MEMORANDUM

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TO: Council Members, Washington State Building Codes Council (SBCC)
Stoyan Bumbalov, SBCC Managing Director
Henry Odum, Ecotope

FROM: Dan Kirschner, Executive Director

DATE: March 11, 2022

RE: Comments, Analysis and Corrections On Cost Benefit Analyses "103_Economic Package", "136_Economic Package" and "179_Economic Package"

VIA ELECTRONIC MAIL: sbcc@des.wa.gov; stoyan.bumbalov@des.wa.gov; henry@ecotope.com

WSEC-C-CR102, 21-GP1-103
Requiring Heat Pumps for Space Heat and Banning Fossil Fuel Heating
Comments on the Cost Benefit Analysis "103_Economic_Package"

GENERAL COMMENTS

- Not Specific to Washington State
  - The proponent is using source data from a "Reach Code Cost Effectiveness Survey" submitted to the Codes and Standards Program of the State of California. There is no Washington State specific data in this report. It's based on energy studies assuming California Climate Zones and California construction costs.
  - Because the study is based on construction costs in California, it does not account for the more stringent Energy Codes currently in place in Washington State. Therefore, the approximated CAPEX installation costs presented are not an accurate representation of the real, present value build costs in Washington State.
- Not Current
  - The date on the report is 2019. Therefore, construction cost data is at least 3 years old and doesn't reflect present value construction costs, which incurred significant inflation over that time.
- Limited Occupancy Type
  - Only two occupancy types were analyzed – Retail and Office. Space uses with high occupancy loads such as Gyms, Auditoriums, Places of Religious Worship and Classrooms were not included. The analysis of these spaces is important because of the high corresponding ventilation load in these occupancy types. Analyzing these space types would show a greater deviation in operating costs

between gas and electric heat because tempering outside air in low ambient conditions is likely more expensive when using electric resistance heat.

- Irrelevant HVAC System Data
    - One of the two HVAC systems presented for economic analysis is a VAV system with electric resistance heat at VAV zone boxes. However, under Section C403.1.4 of the proposed CR102, electric resistance in VAV terminal units is not allowed. Therefore, half of this analysis is not relevant because the proposed VAV system cannot be legally built in Washington State. Relevant code section language from draft CR102 below…

NEW SECTION WAC 51-11C-40314 Section C403.1.4—HVAC heating equipment. C403.1.4 Use of electric resistance and fossil fuel-fired HVAC heating equipment. HVAC heating energy shall not be provided by electric resistance or fossil fuel combustion appliances. For the purposes of this section, electric resistance HVAC heating appliances include, but are not limited to, electric baseboard, electric resistance fan coil and VAV electric resistance terminal reheat units and electric resistance boilers. For the purposes of this section, fossil fuel combustion HVAC heating appliances include, but are not limited to, appliances burning natural gas, heating oil, propane, or other fossil fuels.

- Irrelevant / Unlabeled Charts and Graphs
    - There are data tables included in this report referencing "Commercial Hot Water Heating" which are not relevant to this code change proposal. There are also graphs without labels and no descriptions to identify what, if any, relevancy they have on the analysis of this report.
- Irrelevant Costs of Gas Infrastructure
    - The report references gas infrastructure costs as a burden to the building owner. Such costs include Plan Review, Meter, and Service Extension. These costs are approximated to be $18,316. In reality, these costs are incurred by the gas utility provider and should not be included as part of the construction costs paid by the end user.

SUMMARY AND RECOMMENDATIONS

The Economic Benefit Analysis provided references one, three-year-old report using data from California. It references only 2 HVAC system types, one of which cannot be legally built in Washington State under current provision of the CR102. It only references two occupancy types, both of which have low to moderate ventilation load which shows an operating cost benefit towards electric heating. This is not a cohesive, standalone document, it contains hyperlinks (some of which are not functional) to other source material that is not pertinent to the supporting data of the analysis in this report.

For the above stated reasons, we are recommending the Economic Benefit Analysis, as submitted, be rejected in its entirety under the grounds that it is insufficient and irrelevant. It does not meet the objective of providing an Economic Analysis for the proposed code measure.

WSEC-C-CR102, 21-GP1-136
Heat Pump Water Heating
Comments on the Cost Benefit Analysis "136_Economic_Package"

GENERAL COMMENTS

- Not Current
    - The submitted cost benefit analysis is based on the initial code change proposal. The analysis has not been revised to reflect the many exceptions now incorporated in the CR102 version.
- Limited Occupancy Type
    - Only one occupancy type was analyzed – multifamily housing. What are the impacts on much higher energy users like hospitals and laboratories?
- Not Reflective of the Commercial Market
    - The energy saving and carbon impact implications for this single occupancy appear to be extended to all commercial buildings. Most commercial space – office, retail, etc. – will have much lower domestic hot water demands and will therefore fall under the exceptions in the current version of this proposal. That means under this proposal, most commercial space will be served by electric resistance water heaters. The energy and carbon impacts of this has not been evaluated.
- Not Locale-Specific
    - Costs for electrical infrastructure upgrades source a CA study, not a prototypical WA construction project.

SPECIFIC COMMENTS

- Missing Space Cost Impact
    - It appears no accounting was done for the larger mechanical space required to house the tanks and other appurtenances required for HPWH systems – pumps, more piping, etc. Based on (4) 2000-gallon tanks, (2) Colmac HP units, (1) recirc heater and associated pumps, we estimate 570 square feet (SF) are needed. A single gas water heater with a recirculation pump could fit in a 70 SF room (or less), a difference of 500 SF. Using an average cost of $225/SF for midrise multifamily housing construction in Washington, that equates to $112,500 additional cost for the HPWH system. Ecotope is an experienced expert at designing HPWH systems – they should have exact space requirements for HPWH systems if our estimate needs refining.
- CAPEX and OPEX Problems
    - Several discrepancies in the system CAPEX and OPEX calculations are identified in the attached. In short, it appears the gas-fired water heater plant is vastly

overpriced while the HWPH plant is underpriced. We expect Ecotope has recent cost data for HPWH plants if the changes proposed need refining. Also, the operating cost of the HPWH plant is understated. Specifically, the *current* code proposal allows resistance heating for recirculation losses, making that the code minimum standard (least cost) – the cost/benefit analysis should match.

- Life-Cycle Analysis Updates
    - The suggested revisions to energy usage, CAPEX and OPEX above will affect the rest of the cost-benefit and life-cycle analyses for multifamily housing. Reworking the proponent's analyses is far beyond the scope of this letter – that work should be performed by the proponent or the economic impact reviewer.

From Page 27 of "136 Economic Package"

AS PROPOSED

RECIRC COP 2.4

SUGGESTED REVISION

RECIRC COP 1

Notes: The final proposal allows electric resistance for recirc heat, therefore that would be "code minimum" - the cheapest and simplest option
The economic analysis should match and use electric resistance, not a heat pump, for recirc heat

AS PROPOSED

HPWH Electic Usage (2.8 COP RCC)	143963	kWh/yr
HPWH Recirc Loss	63145	kWh/yr
HPWH Total Electrical Usage	207108	kWh/yr

SUGGESTED REVISION

HPWH Electic Usage (2.8 COP RCC)	143963	kWh/yr
HPWH Recirc Loss (1.0 COP)	151548	kWh/yr
HPWH Total Electrical Usage	295511	kWh/yr

Notes: Recirc heat is a large fraction (majority) of the total load

AS PROPOSED

Heat Pump Plant	QTY	Unit Price	Install and Markup	Total Costs
Heat Pumps (2) CXA-15 and (1) CXA-10	1	$ 79,000	$ 63,200	$ 142,200
Hot Water Storage (2000 gallons)	4	$ 12,000	$ 9,600	$ 86,400
Controls	1	$ 15,000	$ 20,000	$ 35,000
		$ 106,000	**$ 92,800**	**$ 263,600**

SUGGESTED REVISION

Heat Pump Plant	QTY	Unit Price	Install and Markup	Total Costs
Heat Pumps (2) CXA-15 and (1) CXA-10	1	$ 79,000	$ 63,200	$ 142,200
Hot Water Storage (2000 gallons)	4	$ 40,885	$ 5,942	$ 187,308
Controls	1	$ 15,000	$ 12,000	$ 27,000
		$ 134,885	**$ 81,142**	**$ 356,508**

Source: RS Means, 2022, line# 221223133240, Water heater storage tank, glass lined, 2000 gal

Notes: Storage tanks appear underpriced; Controls install and markup appears overpriced (greater than the 80% Mark Up Cost)
Heat pump plant cost may decrease with electric resistance recirc heater. Does the plant cost include pumps, piping, insulation, etc?

From Page 28 of "136 Economic Package"

AS PROPOSED

Central Gas Boiler	QTY	Unit Price	Install and Markup	Total Costs
Gas Boiler (275,000 BTU/hr)	1	$ 6,200	$ 4,960	$ 11,160
Hot Water Storage (2000 gallons)	4	$ 12,000	$ 9,600	$ 86,400
Controls	1	$ 15,000	$ 20,000	$ 35,000
		$ 33,200	**$ 34,560**	**$ 132,560**

SUGGESTED REVISION

Central Gas Boiler	QTY	Unit Price	Install and Markup	Total Costs
Gas Boiler system (600,000 BTU/hr)	1			$ 40,417
Hot Water Storage (2000 gallons)	0			$ -
Controls	0			$ -
		$ -	$ -	**$ 40,417**

Source: RS Means, 2022, line# D20202502260, gas fired water heater system; line# 221123110510, pump (recirc); plus $2K for flue
Notes: A gas boiler system does not require external storage or controls - they are inherent in the water heater
Gas system sized per AO Smith ProSize online app for 137 unit apartment with in-unit laundry, medium demand profile

AS PROPOSED

Capital Cost	Total Cost
Central Electric HPWH	$ 273,940
Central Gas Boiler	$ 132,560

Operational Cost	Total Cost
Central Electric HPWH	$ 17,728
Central Gas Boiler	$ 14,067

SUGGESTED REVISION

Capital Cost	Total Cost
Central Electric HPWH	$ 356,508
Central Gas Boiler	$ 40,417

Operational Cost	Total Cost
Central Electric HPWH	$ 25,298
Central Gas Boiler	$ 14,067

Notes: Reflecting capital costs and usage changes from above

- Not All-Inclusive
    - The cost per receptacle is within reason – for the receptacle itself and wiring to the dwelling unit electrical panel. However, there are many other costs not accounted for:
        - larger electrical panels in each dwelling unit
        - larger feeders to serve those panels from house panels
        - larger or greater number of house panels
        - larger feeders from main switchgear to those house panels
        - larger switchgear
        - larger feeders from the electrical service to the main switchgear

Also, for a normal project the added cost of utility-side electrical service feeders and transformers will often be borne by the electric utility, but that is not a given. In the case of this proposal, "cost to serve" is more likely since dwelling unit appliance loads will not be online when construction is complete, or anytime soon thereafter.

Please include these costs in the cost/benefit analysis.

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