

## RTR Appendix

Southern California Edison, Pacific Gas and Electric, Southern California Gas, and San Diego Gas and Electric (“Joint Utilities” or “Joint IOUs”) developed Responses to Recommendations (RTR) contained in the evaluation studies of the 2013-2015 Energy Efficiency Program Cycle and beyond. This Appendix contains the Responses to Recommendations in the report:

***RTR for the Proposer Defined Study: A Roadmap for Accelerating the Adoption of Low-Global Warming Potential HVAC Refrigerants*** (DNV GL, Calmac ID #CPU0234.01, ED WO #GroupA\_HVAC\_PD\_Y3)

The RTR reports demonstrate the Joint Utilities’ plans and activities to incorporate EM&V evaluation recommendations into programs to improve performance and operations, where applicable. The Joint IOUs’ approach is consistent with the CPUC Decision (D.) 07-09-043<sup>1</sup> and the Energy Division-Investor Owned Utility Energy Efficiency Evaluation, Measurement and Verification (EM&V) Plan<sup>2</sup> for 2013 and beyond.

Individual RTR reports consist of a spreadsheet for each evaluation study. Recommendations were copied verbatim from each evaluation’s “Recommendations” section.<sup>3</sup> In cases where reports do not contain a section for recommendations, the Joint IOUs attempted to identify recommendations contained within the evaluation. Responses to the recommendations were made on a statewide basis when possible, and when that was not appropriate (e.g., due to utility-specific recommendations), the Joint IOUs responded individually and clearly indicated the authorship of the response.

The Joint IOUs are proud of this opportunity to publicly demonstrate how programs are taking advantage of evaluation recommendations, while providing transparency to stakeholders on the “positive feedback loop” between program design, implementation, and evaluation. This feedback loop can also provide guidance to the evaluation community on the types and structure of recommendations that are most relevant and helpful to program managers. The Joint IOUs believe this feedback will help improve both programs and future evaluation reports.

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<sup>1</sup> Attachment 7, page 4, “Within 60 days of public release, program administrators will respond in writing to the final report findings and recommendations indicating what action, if any, will be taken as a result of study findings as they relate to potential changes to the programs. Energy Division can choose to extend the 60 day limit if the administrator presents a compelling case that more time is needed and the delay will not cause any problems in the implementation schedule, and may shorten the time on a case-by-case basis if necessary to avoid delays in the schedule.”

<sup>2</sup> Page 336, “Within 60 days of public release of a final report, the program administrators will respond in writing to the final report findings and recommendations indicating what action, if any, will be taken as a result of study findings. The IOU responses will be posted on the public document website.” The Plan is available at <http://www.energydataweb.com/cpuc>.

<sup>3</sup> Recommendations may have also been made to the CPUC, the CEC, and evaluators. Responses to these recommendations will be made by Energy Division at a later time and posted separately.

**Response to Recommendations (RTR) in Impact, Process, and Market Assessment Studies**

**Study Title:** Proposer Defined Study: A Roadmap for Accelerating the Adoption of Low-Global Warming Potential HVAC Refrigerants  
**Program:** HVAC  
**Author:** DNV GL  
**Calmac ID:** CPU0234.01  
**ED WO:** GroupA\_HVAC\_PD\_Y3  
**Link to Report:** [http://calmac.org/publications/CPUC\\_HVAC\\_Refrigerants\\_-\\_PDS\\_05032021\\_FinalReport.pdf](http://calmac.org/publications/CPUC_HVAC_Refrigerants_-_PDS_05032021_FinalReport.pdf)

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			If incorrect, please indicate and redirect in notes.	Choose: Accepted, Rejected, or Other	Examples: Describe specific program change, give reason for rejection, or indicate that it's under further review.	Choose: Accepted, Rejected, or Other	Examples: Describe specific program change, give reason for rejection, or indicate that it's under further review.	Choose: Accepted, Rejected, or Other	Examples: Describe specific program change, give reason for rejection, or indicate that it's under further review.	Choose: Accepted, Rejected, or Other	Examples: Describe specific program change, give reason for rejection, or indicate that it's under further review.
1	Flammability is the problem. <b>Additional Supporting Information:</b> The single biggest current barrier of adopting low-GWP refrigerants is the issue of flammability. Virtually all low-GWP alternative refrigerants with cooling capacity and energy- efficiency performance characteristics similar to refrigerants currently in use are mild to highly flammable. All the HVAC experts we spoke with emphasized the fact that they are not currently permitted to install mildly flammable refrigerants in most common HVAC equipment today. Lab testing performed by one of the experts we interviewed shows mildly-flammable refrigerants being considered for near-term adoption are only flammable in conditions where high rates of leakage occur in a confined space. Mechanical, fire, and building codes are currently being modified to allow for mildly flammable refrigerants given appropriate measures to minimize risk are in place.	This is a key finding and no recommendation is associated with this finding.	All PAs								
2	Refrigerant transitions take time. <b>Additional Supporting Information:</b> Secondary research and interviews with HVAC-refrigerant experts revealed an extensive list of national organizations, state and local codes, and other authorities required to approve the use of new refrigerants in the United States. Any increase in flammability or change in toxicity for a refrigerant extends the length of time for its approval. The United	This is a key finding and no recommendation is associated with this finding.	All PAs								

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	States is a safety-focused society relative to some other industrialized countries. For instance, Europe and Asia are already moving quickly ahead in using mildly flammable refrigerants and to some degree natural refrigerants in HVAC equipment. The proposed HFC reduction timeline and the recent passing of the American Innovation and Manufacturing Act of 2020, ensures the transition will happen in California and the rest of the United States eventually.										
3	The refrigerant evolution continues. <b>Additional Supporting Information:</b> The current transition away from high-GWP HFCs towards HFCs with GWP levels <750 is rife with challenges and the likely outcome is still pending. All 10 of the HVAC manufacturers and contractors we spoke with agree the preferred near-term refrigerant candidates are all mildly flammable HFCs. There is one technically viable refrigerant, R-466a (Solstice® N41), that is not flammable under normal conditions and has a GWP just below 750. On the surface, these characteristics would make R-466a the preferred option, but it has drawbacks. In terms of performance, it falls short of the other leading <750 GWP candidates, and it's relatively unproven. It also contains a molecule not traditionally used in refrigeration that is concerning because of its slight ozone-depleting potential. Six experts we spoke with at length about R-466a see it as a step in the wrong direction. All experts we talked to said manufacturers are transitioning to mildly flammable refrigerants to meet the low-GWP phasedown requirements.	This is a key finding and no recommendation is associated with this finding.	All PAs								
4	The Refrigerant Avoided Cost Calculator is a valuable tool. <b>Additional Supporting Information:</b> The CPUC Refrigerant ACC is a relatively new tool that holds a lot of value. The tool provides users a simple yet informative option for calculating refrigerant carbon-equivalent emission impacts. The tool's approach is based on a well vetted methodology by the Intergovernmental Panel on Climate Changes (IPCC). Using	The CPUC should consider using the DNV GL prototype lifetime GWP calculator to update the current CPUC Refrigerant ACC. The research findings of this study provide the data needed to expand the outputs of the current CPUC Refrigerant ACC	All PAs	Rejected	We can't recommend any tool without a proper review and scrutiny of such; please provide the tool and documentation in order to PG&E and other PAs to do our own evaluation.	Other	Per CPUC guidance, SCE will be leveraging CPUC's RACC tool - 2021 ACC Refrigerant Calculator v1b.xlsx for the evaluation of 2021 EE measures for which there is a variation on refrigerant charge between the based case and measure case. To the discretion of CPUC, future enhancements and/or improvements to their RACC can be directed and/or supported in future	Other	N/A	Other	Per CPUC DEER 2023 Resolution E-5152, all PAs are to use CPUC Refrigerant Avoid Cost Calculator as stated in section C.6 Refrigerant Avoid Cost and per Attachment A, section 3.6 Refrigerant Avoid Cost, this tool will be utilized for deemed programs.  The given recommendation does not provide information on the specific URL website to download the

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	the IPCC methodology and leveraging CARB emissions estimates, the tool predicts refrigerant impact in a dollar equivalent value. Our review of the tool and based on the findings of this research study, the outputs of the tool are very noteworthy but can be further improved. For example, the current CPUC Refrigerant ACC tool does not consider the energy performance or refrigerant charge required of alternative refrigerants.	tool. Using our evaluation approach, we defined variables impacting equipment energy operation and refrigerant emissions. Using the sourced variables, we developed a prototype add-on tool that calculates energy impacts from alternative refrigerants as well as required charge-level impacts on emissions. The framework of the tool can be extended to measures beyond HVAC refrigerants.					DEER cycles. SCE encourages further enhancements and improvements to CPUC's RACC.				given DNV GL tool to determine if the outputs can be potentially leveraged for custom project applications, therefore SDGE will continue to use the CPUC approved refrigerant Avoided Cost Calculator.
5	Accurate outputs rely on accurate inputs. <b>Additional Supporting Information:</b> Many of the estimates both the CPUC and our add-on tools produce are based on CARB emission inventories. Our discussion with CARB determined annual inventories take a year or more to summarize and become available for use.	It is important to incorporate the latest findings when estimating future impacts. Some operational leakage rates found in current estimates track higher than our outside research indicates. End-of-life emissions could also be tracked better for the purposes of this tool. The outputs of both tools are significant and noteworthy. Minimizing the uncertainties in the tool are that much more important given the significance of the findings.	All PAs	Accepted	Any tool used for the estimating of refrigerant emissions should be updated with the latest data. We suggest consulting with trade organizations such as ASHRAE or similar organizations.	Other	SCE encourage the enhancement and/or expansion of refrigerant leakage data by CPUC and/or Evaluator via both data collection and research including but not limited to HVAC technology, e.g., AC (dx) and heat pump for both standard and high efficiencies and similarly for domestic hot water and dryer heat pump technology.	Other	N/A	Other	SDG&E supports the process of evaluating the most current studies to further improve and recalibrate operational leakage rates for refrigerants based on the given technology type. And support that the given CPUC Avoid Cost Calculator, future revision updates, need to align with the bi-annual DEER Resolution and Business Plan submissions, this is recommended to avoid market disruptions.
6	Mildly flammable HFCs are the near-term solution. <b>Additional Supporting Information:</b> Currently, HVAC contractors are not permitted to install mildly flammable refrigerants in most common HVAC equipment today. The leading mildly flammable HFC candidates for the most common residential and commercial HVAC applications include R-32, R-454B, and R-452B. However, state fire marshal delays now indicate building and fire codes most likely won't be updated to allow these mildly flammable refrigerants for use in	PAs should begin including a requirement for the use of mildly flammable HFCs into their HVAC incentive programs where these refrigerants are currently permitted. The mildly flammable HFC refrigerants are currently allowed in portable, window and smaller air-conditioners as well as in some larger	All PAs	Accepted	PG&E will consider this recommendation for when and where these refrigerants are allowed by law.	Other	We agree that when permitted by Building and Fire Code and local jurisdictions, statewide HVAC IOU lead, in collaboration with all IOUs, should evaluate cost effective program strategies that can support and fully align with statewide decarbonization goals.	Other	N/A	Other	SDG&E is the PA lead for up-stream/mid-stream HVAC and Plug-Load Appliance and will collaborate with Cal TF staff in updating those eTRM measure that can potentially include mildly flammable HFC as permitted by local, state, and federal fire codes, as they become identified and available for program integration.

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	most California HVAC equipment until January 1, 2024. Web survey responses indicate the HVAC supply chain will likely take around two years from when building and fire code requirements are finalized to have a representative selection of <750 GWP HVAC refrigerant equipment offerings.	commercial settings. As more mildly flammable HFCs become viable with updated building codes, the PAs should provide incentives for those options as well.									
7	The goalposts are still moving. <b>Additional Supporting Information:</b> CARB's latest proposed amendment to regulations on HFCs will delay the transition timing from the current 2023 <750 GWP HFC reduction timeline, to 2025. A public hearing was held on December 10, 2020, with the board voting in favor of adopting the amendment, but the bill is still undergoing approval and likely won't receive final approval until October 2021. HVAC experts we spoke with point to updates in the next cycle of California Building and Fire Codes that will include revised policies and guidelines to allow for the use of mildly flammable HFC refrigerants in most major HVAC equipment. Until those updates are released, the goalposts are not set, and the timing of the transition remains uncertain. Once the building and fire codes get finalized, most likely not until the interim code update is published in January 2024, the policy and timing of California's transition, will be more certain.	In the near-term, the PAs should provide incentives for the use of reclaimed high-GWP refrigerants in HVAC equipment. As soon as the building and fire codes allow mildly-flammable HFCs, the PAs should promote these HFCs via their HVAC incentive programs.	All PAs	Other	The industry maybe a bit reluctant going through another transitioning refrigerant such as the case CFCs to HFCs and therefore reluctant to adopt a temporary solution. Extending the adoption of new regulations is probably the result of previous mishaps.	Other	We agree that when permitted by Building and Fire Code and local jurisdictions, statewide HVAC IOU lead, in collaboration with all IOUs, should evaluate cost effective program strategies that can support and fully align with statewide decarbonization goals.	Other	N/A	Other	SDG&E is the PA lead for upstream/midstream HVAC and is regularly collaborating with the third-party implementer (CLEAResult) on meeting the latest regulatory and cost effectiveness test requirements. SDG&E and its third-party implementer plan to act once CARB regulation changes and mildly flammable refrigerants for major HVAC equipment are approved for use by the latest fire code.  Providing incentives for reclaimed high-GWP refrigerants requires CPUC ex-ante review and approval and has the potential of being rejected based on free-ridership given that reclaiming of refrigerants is required by law. URL <a href="https://www.epa.gov/ods-phaseout/homeowners-and-consumers-frequently-asked-questions">https://www.epa.gov/ods-phaseout/homeowners-and-consumers-frequently-asked-questions</a> "Under Section 608 of the Clean Air Act, EPA prohibits individuals from knowingly venting refrigerants containing ozone-depleting refrigerants (including HCFC-22) as well as their substitutes (such as HFCs, including R-410A), while maintaining, servicing, repairing, or disposing of AC and refrigeration equipment".
8	Natural refrigerants are the long-term solution. <b>Additional Supporting Information:</b> The refrigerant evolution will not stop with mildly flammable HFCs. The HFC reduction goals mean that in the next 10-20 years, HVAC equipment will need to push past <750 GWP HFCs towards refrigerants with GWP levels below 150. Findings from literature reviews and interviews with HVAC experts all indicate the long-term goal is refrigerants with	Promote natural refrigerants. The CPUC should recommend the PAs promote the use of natural refrigerants wherever code permits. Incentives should be directed towards accelerating the use of natural HVAC refrigerants over HFCs and HFOs. We recommend the PAs pro-	All PAs	Accepted	Natural refrigerants seem to be the optimum solution, investing and promoting the adoption of natural refrigerants should be a priority for every organization	Other	To the extent permitted by Building and Fire Code and local jurisdictions, we understand that statewide IOU leads (for Emerging Technology, Custom, and HVAC programs), in collaboration with all IOUs, should evaluate cost effective program strategies that can support and fully align with statewide decarbonization goals.	Other	N/A	Other	SDG&E is the PA lead for upstream/midstream HVAC and is regularly collaborating with the third-party implementer (CLEAResult) on meeting the latest regulatory and cost effectiveness requirements. SDG&E and its third-party implementer plan to act once CARB regulation changes and natural refrigerants for major HVAC equipment are approved for use by the latest fire code.

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	GWP levels close to 1. Natural refrigerants like pure CO2, R-290 (propane), and ammonia have GWP levels below 10, but also require significant HVAC system redesigns before they can be made widely available.	mote natural refrigerants either through the emerging technology program, under custom programs, or any other HVAC program.									The promotional use of natural HVAC refrigerants is largely dependent on meeting CPUC cost effectiveness for deemed eTRM measures, and with local third-party implementers, statewide ET program, and upstream/mid-stream program third-party administrators.
9	Significant barriers limit refrigerant-only retrofits. <b>Additional Supporting Information:</b> In all 12 interviews with HVAC experts in which we discussed refrigerant only change-outs, the interviewees reported extensive challenges to changing refrigerants in most existing HVAC equipment. A refrigerant-only changeout would include simply replacing the existing refrigerant with a low-GWP alternative refrigerant with only minimal alterations to the equipment. The list of barriers includes various code violations including mechanical, fire and building codes, the need for partial system redesign once codes permit mildly flammable refrigerants, authorization from the manufacturer, authorization from the owner, and the need for the action to be cost-effective. Web- survey responses show increased feasibility for refrigerant-only retrofits on commercial HVAC equipment and chillers.	PAs should only consider the option of refrigerant-only changeouts in larger HVAC equipment like chillers and commercial roof- top units. The cost of replacing larger existing HVAC equipment is substantially higher than the cost and challenges of a refrigerant only change-out.	All PAs	Other	New refrigerants may not compatible with existing system components (seals for example) and the oil. We learned our lesson during the last refrigerant phased out. PAs should consider these facts before creating programs, this could change the TRCs.	Other	As now, due to decarbonization goals and cost effectiveness of these measures, SCE has discontinued Residential RCA (deemed) measures for PY2022. Similarly, as we understand from SDGE, the lead HVAC IOU has discontinued deemed RCA measures for the commercial sector for PY2022.	Other	N/A	Other	This given recommendation is best addressed by the current custom project review process (CMPA) given that each customer project site varies and likely requires an existing condition report, and pre/post measurement and evaluation (M&V) plan.
10	End-of-life emissions are alarming. <b>Additional Supporting Information:</b> Our research on CARB and EPA emission estimates show emissions either from intentional venting, improper disposal, or leaks during transport, are highest for residential and small commercial HVAC equipment. Everyone we spoke with said there is little to no incentive for contractors to recover and reclaim existing refrigerant in smaller equipment. All contractors we spoke with said the laws regulating intentional venting come with virtually zero enforcement. Among the people we spoke with and surveyed about refrigerant emissions, the most common solution shared is to offer incentives.	Provide incentives for safe and documented end-of-life refrigerant recovery. PAs should require the safe and documented recovery of remaining end-of-life refrigerant a prerequisite for any HVAC system change-out incentive. Providing incentives to promote end-of-life refrigerant recovery would not only reduce emissions but it will help track the rate of end- of-life emissions	All PAs	Other	PA incentive programs are designed to promote energy savings not refrigerant recovery. Programs will have to account for the expense of paying for used refrigerants. The TRC will have to be adjusted.	Accepted	SCE understands that the statewide HVAC IOU lead will likely be supporting the evaluation and creation of non-resource programs supporting the safe and documented recovery of remaining end-of-life refrigerant. SCE supports these activities.	Other	N/A	Other	SDG&E is currently evaluating the possibility of developing a new appliance recycling measure for refrigerator and freezers, for market support.  Providing incentives for reclaimed end-of-life refrigerants requires CPUC ex-ante review and approval and has the potential of being rejected based on free-ridership given that reclaiming of refrigerants is required by law. URL <a href="https://www.epa.gov/ods-phaseout/homeowners-and-consumers-frequently-asked-questions">https://www.epa.gov/ods-phaseout/homeowners-and-consumers-frequently-asked-questions</a> "Under Section 608 of the Clean Air Act, EPA prohibits individuals from

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		and improve future estimates.									knowingly venting refrigerants containing ozone-depleting refrigerants (including HCFC-22) as well as their substitutes (such as HFCs, including R-410A), while maintaining, servicing, repairing, or disposing of AC and refrigeration equipment”.
11	Refrigerant charge adjustments cause emissions to increase. <b>Additional Supporting Information:</b> Our research on CARB and EPA emissions estimates shows operational refrigerant leakage stems from system leakage and incidental leaks when servicing the system. These types of emissions increase every time refrigerant is added to a system. Whenever hoses and gauges are attached to a unit, some minor leakage will occur. Significant leakage can occur because of a temperamental valve or a system getting overcharged. Feedback from HVAC contractors indicates that the standard practice is to avoid even checking the refrigerant charge unless all other common issues are ruled out, but this was not standard practice until just recently. Historical evaluated energy efficiency performance for air-conditioner maintenance programs focusing on refrigerant charge adjustments demonstrate these activities often provide minimal energy performance improvements.	Stop funding refrigerant charge adjustments. PAs should consider discontinuing any HVAC maintenance programs that promote refrigerant charge adjustments. PAs should educate HVAC contractors about the problems associated with pro-active refrigerant charge adjustments and promote best practices for assessing charge levels without tapping refrigerant lines.	All PAs	Accepted	PG&E sunset refrigerant adjustments back in 2020.	Other	As now, due to decarbonization goals and cost effectiveness of these measures, SCE has discontinued Residential RCA (deemed) measures for PY2022. Similarly, SCE understands from SDGE, that the lead HVAC IOU has discontinued deemed RCA measures for the commercial sector for PY2022. Further, SCE understands that the statewide HVAC IOU lead will likely be supporting the evaluation and creation of non-resource programs to educate HVAC contractors about the problems associated with proactive refrigerant charge adjustments and promote best practices for assessing charge levels without tapping refrigerant lines. SCE supports these activities.	Other	N/A	Accepted	All Refrigerant Charge Adjustments (RCA) deemed measures are set to sunset and expire on 12/31/2021. SDGE is currently soliciting for the downstream HVAC Quality Installation/ Quality Maintenance program and will look to work with the successful bidder to incorporate this recommendation.