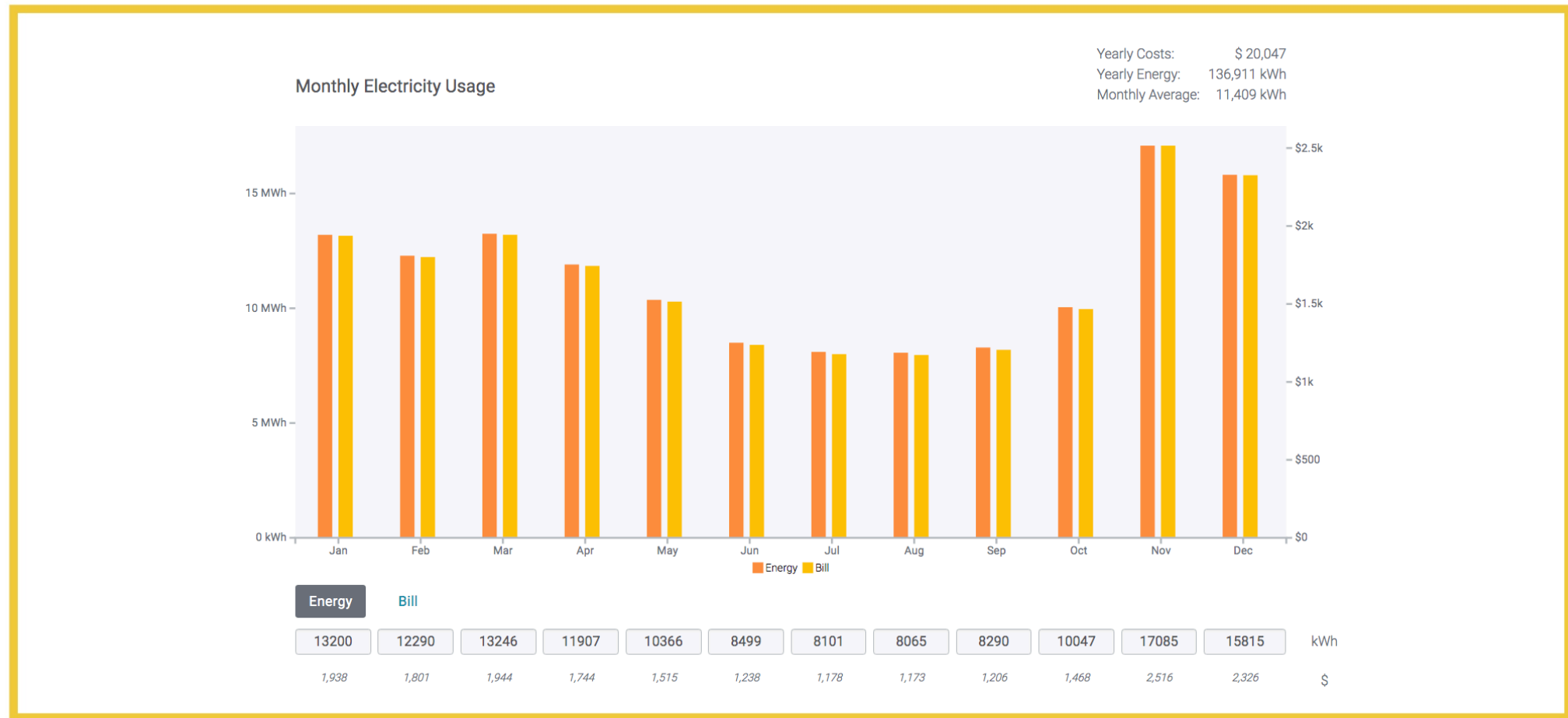
Current Power Consumption

Common Area: Residential Rate



After Retrofit Power Consumption

Common Area: Residential Rate

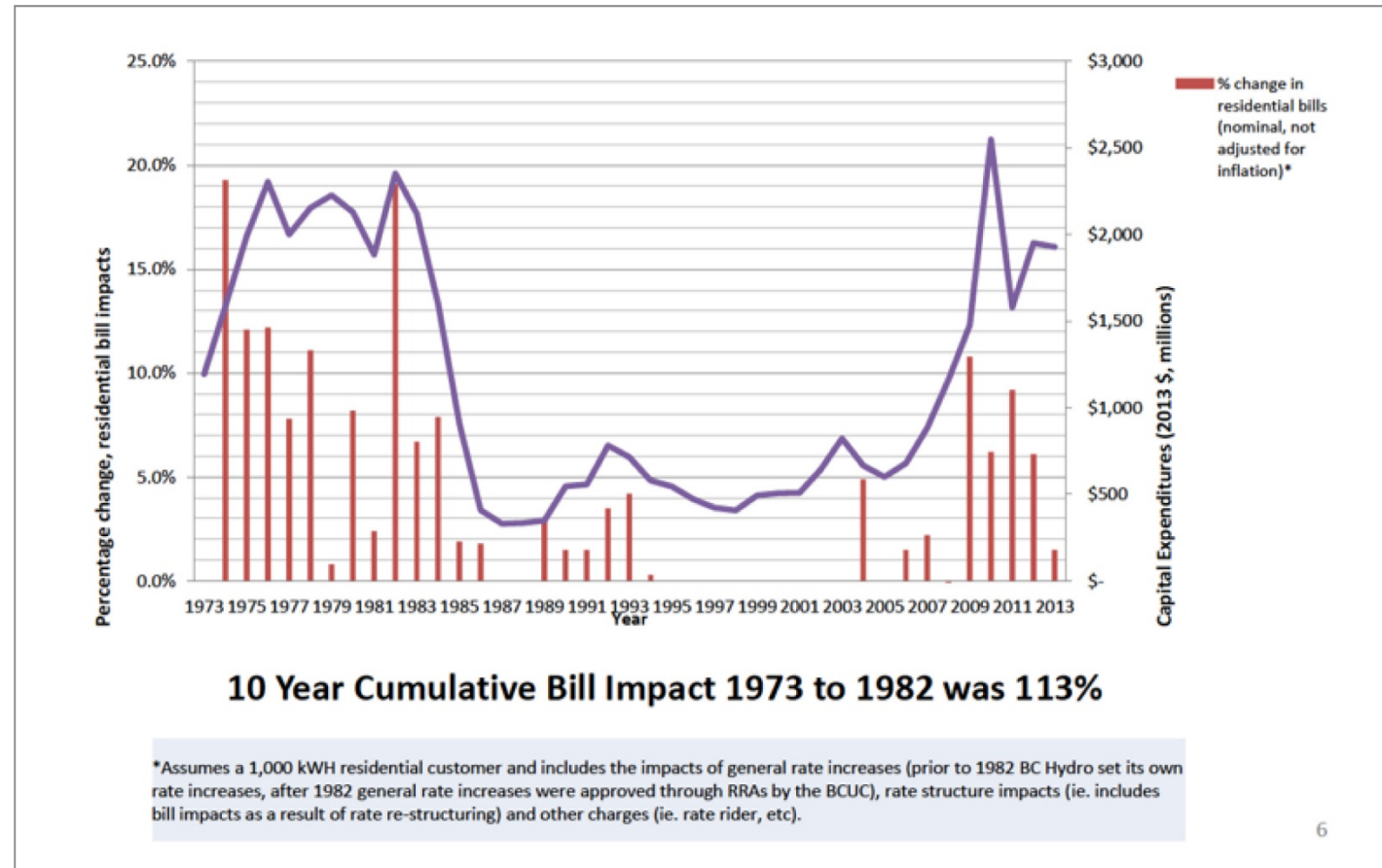


Step 1: 9.35¢ per kWh

Step 2: 14.03¢ per kWh



Hydro Rates Keep Going Up



The Cost Of Doing Nothing

Without solar, the cost of the same amount of power from Hydro:

Over the next 20 years:

\$615,004

Over the next 30 years:

\$1,180,005

The Cost Of Doing Nothing

Without solar, the cost of the same amount of power from Hydro:

Over the next 20 years:

\$615,004

Over the next 30 years:

\$1,180,005

Solution: Go Solar for \$266,400

Meet Your Solar-Powered Building



Meet Your Solar-Powered Building



Solar Power Production

ANNUAL PRODUCTION

137,314 kWh

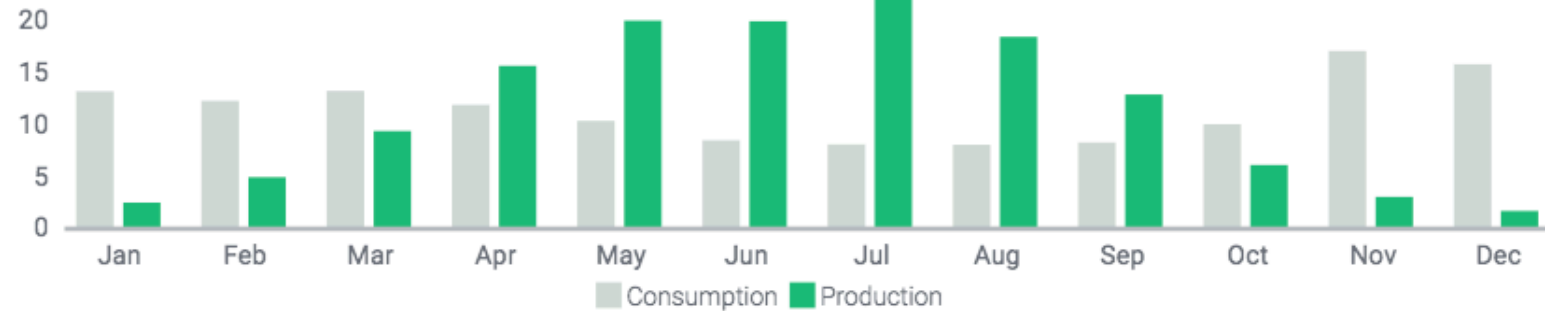
Energy

100%

Energy Offset

MONTHLY PRODUCTION

MWh

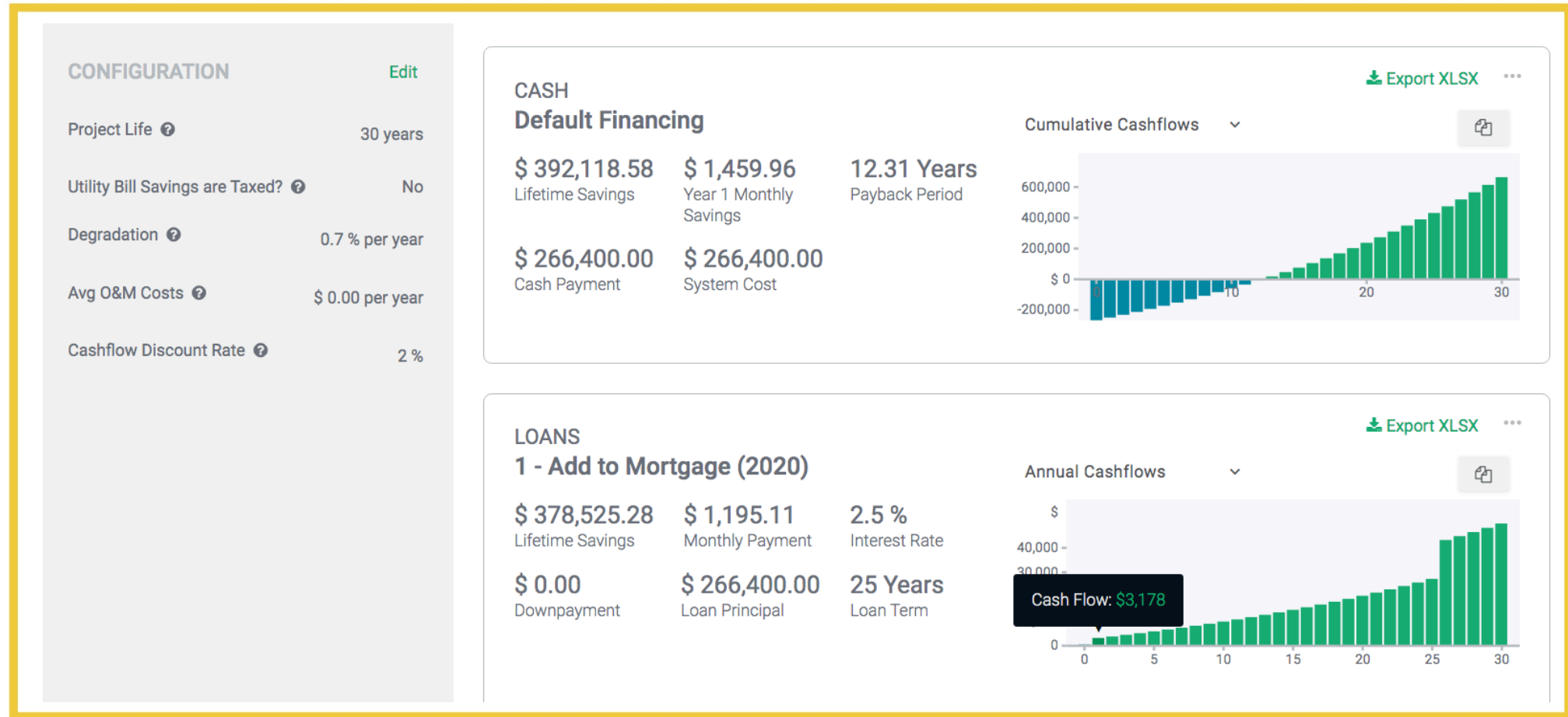


80 Years

PENFOLDS
ROOFING & SOLAR

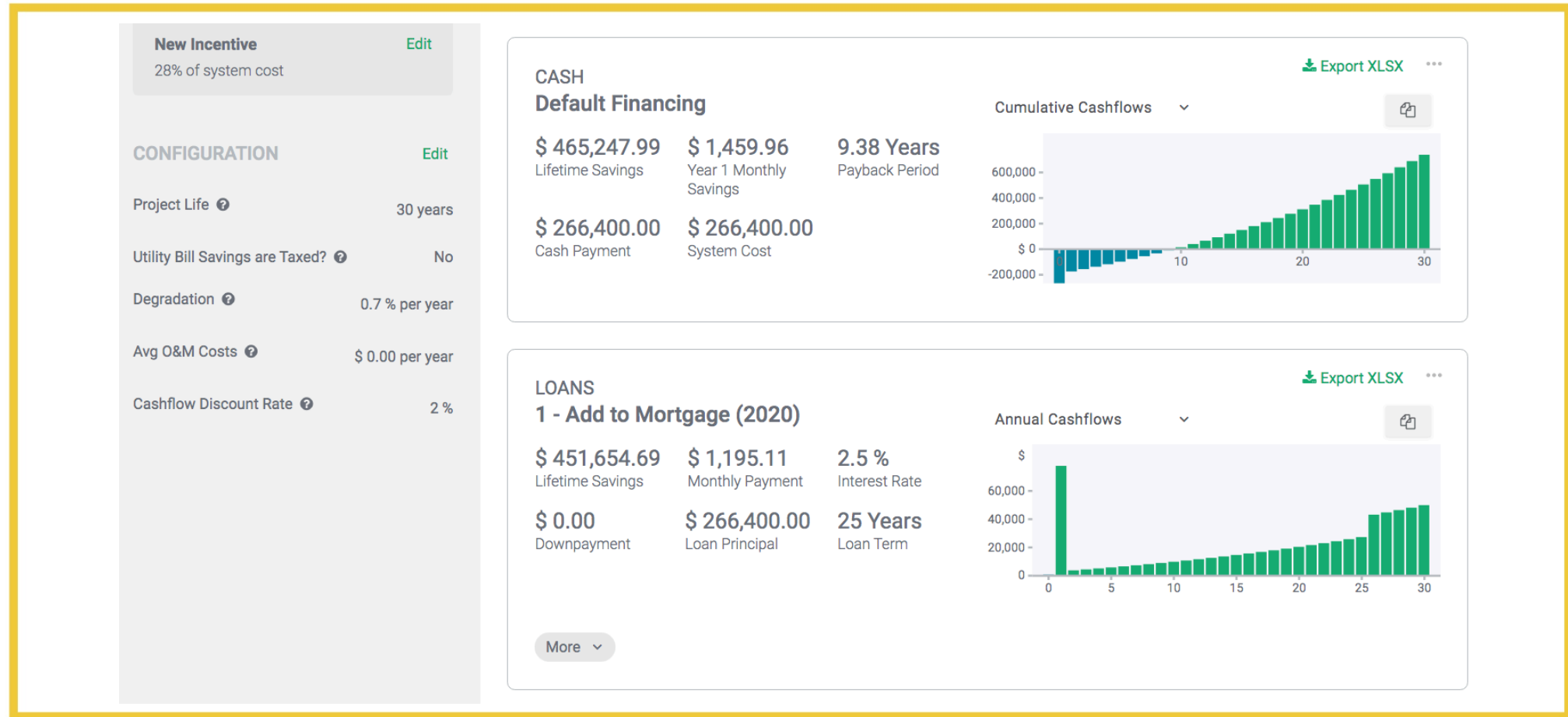
Financial Snapshot

Assumptions: 4.3% utility rate escalation, 2% discount rate, not for profit



Financial Snapshot

Assumptions: 4.3% utility rate escalation, 2% discount rate, for profit



Financial Snapshot

Assumptions: 4.3% utility rate escalation, 2% discount rate

Financed 100% as mortgage-style loan
2.5% over 25 years

Net Present Value

\$378,525

(after paying off loan)

LCOE

10¢ kWh

Summary

Solar **lowers** your **operating costs**

Solar **lowers** your **GHG footprint**

Solar creates **positive cashflow**

Use savings for **deeper retrofit** or

Make existing retrofits **more attractive and bankable**

GO SOLAR!

[insert corny joke here]

**Put Your
Roof To
Work For
YOU**

Thank
YOU

FINANCING
CONSTRAINTS

BUILDING
STOCK

DESIGN
&
CONSTRUCTION

CODE &
PERMITTING

3/0
Energy Conservation
& Source
Retrofit Coupling

Poll

3/0
Seeing examples
that work abroad

3/0
Recognition that
the current model
isn't working at
the political
level. Young
people are young

GOALS

What:

Net-zero Carbon retrofits delivered
at scale across Canada driving carbon
neutrality in the residential market
by 2050.

W: Engage & coordinate the market
as an industrialized turnkey
retrofit process

Questions

Upcoming Reframed Lab

- Request for proposals expected in summer 2020
- Multi-disciplinary teams will design solutions for low-rise residential buildings in B.C.'s Lower Mainland or Victoria area
- Six-month exploration lab with support from climate, energy, and health experts

REGISTER YOUR INTEREST: pembina.org/reframed

Integrated design teams

- Architects
- Building science, electrical, mechanical, and structural engineers
- Contractors, builders, and retrofitters
- Manufacturers, fabricators, and suppliers
- Modeling and data capture specialists
- Monitoring and control equipment specialists

REGISTER YOUR INTEREST: pembina.org/reframed

Solutions of particular interest

- Prefabricated exterior wall and roof panels
- High-efficiency and low-carbon mechanical systems
- Roofing solutions that integrate on-site renewable electricity
- Storage and/or renewable thermal generation
- Seismic upgrades
- Climate adaptation measures
- System controls and performance monitoring

REGISTER YOUR INTEREST: pembina.org/reframed

Reframed Tech Series

Upcoming
Event

Embodied carbon & deep retrofits

July 22, 2020



JOIN THE WEBINAR: pembina.org/ReframedTechSeries

#Reframed

PEMBINA
institute

Contact us

reframed@pembina.org

pembina.org/reframed

Register as a solution provider. Sign up for updates.

#Reframed