Questions and Answers

On January 5, 2022, the Clean Energy Transition Institute and 2050 Institute conducted a webinar releasing the White Paper *Operation 2030: Scaling Building Decarbonization in Washington State*, during which numerous questions were raised.

This Q & A document address all questions posed in the chat during the webinar, including those that were answered live during the presentation. We organize the questions by topic, note who raised the questions in parentheses, and in some cases combine similar questions. The slides that are referred to in the text can be found [here](#).

**Overarching Questions**

Q: On slides 23 and 24, you show a strategic path, but can you share where we are right now? I’m concerned you are saying we don’t have alignment yet across the state on the decarbonization policies and targets.

A: The purpose of the paper was to establish the baseline analysis for the market transformation and technical changes that must get underway now to put Washington state on the path to achieving its 2050 emissions limits.

A number of important policies have been put in place, such as the Clean Energy Transformation Act (CETA), economy-wide emissions limits through 2050, the Clean Building Performance Standard, and an increasingly stringent building code. The paper includes recommendations for how to build upon these policies and expand into more systemic and structural changes as well.

However, there are also multiple issues that must be addressed to align building decarbonization policies and targets necessary to meet emissions limits by 2050. For example, currently:

- There are no formal state targets or a timeline for building sector decarbonization that policies, programs, market development, workforce expansion, and equity efforts can align around.
- There is no structure for tracking building decarbonization progress against targets—if and when they are established and adopted.
- The Energy Code and the Building Performance Standard are not currently structured to deliver on the high-efficiency electric equipment sales shares indicated in the State Energy Strategy or the Operation 2030 zero net carbon recommended targets for new construction and retrofit rates. Some 2022 legislative bills are designed to address aspects of this disconnect.
- Installation of new and replacement gas equipment is not sufficiently limited by existing policies or programs.
▪ There is no cohesive plan for the role utilities should or will play in building decarbonization, and decarbonization analysis and targets are not required in utility conservation potential assessments.
▪ Public utilities are currently barred from implementing electrification programs and therefore cannot directly incentivize the type of fuel-neutral energy efficiency programs required to decarbonize the building stock.
▪ The regional and utility cost tests used to establish cost effectiveness for various energy efficiency measures and programs are not structured to promote decarbonization.
▪ There are no comprehensive statewide strategies or targets for demand response or onsite solar installations, nor estimates of the aggregate impact these technologies will have on the grid.
▪ There are no comprehensive efforts to operationalize large-scale retrofits, such as strategies to dramatically reduce the incremental costs of equipment replacements and retrofits, or how to build market capacity and productivity to the level required to fully scale building decarbonization by 2030.

The paper includes overarching strategies for how to address this lack of alignment and lack of common goals, targets, and properly scaled implementation strategies. We plan to further explore current efforts in achieving the emissions limits and how they can be better aligned to accelerate and scale building decarbonization.

Q: What are the next steps for existing buildings in the next 2 years?

A: The key building decarbonization strategy is to shift the market with policies, programs, and market transformation efforts to ensure that existing gas appliances cycle out of buildings at the end of their useful lives. The state Building Performance Standard could drive the development of residential policies and other policy changes that will limit installs of new and replacement gas appliances in existing buildings.

The paper includes some policy recommendations, but the focus is on the overarching technical and market transformation mechanisms and necessary associated targets for near- and mid-term building decarbonization strategies. In future 2022 work, the Operation 2030 team plans to do more detailed policy analysis and design briefs, including specific policy recommendations on existing buildings.

Questions Relating to Methodology and Analysis

Q: Did the analysis include an exploration of the effect on emissions if residential buildings had used electricity instead of natural gas from 1990 to the present?

A: No. We did not analyze historical emissions, but rather used them in relation to projections for the future. That historical analysis could be interesting and informative but was not part of our analysis.
Q: Is energy line loss considered in the energy reductions? Are generation, transmission costs and back up generation when renewables are not available, considered?

A: Yes. The decarbonization pathways modeling considered energy line loss in the energy reductions as well as generation, transmission costs, and back-up generation when renewable energy is not available.

Q: How do you consider wind being too low or too high to use, cloud cover, and dam removals? Is nuclear energy considered?

A: The model does hourly dispatch of the electricity grid using production shapes from renewables differentiated by geography and quality. In doing so, the model ensures that the system can operate reliably and account for all resources available, including gas, storage, hydro, and a dependable contribution from intermittent renewables. On nuclear, the model extends the Energy Northwest plant beyond 2043 (its current sunset year) through 2050.

Q: How do you consider residential homes in rural areas with unreliable power access (wind or snow knocking trees onto overhead powerlines), where typically propane or wood is used?

A: The Clean Energy Transition Institute has a separate project, Equitable Rural Building Decarbonization, that will address resiliency due to unreliable power and the use of propane and wood to heat homes. The report will be released later this year.

Q: In Figure 4, the lines are flat until the one data point of 2019. What happened between 2015 & 2019 to drive the increase?

A: Figure 4 is based on U.S. Energy Information Administration data. Our analysis was not focused on determining what was driving these historical changes, but we assume that it was potentially due to a change in the building stock population, or other types of changes that occurred over time in the building stock.

Q: Does the projection of falling residential electricity demand [Fig. 16 and Fig. 17] adequately account for home charging of a growing number of electric vehicles?

A: No. Residential and commercial electricity demand in these figures is only for the buildings themselves; vehicle-charging demand is accounted for in the transportation sector.

Q: Have you been able to fully factor in the overall growth of renewables (e.g., solar on residential and commercial)?

A: The decarbonization modeling scheduled 500 MWs of rooftop solar in line with the Northwest Power Conservation Council’s forecasted adoption. The model can select to build solar at grid-scale and on rooftops.
Q: Have you considered the electric price increase scenario due to electrification and capacity increase of supply side? We have seen some of early signs in other states where they have same electrification and decarbonization policies in place.

A: We did not look at average electricity rates in this study, but this is a legitimate question to probe in future studies and one that is of great interest to both the Clean Energy Transition Institute and Evolved Energy Research. With electrification, you are displacing the cost of fuels, so it is important to focus on the overall cost of energy to the consumer and not just the cost of electricity.

Q: Where will the new electricity come from by 2030 to eliminate the carbon from the current generation of electricity? (Charles Spaeth) How do the carbon reduction goals align with the forecast increase in electricity available?

A: The question of where the new electricity will be sourced to meet 2030 demand is precisely what regional energy stakeholders and utilities are tasked with determining to comply with Washington’s Clean Energy Transformation Act, as well as the state’s target of 45% below 1990 emission levels by 2030. There are multiple efforts underway throughout the region attempting to develop the reliable clean electricity that will be required to meet an increasingly electrified future.

Q: Does the natural gas analysis include the effects of methane leakage and the burning residuals that currently are worse than the carbon pollution of natural gas?

A: The decarbonization model assumed a net-zero target for emissions from energy and industry. We assumed that non-energy emissions also achieved a trajectory to net zero at the same time, but the measures by which non-energy emissions, such as methane leakage, would be achieved were not part of the analysis performed for the Washington 2021 State Energy Strategy.

Q: Why are market penetration rates of heat pumps vs. heat pump water heaters different?

A: The graphics in the presentation show sales shares at five-year intervals. They summarize data taken directly from the Washington 2021 State Energy Strategy modeling and therefore reflect the assumptions in the modeling for the total percentage of heat pumps required at different intervals.

In addition, the sales shares for heat pumps used for space heating start out at a higher percentage of overall sales than heat pump water heaters in the early years. Since heat pump water heaters start out at a much lower percentage of total sales, they have farther to go to catch up. Over the planning horizon, they eventually make up a higher percentage of total sales shares than heat pumps for space heating. This difference in later years results from how the model analyzes strategies for hitting the final emissions limits.
The estimates also align to some degree with replacement rates. In terms of how fast the stock can turn over, we have to consider different measure lives for various end use equipment. As long as you are aligning with natural replacement rates, there is only so fast you can go.

However, we should not see these sales share estimates as totally static, but more as a summary of what the assumptions were in the State Energy Strategy. Moving forward, we can think about where we set those dials and how much more efficiency we may want to achieve across various end uses in order to meet emerging and potentially more nuanced policy goals.

The Clean Energy Transition Institute is hoping to rerun the Northwest deep decarbonization pathways modeling this year with updated assumptions. We would be able to look at these types of assumptions in greater detail to inform what must happen between now and 2030. Both the Northwest deep decarbonization pathways modeling and the State Energy Strategy focus on a 2050 target, and we would like to understand more precisely the challenges of getting to 2030 on the way to 2050.

**Questions Relating to the Decarbonization of Gas**

**Q:** Does the scenario assume we are using decarbonized gas in 2050? How is it possible for the Gas in Buildings Scenario to get so close to zero by 2050?

**A:** Yes. The modeling in the Washington 2021 State Energy Strategy optimized the energy supply to meet gas demand in determining the most cost-effective technical strategies required for each scenario to meet the greenhouse gas emissions limits within the constraints of each scenario. While there is about 117 TBtu of pipeline gas remaining in the system by 2050 in the Gas in Buildings Scenario, more than 90 TBtu must be decarbonized to meet emissions limits. The emissions levels decrease because a large ratio of the pipeline gas is assumed to be decarbonized and a high volume of efficiency retrofits and equipment replacements are implemented.

On the electrification side, some pipeline gas also remains in the system in 2050. However, there is only about 18 trillion TBtu and less than half of that must be decarbonized. That is the difference between costs to decarbonize about 8 TBtu in the Electrification Scenario and costs to decarbonize about 90 TBtu in the Gas in Buildings Scenario.

**Q:** Is there an equivalent high efficiency gas technology that could be modeled, or is this the decarbonized gas that you’ve referenced? (Paul Bloom)

**A:** In the Gas in Buildings Scenario, the greenhouse gas reductions do not just come from the pipeline gas being decarbonized. This scenario implies a level of retrofits similar to that used in the Electrification Scenario, but instead of upgrading from gas to high-efficiency electric, it upgrades to modern higher efficiency gas appliances. Hence, it is important to keep in mind that
there is a major equipment replacement and efficiency retrofit component to the Gas in Buildings Scenario.

However, due to limitations on combustion equipment, the efficiencies of the higher efficiency gas equipment are less than 100%, whereas the high-efficiency electric equipment is closer to 200% or 300% efficiency, which significantly reduces overall energy use and costs for energy consumers. This is part of the reason why the Gas in Buildings Scenario is so much more expensive than electrification.

The gas equipment replacements and efficiency retrofits add costs to this scenario, but they do not significantly reduce energy use and energy costs. Further, the remaining pipeline gas—which by 2050 is about six times the amount remaining in the system in the Electrification Scenario—must be displaced with expensive clean fuels. Therefore, the Gas in Buildings Scenario is an expensive option for Washington state, even without considering the question of whether sufficient volumes of clean fuel will be available over the planning horizon.

Q: How did you account for the real-world capacity to produce enough decarbonized gas to meet demand? Is it possible to decarbonize the gas that would be necessary in these scenarios? If not, it seems potentially harmful to the overall conversation to be presenting a scenario that is unrealistic. I have heard numerous times that realistically 2 - 6% of demand could be met with “clean” gas.

A: The modeling accounted for the infrastructure investments necessary to produce decarbonized gas and the projected costs of doing so. We also assume use of the existing infrastructure on the pipeline side to deliver the gas. The modeling results did not see decarbonized gas in use until 2050. There are legitimate questions about how much fossil gas may be able to be decarbonized, what feedstocks will be available to substitute for gas in the future and if they should be used, and how affordable low-carbon gas will be, but the outcome that decarbonized gas is in use in 2050 is realistic.

Q: What is decarbonized gas? Hydrogen?

A: Decarbonized gas can come from a range of different sources. This can include direct hydrogen injection, but injections of hydrogen are limited to 7% of energy into the gas pipeline in the modeling assumptions. Other sources include biogas and methanation combining hydrogen from electrolysis with some source of CO₂.

Q: Is not the decarbonization of natural gas an uncertain technology and is it not expected to be very expensive?

A: Yes, it is expensive to decarbonize natural gas. The modeling assumed estimated costs from this study for the different pathways to produce decarbonized gas: “Technology Pathways in Decarbonisation Scenarios.” (Capros, P., E. Dimopoulou, S. Evangelopoulou, T. Fotiou, M. Kannavou, P. Siskos, and G. Zazias. 2018. Advanced System Studies for Energy Transition.)
In terms of the technical uncertainty for decarbonizing natural gas, there are potential feedstock challenges, as well as how much a substitute fuel, such as hydrogen, can safely flow through pipelines, but the major challenge is cost. There are also massive efficiency losses in producing hydrogen and, on the biofuels side, there are significant costs in producing the biomass. Hence, the cost of the energy production is as significant a factor as conversion processes.

Questions Relating to Policy

Q: Do you make policy recommendations in the White Paper? How did you treat policy in the paper? What specific policies (either past or being considered) are related to your paper?

A: Specific policies are discussed in Section 5 of the paper. There are five overarching strategies for scaling building decarbonization by 2030 listed on Slide 23 of the webinar presentation. On pages 21 – 28 of the paper, there are policy and policy-related recommendations listed for each of these strategies. We are not specifically recommending legislation or referring to particular bills, but we describe the types of policy changes that would drive the market transformation and the technical shifts that the Operation 2030 White Paper lays out.

Key next steps for the Operation 2030 team include developing more detailed policy briefs that lay out the emissions reduction and retrofit rate inputs for effective policy design, as well as trajectories for when critical elements of certain keystone policies such as the energy code and building performance standards should be adopted.

Q: How does this work integrate with the Department of Commerce required study on decarbonizing buildings that was funded in the last legislative session? What is left to figure out?

A: Our analysis is complementary with the Department of Commerce’s work and can be thought of as a bridge between the Washington 2021 State Energy Strategy and the more detailed work the State will conduct as part of its residential and commercial building decarbonization plans. The paper explores the findings in the State Energy Strategy and provides examples of what zero net carbon new construction and retrofit targets would need to be to meet the State’s emission limits.

One of the paper’s key recommendations is to develop building decarbonization plans for the residential and commercial sectors, which the State Energy Strategy also calls for. We also suggest when these plans need to be conducted, what components they should include, and recommend that those plans be a prototype for how building decarbonization planning is performed in Washington. Finally, the methodology for the building decarbonization plans could inform how utilities perform their conservation potential assessments.

Q: Are the current heat pump proposals being considered by the Washington State Building Code Council aligned with what is recommended in this White Paper?
A: While the paper does not go into specific policies or codes at that level, there is some alignment in the way that we structure the recommendations for how and when the zero emission requirements are integrated into the code. One of the recommendations is to start as early as possible so that we have time to fully reduce emissions in the code by 2027.

Q: How can any GAS in Buildings strategy survive the limits that the Climate Commitment Act (CCA) places on deliveries of gas to those buildings by 2030? A gas utility must decrease the deliveries by at least 50% by 2030, at a rate of 7% a year. Isn't most of the 2021 State Energy strategy for Gas in Buildings rendered irrelevant by the CCA's limits on deliveries?

A: The decarbonization modeling was performed before the Climate Commitment Act was passed, and therefore its provisions were not included in the model’s assumptions.

Q: Ever tightening building codes will continue to reduce energy consumption on the commercial side, so why do you project such significant rise in commercial building energy usage?

A: This increase is driven by forecasted increases in building populations. The analysis assumes that there will be an approximately 30% increase in commercial floor area, and there is a significant amount of additional energy associated with that increase, even with efficient energy codes. In addition, there are additional opportunities for increasing the efficiency that is modeled.

Questions Relating to Funding

Q: How will we raise the funds for this effort?

A: The paper does not specifically address funding. However, it is important to keep in mind that the annual replacement rates identified in the paper are not in addition to the number of replacements that would happen naturally as equipment reaches the end of its useful life. Instead, the recommendation relates to the type of equipment installed when those natural replacements happen anyway; that is the market transformation that must take place.

Therefore, the recommendation is not to carry out 110,000 residential equipment replacements per year as a separate challenge that requires massive funding, but rather to focus policies, programs, and market transformation on ensuring that when replacements are made as equipment burns out, the new equipment is high-efficiency electric. As a result, the costs will be limited to the incremental costs for the higher efficiency equipment, rather than for the entire replacement.

A key point in the paper is that we still have enough time to align with natural replacement schedules and dramatically limit the costs of building decarbonization. But to realize this strategy we must align the design of policies, programs, and market transformation efforts around rapidly
increasing the rates of high-efficiency electric new and replacement equipment, eventually scaling up to a peak rate by 2030 and sustaining that rate through 2050. In addition, as discussed in more detail in Section 5 of the paper, there must be a big focus on large-scale cost reductions to make high-efficiency electric upgrades as cost-neutral as possible.

However, it should be noted that some envelope and other efficiency upgrades are assumed in the target retrofit rates in addition to the equipment replacements, and those costs are additive since they are not driven by equipment failure. These efficiency measures are mainly intended to reduce electricity demand primarily for transportation electrification, and to some degree building electrification. After 2030, these types of electric efficiency measures will not directly drive decarbonization but are key to the economy-wide decarbonization.

Q: Replacing gas in my house will cost ~$25,000, and my energy bill will remain about the same. We need solutions that are more cost-effective. What are your ideas on how to make that happen?

A: Section 5 of the paper includes recommendations for the types of strategies that could support more cost-effective solutions. Please also see the question above this one for more information on the role of natural replacement cycles and incremental costs.

The lowest cost approach to decarbonize the building stock is to upgrade equipment when it is already going to be replaced. This is how the State Energy Strategy modeling and the Operation 2030 recommended targets are set up. This approach ensures that costs are calculated as incremental costs.

However, aggressive strategies still must be designed and implemented to reduce these incremental costs as much as possible and to provide incentives and subsidies to move the market in other ways while amplifying positive benefits to vulnerable communities. Those that have resources to decarbonize their homes and buildings prior to the end of the useful life of their current equipment can do so, and this will help accelerate the overall market shift.

Perhaps the most important point is that the building decarbonization transition will be financed, allowing decarbonization costs to be calculated based on monthly loan payments amounts.

Q25: Are there current grants to help home builders work with homeowners to incentivize building to future standards of Net Zero? If so, where would be the best place to access info for these grants?

This paper does not address the financing options for home builders or homeowners to incentivize building to future net-zero standards, but this is follow-on work that we will be undertaking as we build out the steps required to achieve these net-zero targets.
Questions Outside the Scope of the Analysis

We received the following three questions that are relevant to building decarbonization but were outside the scope of the paper we released. We include them here for completeness.

Q: What is the current state of local/municipal codes with regard to liquid fuels? (Sandy Shettler)

Q: Do we have a realistic outlook / forecast now for equipment-system availability, market capacity forecast? (Martin Gibbins)

Q: How much of an impact might COVID-19 have on these findings, given its impact on travel and work patterns? Some travel and commercial space use patterns may not get back to “normal.” (Arvia Morris)