Whitelist for Low-carbon Buildings technologies

This *Whitelist* for green building technologies refers to a curated list of approved and/or recommended technologies that are considered suitably; energy efficient, low-carbon, and/or sustainable, technology options for use in building construction, renovation, and operation. These technologies are selected based on their environmental performance, energy efficiency, and other relevant criteria aligned with the current version of the Climate Bonds buildings criteria intended to achieve a decarbonised building stock.

Listed below are the approved technological interventions that are included as green technologies and in line with the Climate Bonds Buildings criteria and certification programme (this list will be updated periodically as new technologies are assed and approved):

Whitelist of approved technologies

NOTE: This whitelist can be used to support certification of Use-of-Proceeds Instruments and Assets, and also in some circumstances, Sustainability-Linked Debt Instruments and Entities per the Climate Bonds Standard v4.0

Revision	Date	Summary of Changes
Rev. 1.0	07 December 2023	Published for issue

1 Energy-Efficient HVAC Systems:

- Variable Refrigerant Flow (VRF) systems.
- High-efficiency heat pumps and air conditioners.
- Advanced control systems for optimizing heating, cooling, and ventilation.

2 LED Lighting:

- Energy-efficient LED lighting with advanced controls for occupancy and daylight sensing.
- Smart lighting systems that can be integrated with building automation.

3 Renewable Energy Systems:

- Solar photovoltaic (PV) panels for on-site electricity generation.
- Wind turbines for localized power generation in suitable areas.
- Geothermal heat pumps for efficient heating and cooling.

4 Building Envelope Technologies:

- High-performance insulation materials.
- Energy-efficient windows with low-E coatings.
- Cool roofing materials to reduce heat absorption.

5 Low-Emissivity coatings

Low-E (low-emissivity) coatings are microscopically thin, virtually invisible metallic layers applied to the surface of windows and other glazing materials, such as glass. These coatings are designed to improve the energy efficiency of buildings by reducing the transfer of heat and solar radiation through the glass while still allowing visible light to pass through. Low-E coatings are commonly used in energy-efficient windows and are an integral part of modern glazing technology.

The key functions of low-E coatings are as follows:

- **Solar Heat Control:** Low-E coatings can selectively reflect and absorb solar heat, reducing the amount of heat that enters a building during hot, sunny days. This helps in preventing overheating and the need for excessive air conditioning.
- **Winter Heat Retention:** In colder seasons, low-E coatings help to reflect the heat generated inside the building back into the interior, reducing heat loss through the windows and making the space more energy-efficient.
- **Visible Light Transmission:** Low-E coatings are designed to maintain a high level of visible light transmission, ensuring that natural daylight can enter the building, which is essential for aesthetics, comfort, and reducing the need for artificial lighting.
- **UV Radiation Blocking:** Low-E coatings can block a significant portion of ultraviolet (UV) radiation, which can cause fading and damage to furnishings, artwork, and interior materials.

Low-E coatings are available in different variations, including "soft" and "hard" coatings, and can be applied to different types of glazing, such as single-pane, double-pane, and triple-pane windows. They are often combined with other energy-efficient features, such as gas fills (e.g., argon or krypton) in the window's insulating space between the panes, to further enhance thermal performance.

6 Double and Triple Glazed windows:

The efficiency of double- and triple-glazed windows is most impactful in regions with colder winters (temperate climates). The construction and installation of double- or triple-glazed windows should include considerations such as climate, energy efficiency goals:

- Double-glazed windows consist of two glass panes separated by a layer of inert gas like argon or krypton. This design reduces heat transfer through the window compared to single-pane windows, offering better insulation for your home.

  Selection between double- or triple-glazing must consider factors such as local climate range, budget and energy efficiency performance goals.

- Minimum u-values (efficiency rating) of products should meet those stated in the ASHRAE standard, or any suitable in-country (published) regulation.

- Triple glazing windows (like double glazed windows, offer additional benefits due to an extra layer of glass and an additional airspace) are particularly effective in cold climates with harsh winters. They provide superior insulation and reduce heat loss, helping to keep indoor spaces warmer and more comfortable.

- In extremely cold climates, where heating costs are a significant concern, triple glazing provides improved thermal performance helps lower heating expenses.

7 Advanced Building Automation and Controls:

- Building Energy Management Systems (BEMS) for real-time monitoring and control.
- Smart thermostats and sensors for energy optimization.
- Predictive maintenance systems for reducing energy waste.

8 Water Efficiency Technologies:

- Low-flow faucets and fixtures.
- Water-efficient irrigation systems.
- Greywater recycling systems.

9 Sustainable Materials:

- Use of sustainable and recycled construction materials.
- Low-VOC (volatile organic compounds) paints and finishes.
- Environmentally friendly insulation materials.

10 Energy Storage Solutions:

- Battery energy storage systems for storing excess energy generated from renewables.
- Thermal energy storage for heating and cooling applications.

11 Indoor Air Quality Technologies:

- Advanced air filtration systems.
- Demand-controlled ventilation for improved air quality.
- Monitoring systems for detecting indoor air pollutants.

12 Smart Building Technologies:

- Internet of Things (IoT) devices for data collection and analysis.
- Integration of Artificial Intelligence (AI) for optimizing building operations.
- Occupancy and space utilization tracking for efficient use of resources.