BONNEVILLE POWER ADMINISTRATION

Emerging Technologies

Innova View 2.0 Feasibility Study

June 2020

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Prepared for:

Bonneville Power Administration

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The following report was funded by the Bonneville Power Administration, or BPA, to assess emerging technology topics that have the potential to increase energy efficiency. BPA is committed to identify, assess and develop emerging technologies with significant potential for contributing to efficient use of electric-power resources in the Northwest.

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Abstract

This Feasibility Analysis evaluates product performance in four categories: Codes and Certifications, System Components, Cost and Constructability, and Maintenance. The Innova product appears promising but the current model has significant challenges with respect to Code and Certifications. The Innova product design must be modified before it can meet the compliance requirements of the U.S. market. The manufacturer plans to have a U.S.-compliant product available in 2020. With these design adjustments, the Innova View 2.0 has significant potential to transform the Northwest multifamily space-conditioning market.

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Executive Summary

Innova is a promising product that has potential to provide cost effective energy savings in the Northwest multifamily building-construction market

Heating and cooling multifamily buildings represents a substantial BPA energy load. Innova's View 2.0 is an inverter-driven HVAC monoblock emerging technology that potentially offers a cost effective and energy-efficient option to displace electric-resistance heating with heat pump technology. Additionally, monoblocks can provide efficient cooling and mitigate the growing Northwest cooling load. This technology may provide an affordable solution in Northwest multifamily buildings.

This feasibility study is the first step in the BPA Technology Innovation Model, or TIM. This study assessed factors such as certifications, performance, cost, constructability and maintenance.

Certifications: The Innova lacks current UL-listing requirements and has not been tested for energy-code compliance. The manufacturer is aware and plans to redesign its product to comply with the requirements of the U.S. market in 2020.

Performance: The Innova equipment performance is promising sustaining usable heat pump operation at 20 F outside air temperature. Innova plans to make available a 115V, 60HZ and 208V/240V, 60HZ in the U.S.

Cost: The Innova has value to contractors because it can be installed for less than a ductless heat pump, or DHP. Cost for installation is estimated between $3,500 and $4,500, about $1,500 to $2,500 less than a DHP, which typically costs $5,000 to $7,000. The Innova will likely cost $500 to $1,000 more than invertor driven Package Terminal Air Conditioners, or PTAC.

Constructability: The product is easy to install, has minimal structural requirements and does not require separate refrigerant lines. The biggest challenge is managing the liquid condensate, and solutions may vary depending on architectural design and local codes.

Maintenance: Outside the U.S., Innova is a commercially available product. Currently, the product takes 4-6 weeks to manufacture and another 4-6 weeks to ship. The lead time needs to be reduced for mass-market U.S. adoption and sales. Currently, there are no U.S. warranty service centers. However, Innova plans to open a service center in the U.S. within the next year.

Readiness: The technology readiness for market adoption is shown in the table below. While it is still in the planning for entry into the Northwest, the Innova product has potential to play a prominent role in multifamily heating and cooling.

Market/Commercial Readiness—Level 2. Commercially available outside of the Northwest. Requires special order in the Northwest.

Product Readiness —Level 2. Concept validated.

Program Readiness—Level 2. Not cost effective, but preliminary analysis shows a pathway to cost-effectiveness. Limited program design and risk assessment.

Overall, the Innova is a promising product that has potential to provide cost-effective energy savings in the Northwest multifamily building construction market. This product passes the Feasibility Analysis stage-gate with the condition that the product is redesigned, and meets U.S. energy codes and UL standards. Application Testing will further assess the Innova and result in a product performance map. At this time, it is anticipated that testing will occur in 2020.

Background

This research serves as a Feasibility Analysis of the Innova View 2.0, an emerging DHP technology that can be deployed in multifamily, residential and light-commercial buildings. The Feasibility Analysis is the first step after ideation in the TIM. The TIM is designed to take a technology through a series of stage-gates representing different areas of inquiry to ensure that the product can be safely and cost effectively applied in a manner that insures performance and savings in the marketplace.

Key stage-gates for the TIM include:

1. Ideation.
2. Feasibility Analysis.
3. Applications Testing.
4. Field Demonstration.
5. Measurement and Verification, or M&V.
6. System Metrics.

The Innova View 2.0, is a double-ducted inverter-driven packaged terminal heat pump referred to as a monoblock. This new technology has the potential to effectively and efficiently heat and cool living spaces, and operate in low ambient temperatures.

Purpose

The purpose of this Feasibility Analysis is to determine the suitability of the Innova product for multifamily buildings in the Northwest climate. To determine feasibility, the Innova has been assessed for 1) codes and certification; 2) system components; 3) cost and constructability; and 4) maintenance. Each of the four assessments is a different section in this report, which will inform the appropriateness of moving this product forward to the next stage-gate of Application Testing.

Although this study focuses on the Innova View 2.0, there is at least one other monoblock on the market. Many of the aspects of this feasibility study could be used to assess these other monoblock products.

Context

Market landscape

Urban centers in the Northwest are currently experiencing significant population growth from migration of residents that expect cooling to be provided in apartments. At the same time, apartments have been getting smaller and glazing-to-floor-area ratios have been getting bigger resulting in increased heating and cooling needs. Record-breaking temperatures nearly every year and decreasing air quality from wildfires has led to an increased market demand for cooling in apartments. Multifamily developers and property managers seek to offer cost-effective heating and cooling. At the high end of the market, developers are offering DHP or Variable Refrigerant Flow, or VRF, heat pumps. Due to the cost, they are typically only offered in more expensive buildings. In mid-market buildings, developers are offering inefficient PTACs or portable air conditioners for lease to their tenants. The Northwest Power and Conservation Council’s latest forecast projects over 4% annual growth in air-conditioning saturation in multifamily buildings. Regardless of what is done to improve energy efficiency, the prevalence of cooling equipment will increase.

As an alternative to the low cost, inefficient and inconvenient, portable air-conditioners and the expense of DHPs or VRF, some developers are opting for packaged terminal heat pumps, or PTHPs. The traditional PTHPs on the market are mostly of low quality and switch to electric resistance heat when outside temperatures drop below the mid-40s F. These units are installed by cutting a large opening through the insulated shell of the building. This installation increases infiltration and typically introduces high amounts of uncontrolled ventilation air. As a result, currently available PTHPs are not much better — and potentially worse — than electric resistance heaters in heating mode.

This feasibility analysis focuses on a recent variation of the classic PTHP, the monoblock. These products are mounted on the interior side of an insulated exterior wall with two duct penetrations through the outside wall to bring air to the condenser/evaporator. Because of the double ducting, the product was also known as the double-ducted packaged terminal heat pump. This design, along with higher quality components, offers unique advantages that put monoblock in a position to transform the Northwest multifamily market.

Current Installations

Innova has no current installations in the U.S. However, there are many Innova installations throughout Europe. Innova's website includes a list of case studies, mostly in multifamily buildings and hotels including:

- Figure 1. Nottingham Belfry Hotel, England, ~3 years installed.
- Figure 2. Isola di Hvar Apartments, Croatia, Renovation.
- Figure 3. Hotel Rio, Switzerland, ~5 years installed.
- Figure 4. Cento Las Rasta, Office Building, Chile, ~2 years installed.

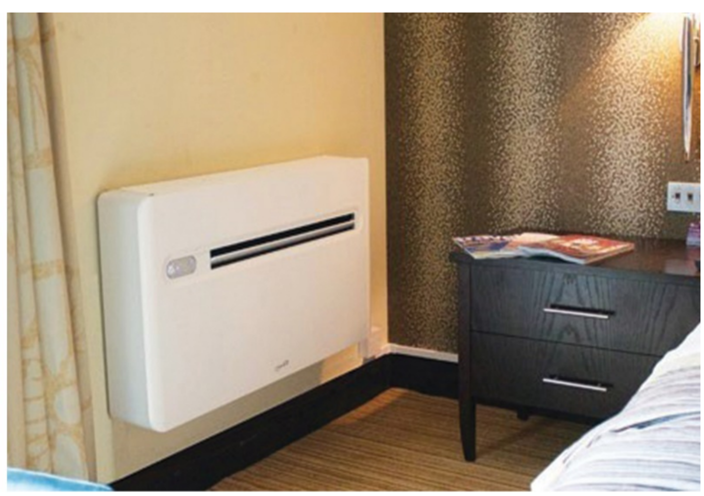


Figure 1. Nottingham Belfry Hotel, England.

Figure 2. Isola di Hvar Apartments, Croatia.

Figure 3. Hotel Rio, Switzerland.

Figure 4. Cento Las Rasta, Office Building, Chile.

Codes and Certifications

Energy, mechanical and plumbing codes address the installation, operations, and performance of air-conditioning systems. Innova must comply with the following codes to be a viable product in the Northwest:[1].

Codes

ENERGY CODE

- International Energy Conservation Code, or IECC. Includes Idaho and Montana.
- Washington State Energy Code, or WSEC.
- Oregon Energy Efficiency Specialty Code, or OEESC.

MECHANICAL CODE

- International Mechanical Code, or IMC.

PLUMBING CODE

- Uniform Plumbing Code, or UPC.
- International Plumbing Code, IPC.

ELECTRICAL CODE

- National Electrical Code, or NEC.

CODE SUMMARY

The Energy Code addresses operational efficiencies and controls, the Mechanical Code addresses allowable refrigerant charge, the Plumbing Code addresses condensate management, and the Electrical Code addresses design of electrical connections.

The Energy Code poses some compliance issues. The product does appear to be able to conform with Mechanical, Electrical, and Plumbing Codes. However, Electrical and Plumbing Codes do present some challenges when designing infrastructure to support the unit. Those challenges are discussed in section 3.2 on Engineering Performance.

Regional Energy Codes are based on the IECC and efficiency requirements are the same across different jurisdictions. The Energy Codes rely on the American Heating and Refrigeration Institute, or AHRI, to classify systems and provide testing procedures for efficiency. Although many people may think of the Innova monoblock as a PTAC or a PTHP, it is considered a unitary system, per AHRI. Unitary systems, with less than 65,000 btu/hr capacity, are required to be tested, per AHRI 210/240, and perform at 14.0 SEER for Energy Code compliance.

The Innova product has not been tested for efficiency, per AHRI 210/240, but the manufacturer intends to complete the test and show compliance with the Energy Code in 2020.

Certifications

The Innova View 2.0 sold in Europe is currently TUV/GS certified. TUV/GS certification is the European equivalent of UL certification in the U.S. It is a German certification system that translates to "Technical Inspection Association/Certified for Safety."

Innova is currently working on altering the View 2.0 to meet UL-listed requirements and expects to have the new product ready for distribution in 2020. To comply with UL requirements, Innova is swapping internal components for UL-listed components.

System Components

The System Components section identifies the equipment needed for a complete product deployment. In the case of the Innova, the product is unitary, and therefore no other components are needed.

Performance Assessment

Performance Assessment confirms the equipment will have adequate performance to gain acceptance of designers and users. It is broken down into four sections, Architectural, Engineering, Owner and User. Each section analyzes performance from a different perspective.

Before discussing equipment performance, it is important to note that Innova plans to release a new design for the U.S. market. This design will have an increased compressor size and larger through wall penetrations (6 inches to 8 inches diameter).

Figure 6. Side-mount Kit.

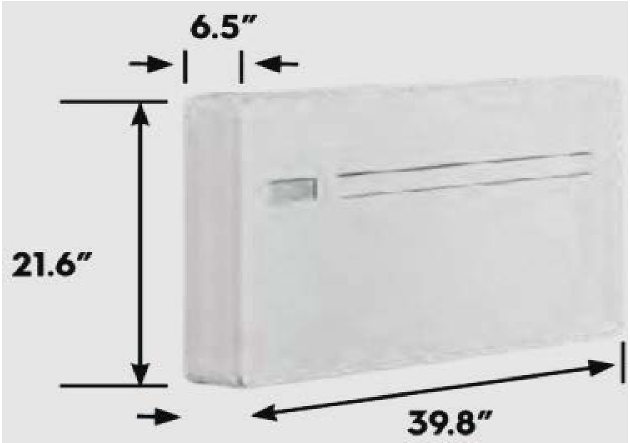


Figure 5. Horizontal Dimensions.

Architecture

The Innova is designed to be sleek, compact, and aesthetically pleasing, making it attractive to architects. To confirm architectural performance, the Innova is assessed from an interior and exterior perspective.

The interior design requirements for the Innova include unit dimensions, required clearances, available orientations, acceptable mounting locations and colors. The dimensions of the horizontal orientations, shown in Figure 5, are sleek and would fit without being obtrusive in any apartment. A clearance of less than 4 inches is required on all sides. The horizontal unit can be mounted in a low or high position. The high position can be installed not more than 98 inches off the ground, acceptable for cooling applications only, and must have an 8-inch clearance from the ceiling.

The largest hurdle in incorporating the Innova into an interior design is the requirement for it to be installed on the inside of an exterior wall. This adds complications when installed in apartments that have floor-to-ceiling windows. However, for most multifamily buildings, it should be easily integrated into the architectural design and can be painted or installed in a cabinet, allowing it to blend into different environments. It is typically installed parallel to the exterior wall, although in special cases it can be installed perpendicular using the side-mount kit, shown in Figure 6. The glass-mount kit enables it to be installed in curtain-wall applications. The glass-mount kit includes feet, a base and a white cover for the back of the unit.

9 inches. The duct endcaps can be color coordinated to match the exterior building as shown in Figure 7. The grilles can be combined into one large rectangular grille of 18 inches wide by 6 inches high. Compared to a typical PTAC, the Innova is superior in exterior and interior aesthetic. Exterior penetrations are always challenging for architects. This can be especially true in jurisdictions with intensive design-review processes. In contrast, the Innova has minimal exterior impacts and easily integrates into building architecture.

Figure 7. Exterior View Comparison of Innova vs. AC Unit.

The Innova must be installed on the inside of an exterior wall because the two small ducts must penetrate the wall and allow the unit to use outdoor air. The duct openings are 6 inches to 8 inches in diameter and must be straight, unless used with a special kit with auxiliary fans. The duct length cannot exceed

Engineering

Engineering performance can be broken into structural, mechanical, electrical and plumbing performance. Due to heating and condensate removal requirements, mechanical and plumbing present the most challenging designs.

Structural

The Innova weighs roughly 100 pounds, mounts via a bracket that comes with the unit and must be mounted to a stud. From a structural perspective, the Innova has minimal requirements and should be no problem for structural engineers to incorporate.

Mechanical

The main function of the unit is to mechanically heat and cool. Mechanical engineers are interested in the peak loads and reliability of heating and cooling equipment. Key performance indicators for mechanical engineers are efficiency and capacity at different temperatures, control sequences, controls integration with other equipment and defrost capability.

Monblocks operate through a vapor compressor cycle using a refrigerant such as R410A. So, unlike an electric resistance heater, monblocks do not produce heat — they move heat. Heat can be moved at a much higher efficiency than it can be produced, which makes monoblocks promising as an energy-efficiency technology. Additionally, the Innova features an inverter-driven compressor. An inverter takes AC current, converts it to DC, and drives a variable speed DC motor to power the compressor. This allows the compressor to operate efficiently at part-load conditions and avoid inefficient cycling.

During heating operation, monoblocks take heat from outdoor air and move it into indoor air, even when it is colder outside than inside. However, as the temperature drops outside it becomes more difficult for the monoblock to extract heat from the outdoor air, so the capacity and efficiency decrease. This poses an issue for mechanical engineers designing equipment for cold climates because they will have to account for a decrease in performance at lower design temperatures. As required heating goes up, because of lower outdoor air temperature, the amount of heat a unit can deliver decreases. The issue is not unique to the Innova product, and will be the same for all monoblocks as well as other heat pump systems such as split systems and VRF.

At 20 F, Innova can produce about 3.4 kBtu from the compressor and 3.4 kBtu from an electric resistance heater. Below 17 F, the compressor still operates, but at a significantly reduced capacity. The electric resistance heater will still run. Depending on the size, orientation and envelope construction, a typical apartment in the Northwest has a heating load between 5 and 20 kBtu. This means in some cases, a single unit will not cover the entire heating load if design conditions are below 17 F. Either multiple units or supplemental electric resistance heating may be required. However, most days will be warmer than design conditions, only requiring the compressor to operate and heat the room efficiently.

Designs combining electric resistance heaters with the Innova present a new challenge. Ideally, only the compressor will operate until it has reached its heating capacity and can no longer meet the setpoint, then the electric resistance heating element should engage. In milder climates, like the Seattle area, the electric resistance heater should rarely, if ever, engage. The Innova controls can integrate with an auxiliary electric heater, which would come separate from the Innova. If the Innova's heat pump and resistance heat fail to reach the desired temperature within 20 minutes then it can activate the auxiliary system until the temperature is reached. The unit comes with a thermostat that measures room air temperature and determines whether heating or cooling is required. Integrated controls are critical for the unit to maximize energy efficiency and Application Testing will provide more details on Innova's internal sequence of operations.

During Application Testing, the defrost cycle will also be evaluated. In defrost mode, the unit turns off its supply air fan, reverses the refrigeration cycle and turns on the electric heating element. This causes the heat pump to temporarily move heat from the room coil, to the outdoor coil and melt any ice that has formed on the outdoor coil. In colder climates, models with electric resistance heaters should always be specified. The electric resistance heater will turn on during the defrost mode to keep the room's temperature from dropping too much. Controls and timing of defrost cycles are critical for proper functioning in cold climates. These controls will be monitored as part of the bench test.

Future bench testing and lab testing are critical with monoblocks to understand operations while heating in cold climates. Detailed performance maps indicating capacity decreases with temperature decreases will help designers understand how to maximize energy savings, optimize costs and meet loads.

In addition to heating and cooling, the Innova can be provided with a fresh air kit. The fresh air kit adds a third penetration through the exterior wall for ventilation. The third penetration is a 4-inch duct with energy-recovery ventilation of air exhausted through the same hole. It can provide up to 15 cubic feet per minute, or CFM, of outdoor air. This is not typically enough to satisfy ventilation requirements of the International Mechanical Code for apartment buildings. As ventilation design is moving towards balanced flow ventilation, we do not anticipate this feature having a significant impact in the Northwest market.

Electrical

The Innova requires a 120V/60HZ/1PH connection, and can be powered via a standard wall receptacle with a cord-and-plug assembly, or wired directly to a branch circuit via local disconnecting means. A cord-and-plug assembly is preferable for simple retrofits, but new construction installations will likely be hard-wired direct connections.

The manufacturer nameplate states a minimum circuit ampacity, or MCA, requirement of 10 amps for the heat pump and 18 amps for the heat pump with electric heat option with a maximum overcurrent protection, or MOP, rating requirement of 10/20 amps. Electrical engineers use MCA and MOP to design and assign loads to branch circuits. For instance, if only 15- and 20-amp branch circuits are available to power this unit — which would be typical in a residential building — the Innova will have to be installed on its own dedicated branch circuit to comply with the NEC Article 440.62. If a 30-amp branch circuit is available, this circuit could also serve other loads and would not need to be dedicated only for the Innova.

In most designs a local disconnect is required to easily shut off the unit when performing maintenance. If a local disconnect is required, then it must be installed within sight — and readily accessible — from the unit (See NEC 440). This could be a simple light-switch type of manual switch located on the wall adjacent to the monoblock.

Overcurrent, short circuit, and/or ground fault protection are not built into the unit, and would typically be provided in the local disconnect, or as part of the panel serving the device. Best practice is to install overcurrent, short circuit and/or ground-fault protection in the local disconnect within the line of sight. Manufacturer installation instructions recommend using a 10-amp time-delay fuse or other equivalent device, which aligns with NEC Article 250 requirements. The time-delay fuse allows a large power draw for a short period of time to start the compressor, but does not allow sustained power spikes that could harm the equipment.

The installation manual states that if the Innova is wired directly, the metal enclosure shall be connected to the equipment-grounding conductor in accordance with NEC Article 440.61.

When the Innova is redesigned for sales in the U.S., the plug connector must be designed with an integral leakage-current detector-interrupter, or LCDI, to align with NEC Article 440.65 requirements. It does not currently have this device.

Finally, note that this unit differs from typical electric resistance heaters in multifamily buildings in its lower voltage rating. Most electric resistance heaters in multifamily buildings are designed for either 208 V (three phase, three pole) or 240 V (single phase, double pole) whereas the View 2.0 is 120 V (single phase, single pole). As a single-phase device, extra care must be taken by the engineer to ensure all phases are balanced when assigning loads on the panel schedule. If the electrical contractor does not balance the load, it could result in unbalanced power and a poor power factor for the building. After this concern was brought to the manufacturer, they agreed to develop a higher voltage product as an option for release in the U.S.

Plumbing

The plumbing designer is responsible for condensate disposal. Condensate forms during heating mode when the coil is defrosted or absorbing latent heat from the surroundings. Water formed during heating mode becomes condensate that must be drained. During cooling mode, the condensate is re-evaporated into the room.

It has been recommended to the contractor that condensate from defrost be re-evaporated into the room just like cooling condensate. However, this requires moving the condensate from the unit's outdoor air section into the indoor air section and could present some design challenges. Ultimately, it was determined that due to the amount of condensate formed under certain heating-mode conditions and the design challenges

Figure 8. Option 1. Innova Nebulizer.

of moving the condensate into the indoor section of the device, it would not be feasible to re-evaporate condensate in heating mode and it must be drained. If the condensate is not drained from the outdoor air section of the unit, it could freeze, expand and damage the device.

The Innova comes with a condensate drain pan and connection but no condensate pump. The condensate connection is at the bottom of the unit but can be routed easily into an exterior wall. The condensate must drain by gravity or be pumped to the nearest appropriate drain location. Condensate pumps can be noisy and add cost, so adding a condensate pump is not an ideal solution. However, code restrictions may present challenges to routing condensate by gravity.

In multifamily buildings, condensate is typically is required to be routed to the sewage system. An indirect drain is required for condensate entering a sewage system. Plumbing code does not allow condensate from one unit to be connected to the sewage line in another unit, so condensate cannot be routed to drain at a sink or other fixture in the unit below.

This leaves at least four options available for plumbing designers. They can:

1. Use Innova's nebulizer, which aspirates the condensate through an additional 3-inch hole.
2. Add condensate pumps and pump condensate from the unit to drain into a sewage connection in the unit they serve, such as the washer box or bathroom sink tailpiece.
3. Add a condensate riser in the exterior wall with an indirect drain to sewage at the bottom of the riser.
4. Add a drain directly below the unit.

Option 1 adds an aspirator, which Innova calls a nebulizer, below the monoblock (See Figure 8). This adds cost and creates additional noise. The nebulizer sits below the unit and can be covered with a decorative base. It requires an additional electrical connection, is another part to install and requires an additional 3-inch hole on the exterior of the building.

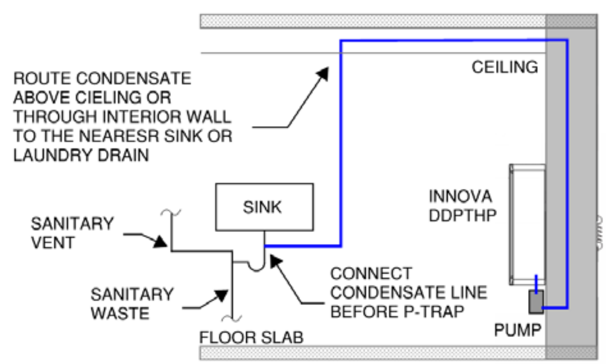


Figure 9. Option 2. Condensate Pump System Diagram

Option 2, Figure 9, adds a condensate pump that increases cost and noise. Additionally, a separate condensate pump requires another electrical connection and is another piece of equipment to install. The condensate pump

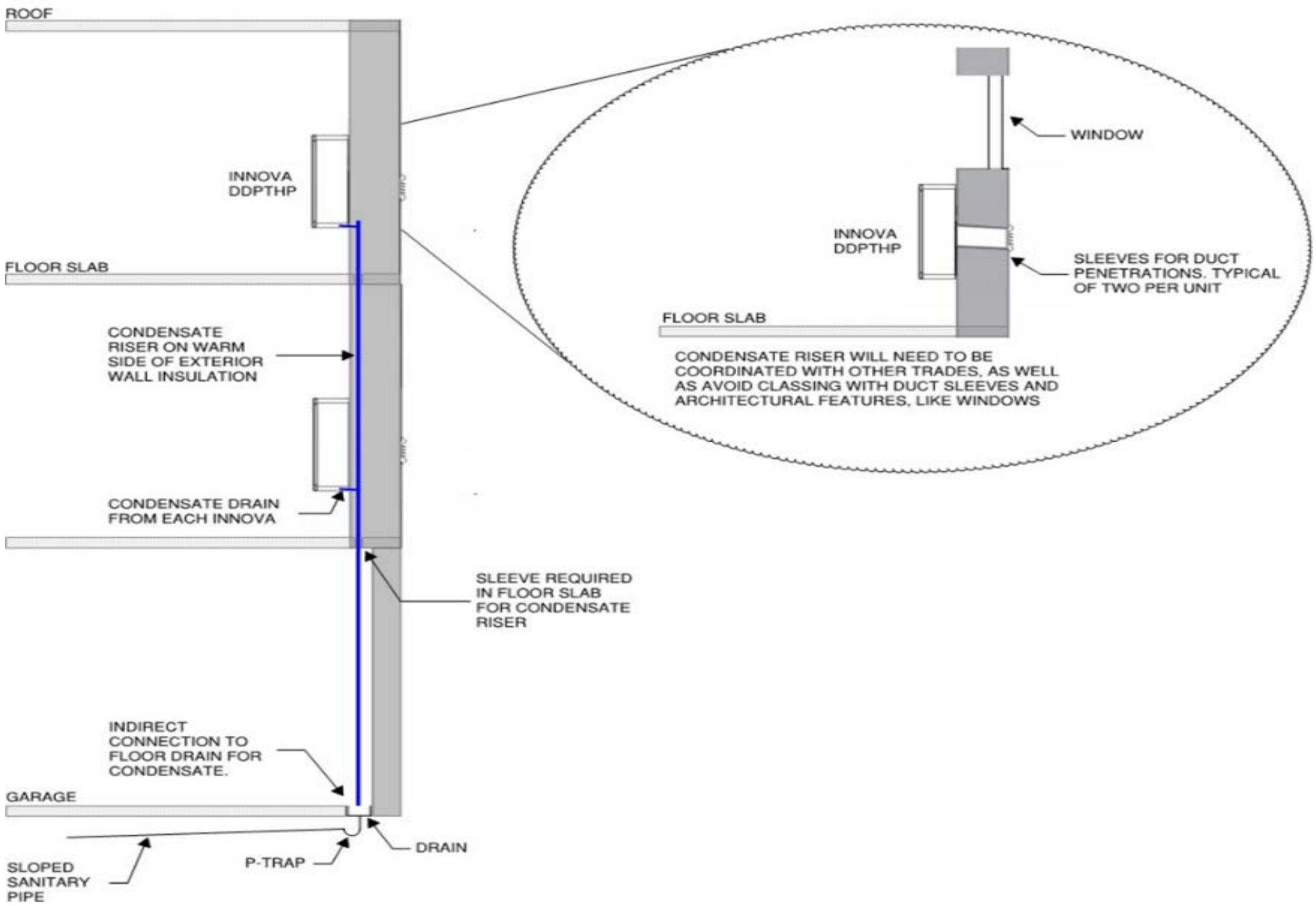


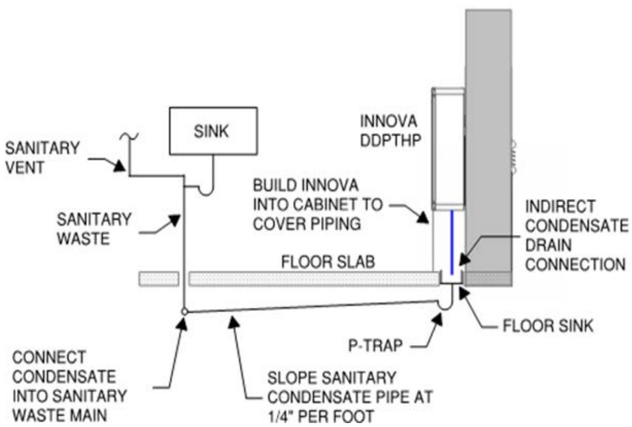
Figure 10. Option 3: Condensate Riser Diagram.

would sit just below the unit and only turn on when condensate in its reservoir has reached a certain level. Pumped condensate has to be routed through the exterior wall, up to the ceiling and over to a sink, down an interior wall and connect into a sink or laundry drain, before the p-trap, as shown below. Pumped condensate pipe could be routed through interior wall or floor. However, there is likely more room above the ceiling to route it and routing through the floor would require another slab penetration.

The third option, Figure 10, adds a riser in the exterior wall — which adds cost, displaces insulation, creates coordination issues and must be accessible at the bottom. The most challenging aspect of adding another riser along the exterior wall is likely coordinating with other trades. Although the condensate riser will be small, each floor slab must be drilled through. If the riser is run in the exterior wall, architectural features such as windows will have to be avoided. The riser could run through an interior wall, in which case, the condensate pipe would need to be sloped and routed horizontally. However, running pipes horizontally may cause conflicts with the framing.

The fourth option, Figure 11, may be undesirable from an architectural perspective because it requires a sink near the exterior wall where the Innova is installed. In some small one-bedroom apartments and studios, this architectural design may happen naturally. In that case, Option 4 is likely the most viable option. A p-trap is required 1 foot below the unit's condensate outlet. With this option, it may be desirable to install a cabinet below the unit to hide the p-trap. From the p-trap, the condensate drains through the floor slab and slope to the unit's main sewer line as shown in the diagram below. Some jurisdictions may not permit a drain inside a cabinet.

Figure 11. Option 4. Sink and Sloped Condensate Diagram



The condensate option chosen will be on a project-by-project basis. Condensate management is one of the trickier aspects of working with the Innova product, and engineers and contractors need to coordinate and determine the best method for disposing of condensate.

Some jurisdictions may permit condensate to be used for sub-surface irrigation. If the jurisdiction does not permit draining to the landscaping and there is no place for an open sight drain at the ground level to collect condensate risers from above, then condensate pumps will be the likely alternative.

Owner

Owners are primarily concerned with the durability of the product. Current installations in Europe have reportedly performed well. According to the manufacturer, most common malfunctions occur from water damage related to condensate failures or forgetting to clean the air filter. Water damage can occur from improper cleaning or spills. The exterior of the equipment can be cleaned with a damp rag, but in no circumstance should water be poured on the product. Removing and cleaning the filter can be done by the occupant or a maintenance person. However, if maintenance is deferred, the clogged filter reduces performance until the product can no longer provide heating and cooling. Luckily, if operation ceases due to a clogged filter, the solution is simply to clean the filter. It has been requested that the manufacturer provide a full-filter alarm with the newly designed model.

Monoblocks are complex, and with complexity comes more potential points of failure. The subsequent steps in this emerging technology study, Application Testing and Demonstrations, will further assess the product's robustness.

If a unit does fail, Innova asks the customer to ship it back to their U.S. facility so the failure can be assessed and the unit can be repaired, or the working components can be removed and used in another unit. Currently, the Innova factory is in Italy. Although in the long term there will be maintenance centers on the east and west coasts. Innova has said it will pay for freight on products that must be shipped for repair. In the case of a multifamily building, it would be advisable for the maintenance contractor to have a spare unit in storage so when a unit fails it can be swapped out while the other is being sent back for repair or replacement. Innova will provide 2% complimentary units to be used in case of a problem to multifamily projects with more than 50 units.

Users

Users are swayed by product comfort, acoustics, efficiency and ease of operation. The Innova features an inverter-driven compressor that increases comfort by allowing the equipment to operate at part-load condition, avoiding equipment cycling and temperature swings.

The Innova is much quieter than a typical PTAC (~ 44dB) and emits 27dB of sound. Installation also impacts sound levels. If installed in a wall soffit, as shown in Figure 12, the sound is further reduced.

The user interface is a touchscreen that is onboard or can be ordered with a wall-mounted version. The connection between the control's touchscreen and equipment, when remote mounted, is hardwired. In addition to the control's touchscreen, the Innova includes Wi-Fi capability. Wi-Fi capability allows integration with Android/iOS devices, Alexa, and/or Windows/PC desktops. Controls allow for temperature schedules to be programmed by day of the week. Thermostat is seven-day programmable. Applications Testing will determine whether the thermostat allows for heating and cooling setpoints. Thermostat controls are adjustable.

Cost and Constructability Assessment Findings

The Cost and Construction Assessment confirms additional costs associated with acquiring and installing the product. It assesses cost associated with initial market entry and the potential for cost reduction as the product becomes more widely available.

Contractors were interviewed for this section of the report. All parties contacted were excited about the product and curious when they could start using it. The equipment was viewed as a potential way to cut costs and save time.

Figure 12. Innova View 2.0 Installed in a wall.

Availability

This section discusses the capacity of the manufacturer to provide products for the growing Pacific Northwest market and lead-times associated with the product in a fast-paced construction economy.

Innova currently makes 15,000 – 20,000 units per year for the European market. Innova will need to scale up to support North America. Although Innova currently lacks the capacity to produce the quantity of products required for both continents, it is well established and familiar with mass production of quality products.

Because it is manufactured in Italy, the current lead-time for an Innova is about 8-12 weeks. The product is made to order, so lead-times include 4-6 weeks to build the order and an additional 4-6 weeks of ocean freight. Air freight is also available at a higher cost.

Furthermore, it is expected that other monoblocks will enter the Northwest market to compete with Innova. Olympia Splendid makes another product similar to Innova's called the Unico. To ease expansion stress on Innova, allowing other products, such as the Unico, to go through the TIM would be beneficial. The structured TIM facilitates market transformation to more efficient technologies by providing a quality vetting process, manufacturer engagement and feedback and development of a product that meets regulatory and consumer needs.

Innova is well positioned to enter the Northwest market, but significant work is required by Innova to scale up production and reduce lead times. In addition to providing TIM analysis for the Innova product, facilitating other manufacturers to enter the market would be beneficial for monoblock adoption by reducing cost, reducing lead times and making multiple product options available.

Innova is well positioned to enter the Northwest market, but significant work is required by Innova to scale up production and reduce lead times.

Supporting Infrastructure

Buildings are a community of interacting systems: architectural, structural, mechanical, electrical, plumbing and ethernet. Every component in a building is installed to support another component or provide a service to the occupants. A monoblock provides heating and cooling to the occupants. To perform the Innova requires support from architectural, structural, plumbing and electrical systems.

Architecturally, the Innova requires dedicated space on an inside of an exterior wall for the space it is conditioning. The exterior wall must accommodate two small holes that allow the unit to draw outdoor air for heat exchange. During construction, these holes either need to be cored after the wall is constructed or sleeved though the wall before it is insulated and drywalled. For curtain wall installations, the Innova requires a special kit.

Adding monoblocks to a design should have little impact on structural systems. The units are light, approximately 100 pounds, and come with a mounting bracket. Penetrations are small and typically will not go into load-bearing walls. Coordination between framers, architects and HVAC installers is required to ensure the unit can sit in the desired spot without 6-8-inch duct holes conflicting with studs.

Depending on the method for managing condensate, the cost and coordination will vary. If condensate pumps are added, coordination between mechanical engineers, electrical engineers and architects is needed. If a drain is added below the unit, the architect needs to design accordingly by adding a cabinet below the unit for a p-trap and drain, and placing a sink or other plumbing fixture near the monoblock. If a riser is added in the exterior wall, the framing contractor needs to plan and construct accordingly. The cost of materials and labor will depend on the design.

Electrical requirements may include adding another wall plug. Or alternatively, 120V/60HZ/1PH power will need to be hardwired to the unit. If a condensate pump is used, then an additional 120V/60HZ/1PH connection is required. Net additional costs from the above electrical requirements should be minimal since this Innova unit is replacing another heating device that would require electrical connections.

Construction Schedule

Unlike split systems that require refrigerant to be routed through the building to a remote outdoor unit, monoblocks such as the Innova are relatively compact. They do not require pipe other than inexpensive condensate pipe to be routed any significant distance, which limits coordination requirements with other trades. As this is a new technology, it is to be determined how general contractors will manage the construction schedule. However, all infrastructure support, such as condensate piping and electrical, should be installed at rough-in phase. The units can be hung after insulation and sheetrock, drilling of exterior wall holes and installing sleeves. The construction-schedule impacts will be further assessed during Application Testing.

Once all supporting infrastructure is in place the Innova should take 30 minutes for two people to install.

Installation

Because the Innova was originally designed for use in retrofits, it is easy to install late in the construction process. Installation requires the unit be connected to the necessary supporting infrastructure: plumbing for condensate collection, electrical for power and holes for airflow. Once all supporting infrastructure is in place, it should not take more than 30 minutes for two people to install each unit.

Cost Impacts

Each unit will likely cost between $2,000 and $2,500 without installation. The unit requires prep work from three different sub-contractors to add the necessary supporting infrastructure before the unit can be installed by a mechanical sub-contractor.

An electrical contractor must provide a dedicated 15-20-amp branch circuit for the unit for an approximate cost of $200-$300 per unit. However, this should not be a net increase in construction costs because the multifamily unit required heater installation regardless of the product.

The plumbing or mechanical contractor must provide a condensate riser to a drain — provided by the plumbing contractor — in the garage, estimated at $500 per unit. The siding crew must install wall penetrations and louvers, about a $200-$300 cost per unit. The mechanical contractor will mark up the unit costs by at least 20% and add another installation fee estimated at $200-$400 per unit.

A monoblock such as the Innova product saves significant cost in refrigerant piping when used in place of a split-system heat pump. Refrigerant piping adds cost in three ways: coordination, materials and installation. Split-system heat pumps require refrigerant to be routed from the indoor unit to the outdoor unit. In taller buildings, the refrigerant pipe routes all the way to the ground level or garage to connect to the outdoor unit. As length of refrigerant pipe increases, there are more opportunities for creating conflicts with other trades. This creates increased cost in materials and coordination efforts. Refrigerant piping is expensive to install, as it requires significant time from a certified installer.

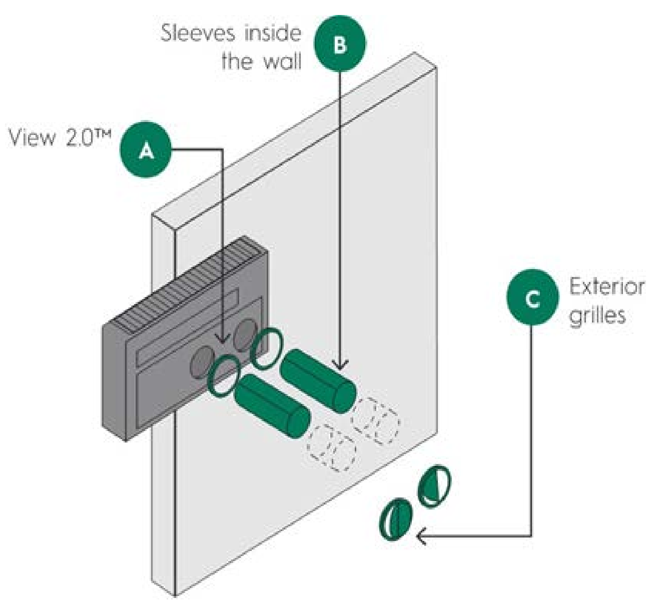


Figure 13. Air Exchange Holes

Another major benefit of the monoblock is that it uses smaller refrigerant charge. Space-heating refrigerants, such as R410A, are potent global-warming gases when they escape from the refrigerant circuit. Decreasing the amount of refrigerant used has significant environmental benefits.

The Innova will be appealing to contractors if it can be installed for less than a DHP. Cost for installation is estimated between $3,500 and $4,500 — about $2,500 less than a DHP — which typically costs $6,000 to $7,000. The Innova will likely cost slightly more than an equivalent PTAC, but only by $500 to $1,000.

Retrofit Feasibility

The Innova is designed to be easily retrofit into small single-story buildings where condensate can be drained directly through the exterior wall. However, in multifamily buildings, or other buildings where it is unacceptable to drain condensate through the exterior wall, retrofits will be more challenging.

The unit requires all the supporting infrastructure noted above. The exterior wall must be constructed of a suitable material for drilling two 6-8-inch holes. A 115V power connection must be available and a condensate management system must be installed or must already exist. The most challenging of these requirements in many cases will be the condensate management system. If a condensate management system does not already exist, this could mean drilling through the structure, adding a condensate pump, anti-siphoning device and connecting to the sewer.

Maintenance Assessment

Maintenance Assessment is broken into two sections: maintenance and customer service. Customer service assesses the ability of the manufacturer to aid Northwest customers. Maintenance addresses maintenance requirements performed by the owner to insure product longevity.

Customer Service

Innova is finalizing its process for providing customer service to the Northwest and the U.S. overall. In Europe, when a unit malfunctions or is damaged, Innova has the unit shipped to their factory or repair center and sends a replacement unit. In the U.S., defective units will be swapped out and replaced. As mentioned previously, Innova plans to provide one unit as a backup, free of charge, for every 50 units purchased for a project. Additionally, the product comes with a 10-year warranty on components related to the refrigeration cycle: compressor, refrigerant piping, refrigerant, etc.

Maintenance

The only maintenance requirement of the Innova is external cleaning and filter cleaning. The Installation, Operations, and Maintenance Manual, or IOM, provides instructions for cleaning. External cleaning is purely aesthetic. The IOM includes instructions on external cleaning mostly so customers do not dump water or cleaning products on the unit as they can damage it. Filter cleaning is a requirement for proper operation. Instructions for filter removal and cleaning are clearly documented in the IOM. Like most window AC units, the filter can be cleaned and does not need to be thrown out and replaced.

Conclusions and Recommendations

Conclusions

Innova's View 2.0 is a monoblock emerging technology that potentially offers a cost-effective way to displace electric resistance heating with more efficient heat pump heating. Heating is a major resource use and replacing electric resistance heating with monoblocks has potential to save significant energy. Additionally, monoblocks can provide efficient cooling and mitigate growing Northwest cooling load. In the future, the Northwest will see an increase in cooling equipment installed and used in multifamily buildings. Denser population centers, and more severe climate conditions, will create an increase demand for cooling. As a result, there is a need for a new technology that can provide efficient heating and cooling in multifamily buildings.

This Feasibility Analysis is the first step in the TIM to assess the Innova View 2.0, an inverter-driven monoblock. Monoblocks have been identified as a candidate for potentially providing efficient heating and cooling in new construction and retrofit projects. The goal of this study was to analyze the Innova, an Italian product, for potential adoption in the Northwest market. The Innova has been assessed for certifications, performance, cost and constructability, and maintenance.

Certifications were the weakest of the four areas assessed. The Innova does not meet current UL-listing requirements and has not been tested for energy-code compliance. However, the manufacturer is aware of these deficiencies, and plans to redesign the product to meet compliance requirements before the U.S. market.

The Innova equipment performance is promising, and aspects of the design will appeal to architects, engineers, owners and users. Later in the TIM, equipment will be thoroughly tested for energy performance and ease of use.

The largest concern for the Innova product in cost, constructability and maintenance is Innova's ability to expand production and service to shorten lead times, and provide customer support. Currently, the product takes 4-6 weeks to make and another 4-6 weeks to ship. For adoption in the U.S. market, the lead time needs to be reduced. Additionally, a lack of service centers in the U.S. presents a barrier when a small percentage of products inevitably fail. Innova plans to open a service center in the U.S. within the next year.

Manufacturer Recommendations

Two potential improvements that would make the Innova a more attractive product for the U.S. market have been recommended to the manufacturer, but only one was deemed feasible by the manufacturer.

1. In heating mode, the unit can produce up to 1.2 liters per hour of condensate, which is too much to re-evaporate into the room.
2. A 208V/240V version will be available in the redesigned product for US market.

Ecotope recommended Innova design the product so condensate from defrost and cooling coils drain into the same drain pan and be re-evaporated into the room. Unfortunately, this is not feasible because in heating mode the unit can produce up to 1.2 liters per hour of condensate, which is too much to re-evaporate. Ecotope suspects this is because in cool but humid climates like the Pacific Northwest, the outdoor air coil will pull much of its heat from latent heat of condensation and create large amounts of condensate even before the coil freezes.

Ecotope recommended adding a 208V/240V version, and Innova responded that it plans to make available both 115V, 60HZ and 208V/240V, 60HZ available in the redesigned U.S. product.

Utilty Recommendations

Overall, the Innova is a promising product that has potential to save energy and costs in the Northwest construction market. We recommend that it pass the feasibility study stage-gate in the TIM with the contingency that the product redesign meets energy codes and is UL listed. The next stage in the TIM is Application Testing that will assess functionality of the Innova product and result in a product performance map. The Application Testing can either be performed on the current product or the redesigned product. Ecotope recommends the bench test be performed in Winter 2021.

It is recommended to wait until the redesigned product is available to perform third-party testing for performance mapping. When each stage-gate is completed the product should move forward to the next stage as listed below. Thorough evaluation through each stage-gate ensures that the product enters the marketplace as a robust technology with proven capability to succeed, provide heating, cooling and quantifiable energy savings over current technologies.

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