Energy+Environmental Economics

IDER 2020 Avoided Cost Calculator Update

Avoided Cost of High GWP Gases

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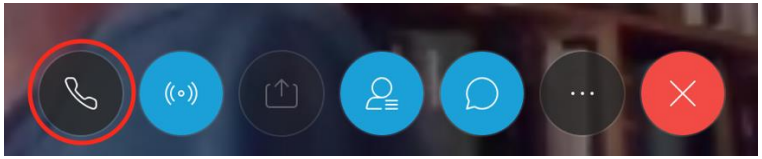
Agenda

- **What are high GWP gases and why do we need a new avoided cost? (15 min)**
  - Discussion/Questions (5 min)
- **Methane leakage methodology (15 min)**
  - Discussion/Questions (20 min)
- **Break (10 min)**
- **Refrigerant leakage methodology (15 min)**
  - Discussion/Questions (20 min)
- **Use cases in the Avoided Cost Calculator (15 min)**
  - Discussion/Questions (20 min)

Logistics

- **Please use the Q&A feature to ask questions.**
- **Questions will be answered during the allotted discussion periods after each section.**
- **If you have a longer question you would prefer to use your microphone for, you can request to be unmuted by clicking on the button with the phone icon:**

  - Once you are given speaking permissions, you will need to connect your audio by clicking on the phone icon on the main screen:



What are high GWP gases?

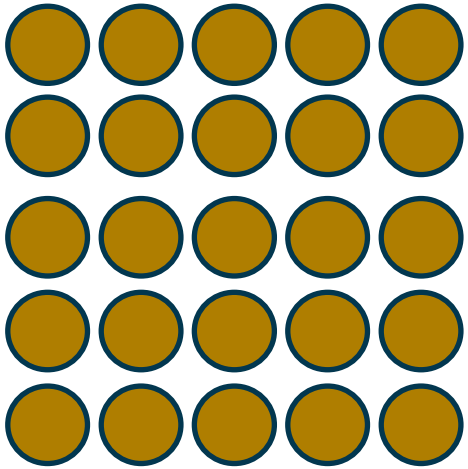
- GWP stands for Global Warming Potential, which is the potency of a greenhouse gas relative to CO2
- Methane, the primary component of natural gas, is one high GWP gas, with a 100-year GWP of 25
- Refrigerants are also high GWP gases, with typical GWPs around ~2,000

"Methane has a GWP of 25" means…

1 tonne methane

…has the same global warming impact as…

25 tonnes CO2



Why do we need a new avoided cost?

- The impetus for this new avoided cost is fuel substitution efforts, which could substantially change the amount of high GWP gases that are emitted to the atmosphere
- Fuel substitution efforts have the potential to change both methane leakage and refrigerant leakage

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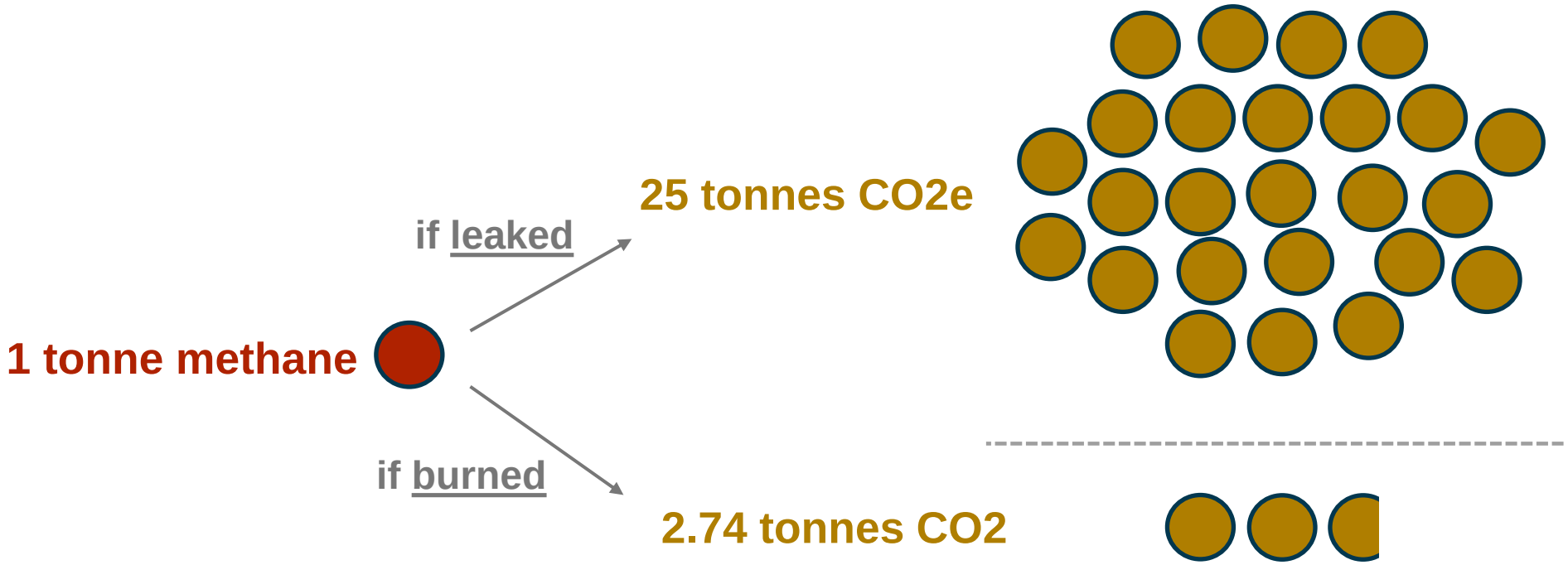
Discussion/Questions

Methane leakage

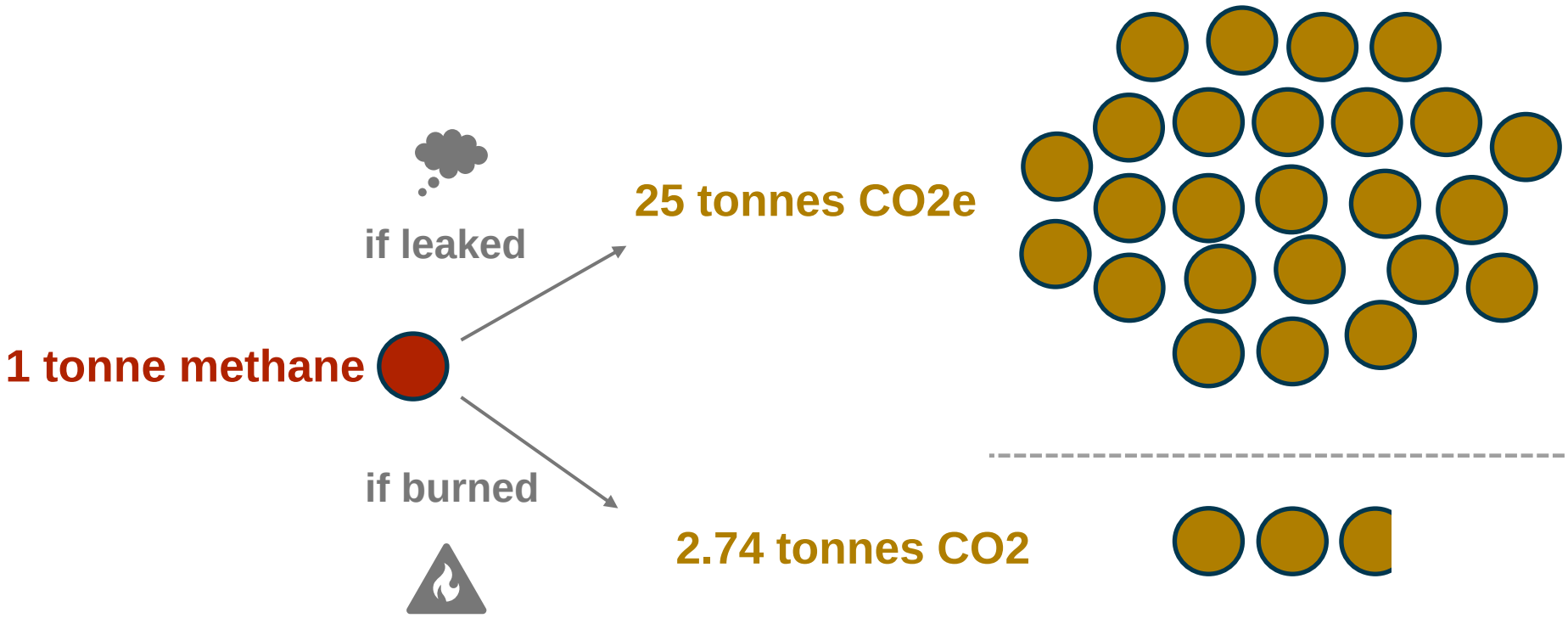
- Methane leaks from the natural gas system significantly increase the lifecycle GHG impact of natural gas
- National average methane leak rate estimated to be at least 2.3% of consumption
- Since Staff Proposal, methane leakage methodology was reviewed in coordination with CARB; have adopted a revised in-state methane leakage rate

Methane leakage Rates and Adders

- Originally proposed in-state leakage rate was 0.7% of consumption
- 0.7% of methane consumption leaked leads to a 6.4% increase in total CO2-equivalent emissions from natural gas. We refer to this 6.4% as a leakage adder.



Methane leakage Rates and Adders



$$\frac{\textbf{25}\ \text{tonnes CO2e if leaked}}{\textbf{2.74}\ \text{tonnes CO2 if burned}} = \textbf{9.1}\ \text{times more CO2e emissions if leaked than if burned}$$

Methane leakage Rates and Adders

$$\frac{\textbf{25}\ \text{tonnes CO2e if leaked}}{\textbf{2.74}\ \text{tonnes CO2 if burned}} = \textbf{9.1}\ \text{times more CO2e emissions if leaked than if burned}$$

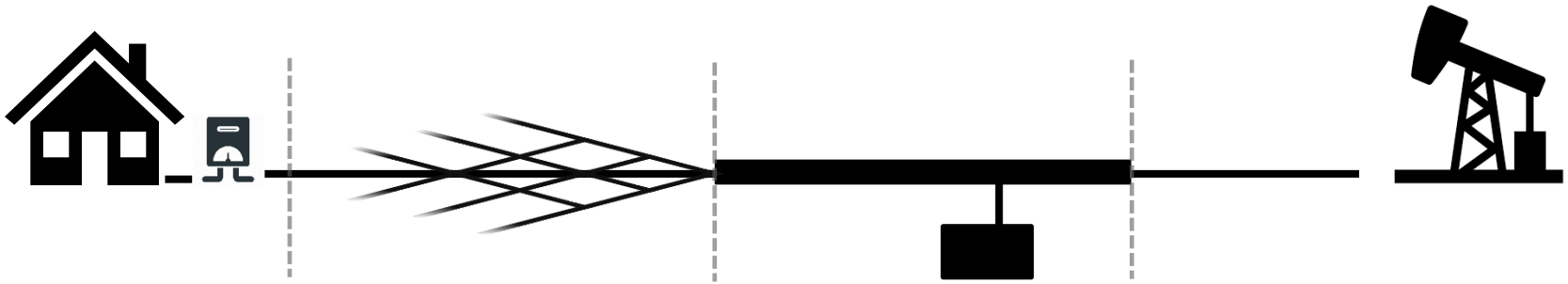
And therefore…

0.7% methane leakage rate * 9.1 = 6.4% increase in total CO2-equivalent emissions

= "6.4% leakage adder"

In-state methane leakage: new estimate

- **Since the Staff Proposal, we have coordinated with CARB to refine the 6.4% estimate into two components:**
  - an upstream methane leakage adder of 5.57%, and
  - a residential behind-the-meter leakage adder of 3.78%.



Behind-the-meter | **Distribution** | **Transmission & Storage** | **Production (95% outside of California)**

$$6.4\% = \frac{\text{Res behind-the-meter leakage + Distribution leakage + Transmission \& Storage leakage + In-state production leakage}}{\text{Total in-state natural gas consumption}}$$

$$5.57\% = \frac{\text{Distribution leakage + Transmission \& Storage leakage + In-state production leakage}}{\text{Total in-state natural gas consumption}}$$

$$3.78\% = \frac{\text{Res behind-the-meter leakage}}{\text{Res natural gas consumption}}$$

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Discussion/Questions

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Break

Refrigerants

- Refrigerants are gases that absorb and transfer heat
- They are used in all air conditioners and refrigerators, as well as in heat pumps
- The most common refrigerants in use today have a GWP of around 2,000

Refrigerant leakage

- Including refrigerant leakage in the ACC will allow us to accurately determine the lifecycle emissions savings of fuel substitution measures, and incentivize low-GWP refrigerants
- The California Air Resources Board has compiled data on average leakage rates for appliances that use refrigerants

Appliance	Typical refrigerant	Refrigerant GWP	Average refrigerant charge	Average annual leakage	Average end-of-life leakage
Central A/C	R410A	2088	7.5 lbs	5%	80%
Air-source ducted heat pump	R410A	2088	8.2 lbs	5.3%	80%
Heat pump water heater	R134A	1430	2.4 lbs	1%	95%

Refrigerant leakage in the ACC

+ Excerpt from ACC refrigerant leakage table:

Sector	Device type	Average lifetime (years)	Average charge size (lbs)	Average annual leak rate	Average end-of-life loss rate of remaining refrigerant	Number of years prior to EOL with no "top-off" refrigerant added to replace full charge	Percentage of refrigerant charge lost during lifetime	Mass of refrigerant lost during lifetime for average unit (lbs)
Stationary Air-conditioning	Large Chiller 2,000 lbs. +	20	3,978	2.3%	20.0%	0	**66%**	2,625.5
	Medium Chiller 200-2,000 lbs.	20	526	3.0%	20.0%	0	**80%**	420.8
	Commercial Unitary AC 50-200 lbs., > 135,000 BTUh size	20	70	7.0%	20.0%	0	**160%**	112.0
	Commercial Unitary AC, < 50-lbs., < 135,000 BTUh size (includes smaller "residential-type" central AC and heat pumps)	15	18.2	4.7%	56.0%	0	**127%**	23.0
	Window/Room AC and PTAC Units, commercial	12	1.54	2.0%	98.5%	12	**99%**	1.5
	Residential Unitary AC	15	7.5	5.0%	80.0%	3	**143%**	10.7
	Residential Heat Pumps	15	8.2	5.3%	80.0%	3	**147%**	12.0
	Window/Room/Wall AC and Packaged Terminal AC (PTAC) Units, residential	12	1.54	2.0%	98.5%	12	**99%**	1.5
	Portable AC	10	1.54	1.0%	98.5%	10	**99%**	1.5
	Dehumidifiers	5	1.00	1.0%	98.5%	5	**99%**	1.0

+ Standardized refrigerant GWPs also included in a separate tab

+ Separate refrigerant calculator to be used for cost-effectiveness analyses will be available soon

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Discussion/Questions

Use Cases

- **Methane and refrigerant leakage will be incorporated into the avoided cost framework under three "use cases":**
  1. Changes in electricity usage
  2. Changes in gas usage
  3. Changes in refrigerant usage or type
- **The primary adopted High GWP avoided costs use a 100-year GWP, but a toggle to use the 20-year GWP is included for sensitivity analysis.**

Use Case #1: Electricity Usage

- This use case will apply to all DERs that result in changes in electricity usage
- The upstream methane leakage adder of 5.57% is added to the GHG adder, to reflect the additional GHG intensity of natural gas consumption by electric generators when gas is the marginal resource

Total emissions avoided cost ($/tonne) = GHG adder ($/tonne) * (100% + 5.57%)

Use Case #2: Natural Gas Usage

- This use case will apply to all DERs that result in changes in direct natural gas usage in a building
- Upstream methane leakage adder of 5.57% is applied as an increase in the GHG intensity of all natural gas consumption
- Additional behind-the-meter methane leakage adder of 3.78% for measures that eliminate natural gas appliances from a residential building

Total emissions avoided cost ($/therm) = GHG adder ($/therm) * (100% + 5.57% *+ 3.78%*)

if gas appliance is removed from Residential building

Use Case #3: Changes in Refrigerant Usage or Type

- This use case will apply to all DERs that change the amount or type of refrigerant being used in a building
- Refrigerant leakage is calculated for both the new and replaced appliances, using leakage rates and GWPs from CARB included in the ACC spreadsheet
- Refrigerant leakage emissions valued at GHG adder $/tonne

Change in refrigerant leakage emissions	=	New appliance refrigerant leakage	-	Replaced appliance refrigerant leakage
(CO2-equivalent)		(CO2-equivalent)		(CO2-equivalent)

Example: Heat pump water heater

- **Can compare annualized lifecycle emissions of a heat pump water heater and a gas water heater**
  - **Heat pump water heater emissions:**
    - Upstream electricity emissions

      + lifecycle refrigerant leakage emissions / lifetime
    - = 0.2 tonnes upstream electricity emissions

      + (2.4 lbs R134a)*(100% lifetime leakage)*(0.00045 tonnes/lb)*(1430 GWP) / 14-year lifetime
    - **Total = 0.31 tonnes/yr**
  - **Gas water heater emissions:**
    - Gas combustion emissions

      + avoided methane leakage emissions
    - = 0.7 tonnes gas combustion emissions

      + 5.57% upstream leakage adder + 3.78% behind-the-meter leakage adder
    - **Total = 0.765 tonnes/yr**

Summary of changes to ACC

- Upstream methane leakage adder of 5.57% is included in the ACC as an increase to the GHG intensity of natural gas
- Behind-the-meter leakage adder of 3.78% is additionally added for measures that remove gas appliances from residential buildings
- Refrigerant leakage table is included in the ACC, to be applied for any measure that changes refrigerant amount or type

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Discussion/Questions