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Document Title:	Multifamily Restructuring Duct Leakage supplement
Description:	This memo presents cost-effectiveness results for the HVAC duct leakage submeasure from the Multifamily Restructuring CASE Report, as a supplement to the full report.
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To: Javier Perez & Payam Bozorgchami
California Energy Commission

From: The Statewide CASE Team

Date: December 9, 2020

**Subject: Updated Duct Leakage Cost Effectiveness with Residential TDV –
Multifamily Restructuring**

This memo presents cost-effectiveness results for the HVAC duct leakage submeasure from the Multifamily Restructuring CASE Report. The approach and assumptions as described in the Final CASE Report remain the same except the 30-year residential TDV multipliers and net present value of \$0.173/TDV were used in place of the 30-year nonresidential TDV multipliers and net present value.

Cost Effectiveness

Submeasure G: Space Conditioning – Duct Leakage Testing

Results of the updated per-unit cost-effectiveness analyses are presented in Table 1 through Table 2 for new construction. The proposed submeasure is cost effective for new construction over the 30-year period of analysis relative to the existing conditions in both prototypes in all climate zones except Climate Zones 1, 3, 5, and 7. It is very close to being cost effective in Climate Zone 7 with a benefit-to-cost ratio of 0.96 for the mid-rise prototype and 1.02 for the high-rise prototype. Based on nonresidential TDV this measure was not cost effective in Climate Zones 1, 3, 5, 7, and 16. These results can be used to justify including this new construction measure in additional climates zones beyond what was presented in the December 2nd workshop, specifically Climate Zones 7 and 16.

Results of the updated per-unit cost-effectiveness analyses are presented in Table 3 for alterations. The proposed submeasure is cost effective for alterations over the 30-year period of analysis relative to the existing conditions in all climate zones. Based on nonresidential TDV this measure was not cost effective in Climate Zones 1, 5, and 7. These results can be used to justify including this alteration measure in additional climates zones and excluding the exception that was presented in the December 2nd 2020 workshop.

Table 1: 30-Year Cost-Effectiveness Summary Per 5-Story Mixed-Use Dwelling Unit – New Construction Duct Leakage

Climate Zone	Benefits TDV Energy Cost Savings + Other PV Savings^a (2023 PV\$)	Costs Total Incremental PV Costs^b (2023 PV\$)	Benefit-to-Cost Ratio
1	\$60	\$147	0.41
2	\$181	\$147	1.23
3	\$107	\$147	0.73
4	\$199	\$147	1.35
5	\$85	\$147	0.58
6	\$163	\$147	1.11
7	\$141	\$147	0.96
8	\$218	\$147	1.48
9	\$225	\$147	1.53
10	\$240	\$147	1.63
11	\$307	\$147	2.09
12	\$247	\$147	1.68
13	\$334	\$147	2.27
14	\$282	\$147	1.92
15	\$435	\$147	2.96
16	\$174	\$147	1.18

- a. **Benefits: TDV Energy Cost Savings + Other PV Savings:** Benefits include TDV energy cost savings over the period of analysis (Energy + Environmental Economics 2016, 51-53). Other savings are discounted at a real (nominal – inflation) three percent rate. Other PV savings include incremental first-cost savings if proposed first cost is less than current first cost. Includes PV maintenance cost savings if PV of proposed maintenance costs is less than PV of current maintenance costs.
- b. **Costs: Total Incremental Present Valued Costs:** Costs include incremental equipment, replacement, and maintenance costs over the period of analysis. Costs are discounted at a real (inflation-adjusted) three percent rate and if PV of proposed maintenance costs is greater than PV of current maintenance costs. If incremental maintenance cost is negative, it is treated as a positive benefit. If there are no total incremental PV costs, the B/C ratio is infinite.

Table 2: 30-Year Cost-Effectiveness Summary Per 10-Story Mixed-Use Dwelling Unit – New Construction Duct Leakage

Climate Zone	Benefits TDV Energy Cost Savings + Other PV Savings^a (2023 PV\$)	Costs Total Incremental PV Costs^b (2023 PV\$)	Benefit-to-Cost Ratio
1	\$67	\$147	0.45
2	\$185	\$147	1.26
3	\$113	\$147	0.77
4	\$205	\$147	1.39
5	\$90	\$147	0.61
6	\$171	\$147	1.16
7	\$149	\$147	1.02
8	\$224	\$147	1.53
9	\$234	\$147	1.59
10	\$250	\$147	1.70
11	\$331	\$147	2.25
12	\$253	\$147	1.72
13	\$345	\$147	2.34
14	\$304	\$147	2.07
15	\$457	\$147	3.11
16	\$191	\$147	1.30

- a. **Benefits: TDV Energy Cost Savings + Other PV Savings:** Benefits include TDV energy cost savings over the period of analysis (Energy + Environmental Economics 2016, 51-53). Other savings are discounted at a real (nominal – inflation) three percent rate. Other PV savings include incremental first-cost savings if proposed first cost is less than current first cost. Includes PV maintenance cost savings if PV of proposed maintenance costs is less than PV of current maintenance costs.
- b. **Costs: Total Incremental Present Valued Costs:** Costs include incremental equipment, replacement, and maintenance costs over the period of analysis. Costs are discounted at a real (inflation-adjusted) three percent rate and if PV of proposed maintenance costs is greater than PV of current maintenance costs. If incremental maintenance cost is negative, it is treated as a positive benefit. If there are no total incremental PV costs, the B/C ratio is infinite.

Table 3: 30-Year Cost-Effectiveness Summary Per 10-Story Mixed-Use Dwelling Unit – Alterations Duct Leakage

Climate Zone	Benefits TDV Energy Cost Savings + Other PV Savings^a (2023 PV\$)	Costs Total Incremental PV Costs^b (2023 PV\$)	Benefit-to-Cost Ratio
1	\$169	\$147	1.15
2	\$290	\$147	1.97
3	\$201	\$147	1.37
4	\$272	\$147	1.85
5	\$174	\$147	1.18
6	\$197	\$147	1.34
7	\$160	\$147	1.09
8	\$272	\$147	1.85
9	\$290	\$147	1.97
10	\$320	\$147	2.17
11	\$449	\$147	3.05
12	\$351	\$147	2.39
13	\$443	\$147	3.01
14	\$410	\$147	2.79
15	\$546	\$147	3.71
16	\$357	\$147	2.43

- a. **Benefits: TDV Energy Cost Savings + Other PV Savings:** Benefits include TDV energy cost savings over the period of analysis (Energy + Environmental Economics 2016, 51-53). Other savings are discounted at a real (nominal – inflation) three percent rate. Other PV savings include incremental first-cost savings if proposed first cost is less than current first cost. Includes PV maintenance cost savings if PV of proposed maintenance costs is less than PV of current maintenance costs.
- b. **Costs: Total Incremental Present Valued Costs:** Costs include incremental equipment, replacement, and maintenance costs over the period of analysis. Costs are discounted at a real (inflation-adjusted) three percent rate and if PV of proposed maintenance costs is greater than PV of current maintenance costs. If incremental maintenance cost is negative, it is treated as a positive benefit. If there are no total incremental PV costs, the B/C ratio is infinite.