
PASSIVE
HOUSE
PERKINS+WILL

WHAT IS PASSIVE HOUSE?

passive house /ˈpæsiv haʊs/ *n.* An internationally recognized, performance-based energy standard in construction. The primary aim is to achieve exceptional energy efficiency while maintaining superior inhabitant comfort. *[German Passivhaus]*

A building can be certified as a Passive House building if it meets a series of technical requirements (see below). The Passivhaus Institut (PHI), founded in Germany in 1996, developed the standard based on the fundamentals of building physics. It is performance based as opposed to prescriptive; design teams can develop their own design strategies as long as the requirements are met and validated. The focus is on 'passive' measures that are inherent in the design of the building to achieve these performance levels as opposed to conventional 'active' systems that require energy use. The result is a building that uses over 75% less energy for heating and cooling, and over 50% less overall energy than a typical building in North America.

The Passive House standard has been applied globally to a wide variety of building types and scales including multi-family residential, schools and offices.

CERTIFICATION CRITERIA

Primary energy	30-60 kWh/m²yr	**Space Heat load**	10 W/m²
Space Heating Demand	15 kWh/m²yr	**Airtightness**	0.6 ACH@50Pa
Space Cooling Demand	15 kWh/m²yr	**Overheating**	(over 25°C) ≤ 10%

WHY?

"The building sector offers the largest low-cost potential in world regions to lower [green house gas] emissions.

Research conservatively estimates that if all current building stock were to achieve passive-house levels of energy reduction, world energy consumption would fall by 30 percent."

- Dr. Diana Urge-Vorsatz, Vice Chair, Intergovernmental Panel on Climate Change (IPCC).

There are 3 principal reasons why a project should consider building to the Passive House Standard.

1 / COMFORT

Inhabitant comfort is the prime focus in the Passive House Standard. The rigorous methodology ensures thermal comfort criteria are met and a high quality indoor environment is maintained throughout the year.

2 / CLIMATE CHANGE

The Passive House Standard offers a proven path to reduced carbon emissions. This is evident through regulatory policies such as the City of Vancouver's Zero Emissions Plan for New Buildings and the BC Energy Step Code. The Passive House Standard is embedded in these as the highest level of compliance.

3 / QUALITY

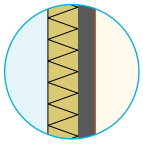
The rigorous nature of the Passive House methodology and the focus on a high performance envelope results in buildings that perform as per their design intent. This means reduced operating and maintenance costs, and increased durability of the building envelope over the lifetime of the building.

ADDITIONAL BENEFITS

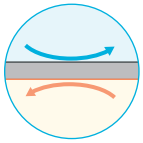
- Reduced energy costs
- Improved Acoustics
- Resiliency
- Reduced building systems depreciation
- Demonstrated leadership
- Increased long-term property value

HOW?

THE FIVE PRINCIPLES OF PASSIVE HOUSE



1 / Continuous Insulation:
Wrap the building in a thick continuous layer of insulation. Part 3 (large) buildings in a Vancouver climate typically require R15-25 levels of insulation. Passive House levels of performance require assembly R-values in the range of R25-40.

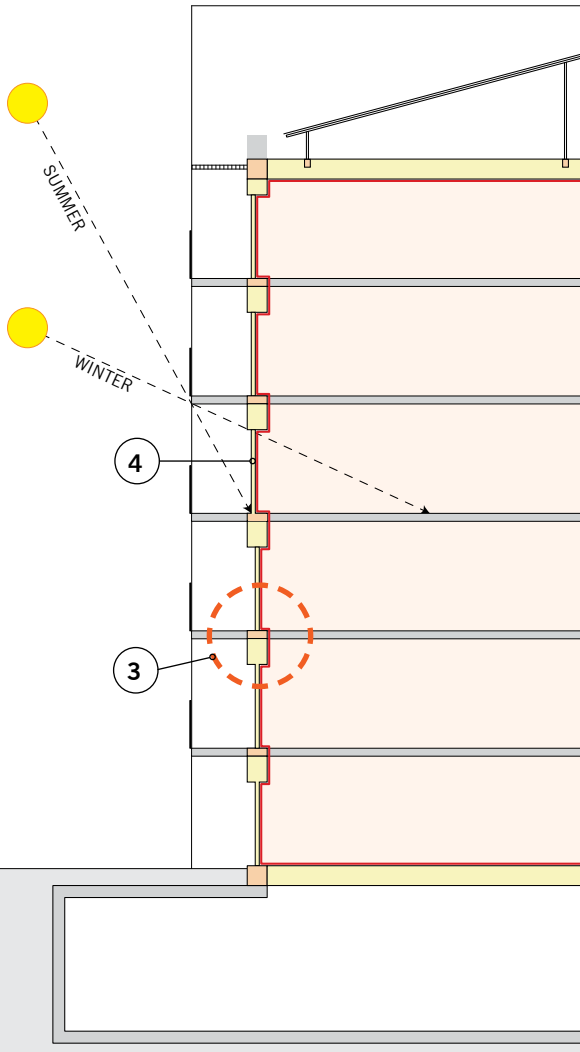


2 / Airtightness:
Build an airtight enclosure, eliminating heat loss and the risk of condensation while improving comfort. Operable windows are required in all habitable rooms.

3 / Thermal Bridging:
Eliminate thermal bridges through careful design. Thermal bridging leads to heat loss and low internal surface temperatures. This results in a risk of condensation and compromised occupant comfort.

4 / High Performance Windows:
Specifying high performance windows reduces heat loss while ensuring internal surface temperatures remain high. This ensures occupant comfort and eliminates the risk of condensation and mold growth. Solar gains are optimized through design while overheating is analysed and mitigated.

5 / Mechanical Heat Recovery:
Ensuring a constant supply of fresh air is paramount. Energy losses are minimized by utilizing a high efficiency heat recovery ventilator.



PATH TO NET ZERO
Passive House buildings have a low energy footprint. The remaining low energy demand can be met using renewable energy sources, making the Passive House Standard an ideal foundation for achieving a Net Zero Energy Building.

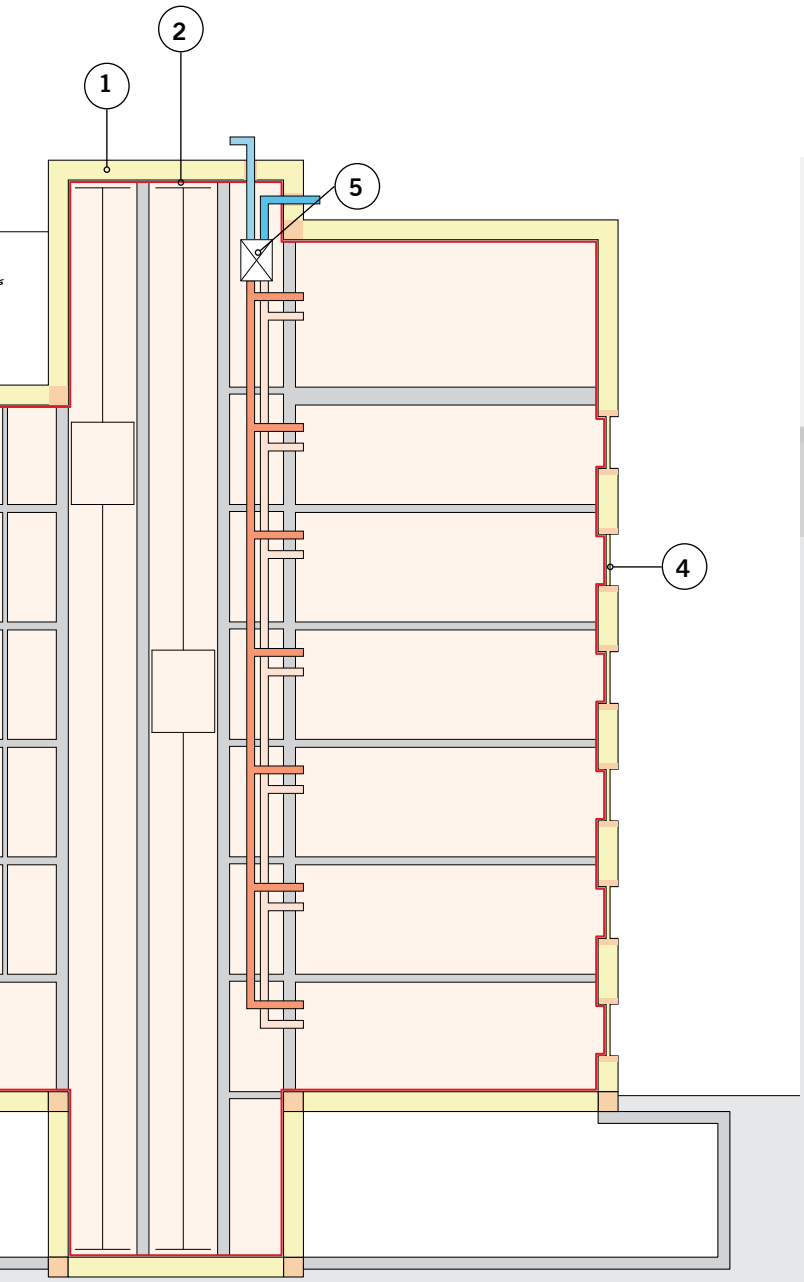
CONCEPTUAL APPROACH

The conceptual approach is simple:

1 / MINIMIZE LOSSES due to infiltration, the ventilation system and through the building envelope.

2 / MAXIMIZE GAINS from the sun, and utilize internal loads from equipment and occupants of the building.

3 / ENSURE COMFORT through a constant supply of fresh air and remove the risk of overheating.



EARLY DESIGN CONSIDERATIONS

The Passive House Standard is a “fabric first” approach relying on a high performance building envelope to deliver exceptional indoor comfort and building energy efficiency. There are some considerations at early design stage that can make the path to certification easier and more economical.

Form Factor This is the relationship between conditioned floor area and the area of the building envelope. A more compact building is more energy efficient, making it easier and less expensive to achieve the Passive House standard.

Window Wall Ratio, Solar Access and Solar Control
Careful consideration should be given to the orientation and placement of windows and glazed elements. This is a balance between reducing heat loss, allowing passive solar heat gain in the winter and reducing the risk of overheating in the summer.

The Passive House Planning Package [PHPP] Energy model is used from early schematic design to optimize and validate the design. This ensures the project is on track to meet the Passive House requirements.

BUILDING POLICY

CITY OF VANCOUVER ZERO EMISSIONS PLAN AND THE PASSIVE HOUSE STANDARD

The City of Vancouver is targeting all new buildings to have zero annual greenhouse gas emissions by 2030 or earlier. The *Zero Emissions Building Plan for New Buildings*[1] came into effect in May 2017 for all rezonings. Projects must either comply with one of the following:

- Path A: Near Zero Emissions Building (achieving the Passive House standard)
- Path B: Low Emissions Green Buildings (LEED v4 for Commercial Buildings plus 10 additional requirements for Commercial and Residential Buildings).

The City of Vancouver Permitting Process for Passive House projects is described below:

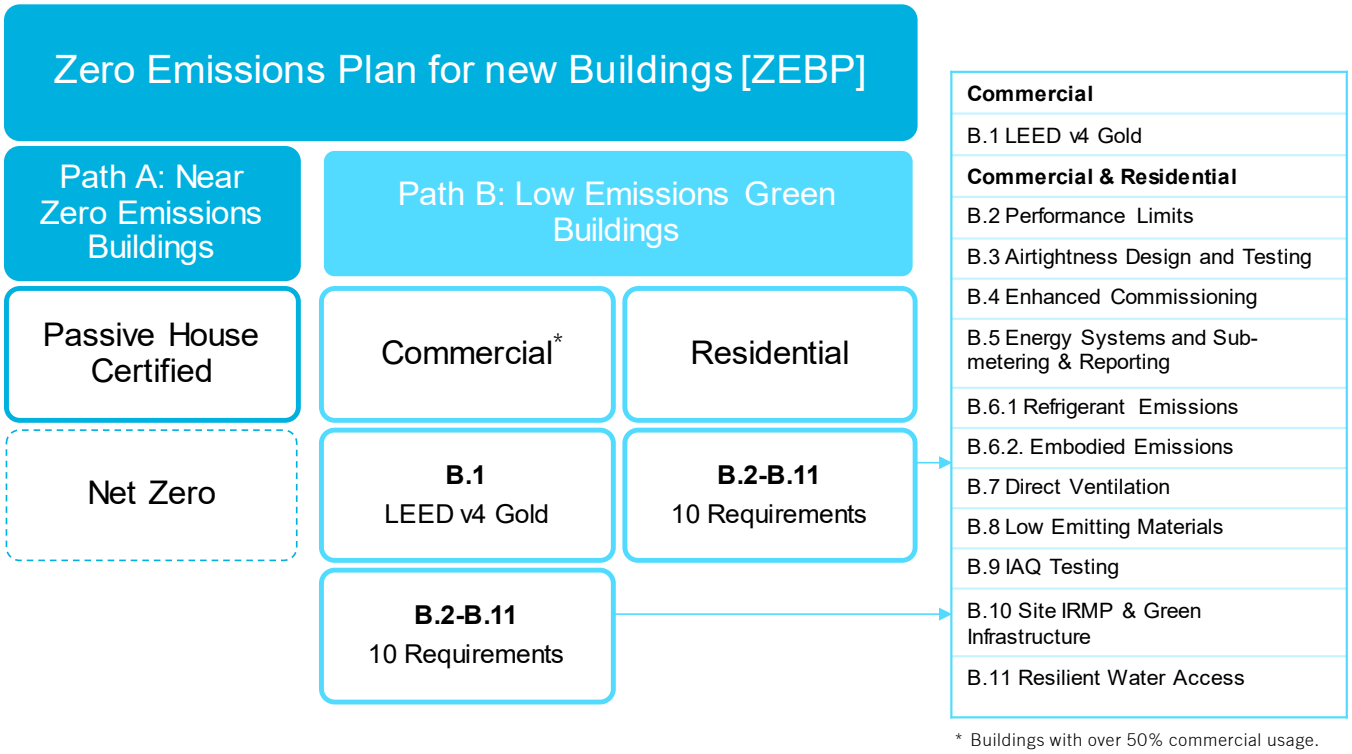
REZONING PERMIT SUBMISSION
As part of the Rezoning Application, a letter must be submitted from a Certified Passive House Designer/Consultant confirming they have been retained as a consultant on the project, summarizing the main Passive House criteria and describing the key design strategies to achieving certification.

DEVELOPMENT PERMIT SUBMISSION
As part of the Development Permit application, an updated letter must be submitted from the Certified Passive House Designer/Consultant confirming that the preliminary building design meets all the design criteria necessary for PH certification, that a recognized Passive House certifier has been identified and retained for the project and highlighting the key design strategies and challenges to achieving certification.

BUILDING PERMIT SUBMISSION
As part of the Building Permit application, a Design Stage Assurance letter must be submitted from a recognized Passive House certifier confirming the building design meets all the design criteria necessary for Passive House certification and detailing the as-designed Passive House criteria including an airtightness plan which outlines the consultant's involvement on site.

OCCUPANCY PERMIT SUBMISSION
As part of the Occupancy Permit application, a letter must be submitted from the Passive House certifier detailing the updated as-built Passive House criteria and confirming the building has submitted for Passive House certification (alternatively indicate that the project has pre-paid for certification and provide a timeline noting when the project will submit for Certification).

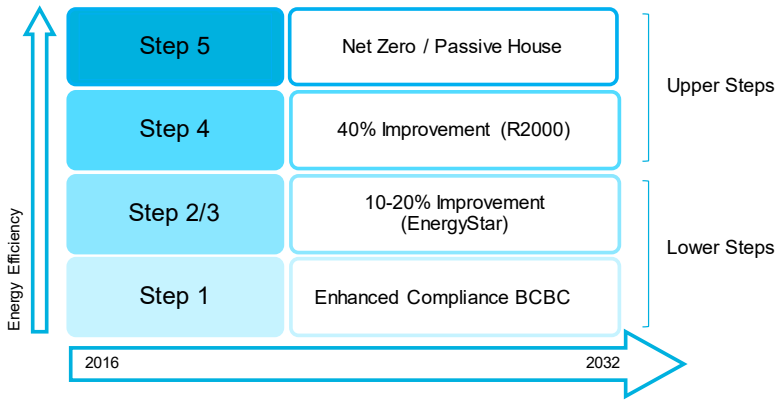
1 http://vancouver.ca/home-property-development/zero-emissions-buildings.aspx



* Buildings with over 50% commercial usage.

THE B.C. ENERGY STEP CODE

The B.C. Energy Step Code[2] is currently voluntary set of incremental performance steps for new buildings in British Columbia. It communicates the future intent of the BC Building Code as the Province transitions to net zero energy ready buildings by 2032. There is a fundamental alignment with the City of Vancouver Zero Emmisions Plan [ZEBP], the B2 Performance limits within the ZEBP equate to Step 3 of the B.C. Step Code. Similar to the Zero Emissions Plan, the Passive House standard is embedded as the highest level of performance. Municipal authorities can choose which level of performance they wish to implement ahead of these policies being mandated by code.



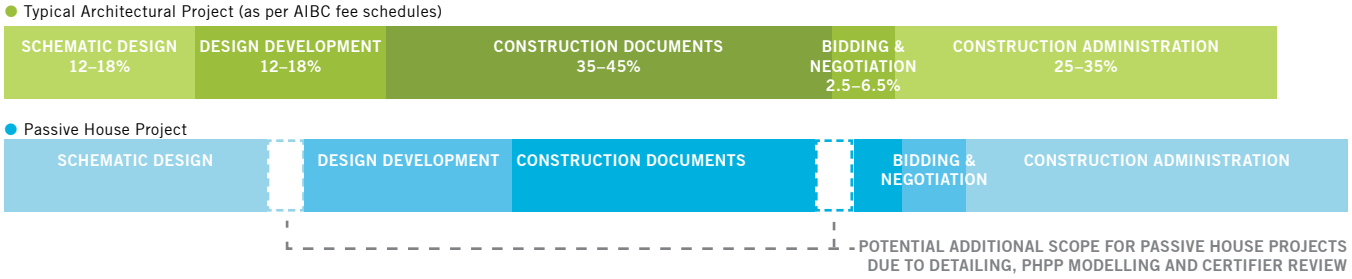
2 http://www2.gov.bc.ca/gov/content/industry/construction-industry/building-codes-standards/energy-efficiency/energy-step-code

HOW MUCH DOES PASSIVE HOUSE COST?

The Pembina Institute has found that there is currently a capital cost increase of approximately 6% to build to the Passive House standard in North America. This is expected to trend towards cost parity as building codes set more stringent performance standards, and knowledge and experience grow within the industry.

When the lifecycle costs over the lifespan of the building (50+ years) are taken into account, the higher initial investment in the building fabric is offset by savings gained via a reduced mechanical system, plus lower operational and maintenance costs. This can result in a positive net present value (i.e. the project becomes profitable for the building owner in the long run). The lower operational costs are in addition to the other benefits that are more difficult to quantify in monetary terms, but enhance desirability from a client and building owner perspective (see section on “WHY” pg. 2).

ALLOCATION OF TIME AND FEES BY PROJECT TYPE



Projects should allow for additional time at early design stages for PHPP modelling as well as airtightness and thermal bridging detailing. Allowance should also be made prior to Tender for a Design Stage Assurance Review by a Passive House Certifier.

PASSIVE HOUSE COSTING STUDIES

Accelerating Market Transformation for High-Performance Building Enclosures
Pembina Institute 2016 - www.pembina.org/pub/passive-house-report

Feasibility of Implementing the Passivhaus Standard for Tall Residential Buildings
FxFowle, NYSERDA et al. - *issuu.com/fxfowle/docs/final_report-170330-final*

City of Vancouver Passive House Costing Study; City of Vancouver/RDH/Red Door Energy Design - vancouver.ca/files/cov/Dec_1_City_of_Vancouver_Passive_House_Study_V2.pdf

The Business Case for Passive House - Synergy Sustainability Institute
www.passivehousecanada.com/downloads/Business_Case_for_Passive_House.pdf

FURTHER READING

B.C. Energy Step Code - 2017 Metrics Research
http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/reports/bc_energy_step_code_metrics_research_report_full.pdf

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OUR TEAM

The Perkins+Will Vancouver office has worked closely with Passive House Canada to offer an in-house Passive House training program tailored to the types of large educational, healthcare, office, residential, and cultural buildings that we design.

We include staff at intermediate, senior and leadership levels and invite consultants, contractors and clients to participate in the seven day course. This fosters a dynamic learning environment due to the wide range of backgrounds and experiences. The Perkins+Will office in Vancouver now has a total of 16 Passive House Certified staff—the largest number of any design firm in North America!

PASSIVE HOUSE CERTIFICATION

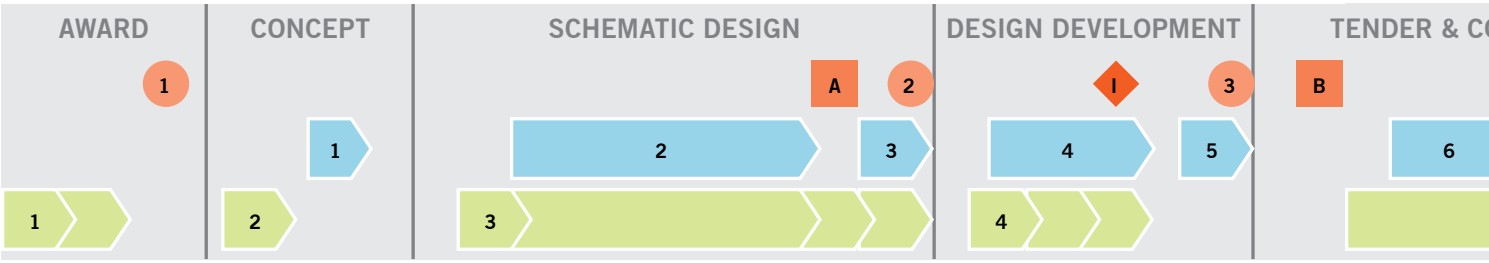
Passive House Certification is administered by the Passive House Institute (PHI) and requires a third party licensed certifier to verify the project has been designed and built in accordance to the Passive House requirements.

Typical submittals include drawings, specifications, energy models, site photographs, commissioning data and airtightness test results.

We recommend that a certifier is engaged early in the design process to ensure the performance and specification criteria are well integrated into the building design.

PASSIVE HOUSE PROCESS

The graph indicates the processes involved at each stage of the project schedule. Allowances should be made in certain areas—in particular airtightness and thermal bridging—that require both additional and earlier attention than would be the case in a normal project. There are areas of additional scope under the remit of the Certified Passive House Designer [CPHD] that are also identified.



MILESTONES

Project Milestones

1. PROJECT AWARD
2. SCHEMATIC DESIGN ISSUE
3. DESIGN DEVELOPMENT ISSUE
4. ISSUE FOR TENDER
5. ISSUE FOR CONSTRUCTION
6. OCCUPANCY

City of Vancouver Permitting

A. REZONING APPLICATION
B. DEVELOPMENT PERMIT
C. BUILDING PERMIT
D. OCCUPANCY PERMIT

Passive House Certification

I. APPOINT CERTIFIER
II. DESIGN STAGE ASSURANCE REVIEW [DSAR]
III. AIRTIGHTNESS TEST
IV. VENTILATION COMMISSIONING
V. PASSIVE HOUSE CERTIFICATION

AWARD

1 Architect Tasks

- Establish effect of Passive House on Staffing/Timeline /Fee
- Assess project potential for Passive House (Site / Typology)
- Client Education on Passive House Benefits

CONCEPT DESIGN

2 Architect Tasks

- Establish Passive House as project goal.
- Identify key primary consultants, including CPHD
- Discuss with Municipal Authority about alignment with City goals.

1 *CPHD Tasks*

- Analyze Project potential for Passive House - Site / Solar Potential / Form Factor Potential

SCHEMATIC DESIGN

3 Design Team Tasks

- Establish Massing
- Establish Basis of Design (assemblies, glazing ratios, occupancy usage, ventilation strategy, shading strategies)
- Identify key details impacting airtightness and thermal bridging
- Draft Outline Spec identifying components critical to Passive House

2 CPHD Tasks:

- Thermal Bridge Calculation
- Schematic PHPP Modeling

3 SD CPHD Deliverable

- Design PH model (if applicable)
- Develop PHPP model to assess Heat Load (10W/m^2) and Specific Heat Demand (15kWh/m^{2}yr)

A Rezoning Application requires letter from CPHD outlining key strategies to achieve Passive House certification.

DESIGN DEVELOPMENT

4 Design Team Tasks

- Detail key junctions for Thermal Bridging and Airtightness. Therm modelling as required
- Optimized Mechanical design: establish occupancy rates, reconcile ASHRAE/code requirements and Passive House recommendations
- Develop 3-part Specification

4 *CPHD Tasks*

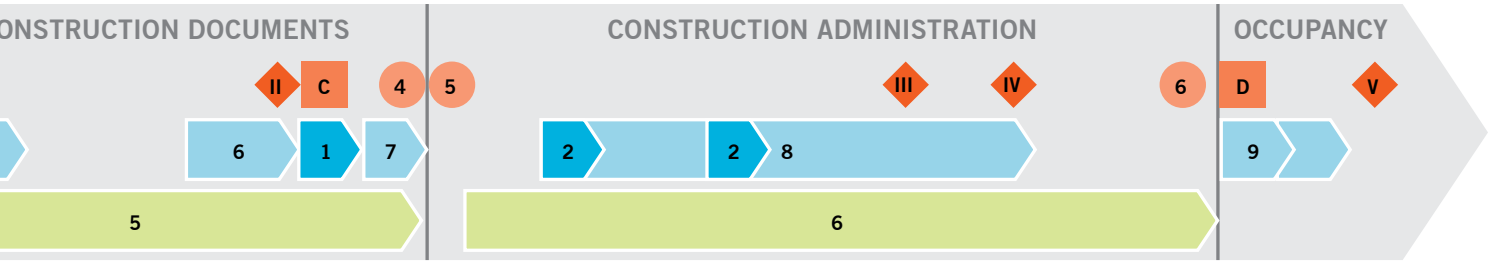
- Engage PHI Certifier
- Review Airtightness detailing
- Review Thermal bridge detailing + modeling
- Calculate Primary Energy
- Update PHPP model
- Determine Passive House certification Class

5 DD CPHD Deliverable

- Develop PHPP model

LEGEND

- Passive House Scope
- Construction Manager Scope
- Design Scope



PASSIVE HOUSE PLANNING PACKAGE [PHPP]

The Passive House Planning Package (PHPP) is the energy model used for design and certification of Passive House Projects. It is updated throughout the design process to validate any changes to design and ensure the Passive House metrics are being adhered to. Any changes to building geometry, window size and position, shading, and M&E design must be reevaluated.

PASSIVE HOUSE [CPHD] SCOPE

The City of Vancouver requires a Certified Passive House Designer/Consultant (CPHD/C) to be appointed for Passive House projects. This scope may be taken on internally by Perkins+Will or externally by an experienced Passive House Designer

TENDER & CONSTRUCTION DOCUMENTS

5 Design Team Tasks

- Prepare drawings and specifications incorporating all elements critical to Passive House

6 CPHD Tasks

- Review Consultants Tender Packages
- Review uncertified components (glazing/HRV)
- Prepare DSAR package for Certifier
- Revise + update PHPP model

1 Construction Manager Tasks

- Review Constructability

7 DD CPHD Deliverable

- Prepare DSAR Documentation
- Complete PHPP validating all Passive House metrics

II C Submit DSAR letter from Certifier as part of BP Application.

CONSTRUCTION STAGE

6 Design Team Tasks

- Undertake Contract Administration
- Coordinate with CPHD

8 CPHD Tasks

- Monitor on-site practices to ensure compliance with Passive House requirements
- Update PHPP as required
- Collate project information for certification submission

2 Contractor Tasks

- Airtightness Workshop/Toolbox talks and appoint Airtightness champion. Undertake Certified Passive House Tradesperson training. Institute airtightness inspection regime.
- Pre-certification Airtightness testing

III Perform Airtightness test at positive and negative pressures as per PHI protocols

OCCUPANCY

9 CPHD Tasks

- Update PHPP as required
- Prepare Post Construction Assessment (PCA) package for Certifier review including airtightness test and ventilation commissioning results
- Prepare User Guide as per PHI requirements

D Submit Letter from Certifier confirming certification requirements are met as part of Occupancy Permit application

PASSIVE HOUSE CERTIFICATION

V Certification submission requirements as per PHI requirements and with submittal process agreed with Certifier.

www.passiv.de/downloads/03_building_criteria_en.pdf

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This brochure reflects understanding of
relevant policies as of February 2018

Comments/Enquires
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