California Statewide Gas Emerging Technologies

Final Presentation- ET23SWG0020

Clean O2 Technology Focused
Pilot Market Study

11/19/2024

Agenda

- Project Objectives
- Literature Review
- Survey Tools
- Interviews and Survey Results
- Conclusion
- Recommendation

Project Objectives

Project Objectives

- The main objectives of this market study are to conduct a literature review on waste heat recovery technologies with energy savings benefits that also have a carbon capture element, followed by a series of surveys to identify potential opportunities for the technology including ways to utilize the potassium carbonate product.
- Another objective was to identify potential energy efficiency programs that could include this technology in their measure portfolio.
- The last objective was to identify potential customers that would benefit from this technology.

Literature Review

Literature Review – CarbinX™ Technology Overview

- The CarbinX™ unit, is defined as a micro-scale carbon capture unit (MCCU). The unit operates by diverting a portion of waste carbon emissions from natural gas heating appliances flue gas emissions.

Figure 1. CarbinX ™ Unit

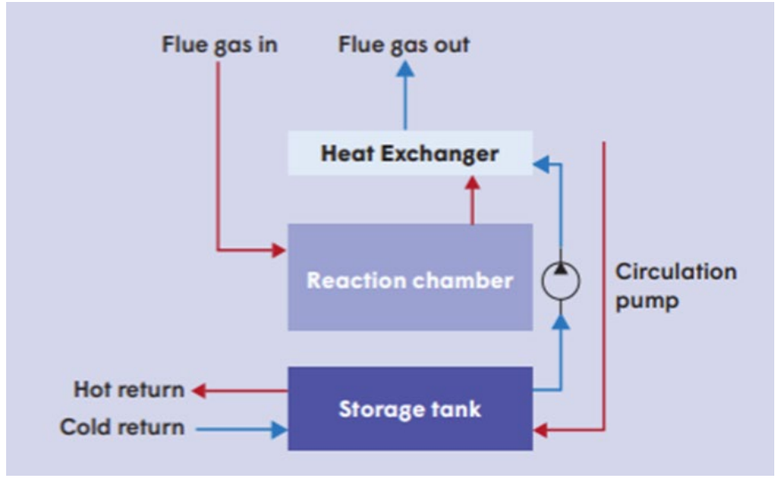


Figure 2. CarbinX™ heat recovery process

Literature Review – Life Cycle Analysis

- Independent LCA concluded that the project scenario emits 30-73% less CO_2 than the baseline.
- The study found that the unit decreases the building overall net emissions by 21-27%
- The CarbinX ™ unit offers a 5-6 year payback period through energy savings and rebates from the sale of the potassium carbonate product

Table 1. LCA Project Scenario and Baseline Comparison

CO_2 Emissions	Baseline Scenario	Project Scenario	Difference Between Scenarios
Kg of CO_2e/kgK_2CO_3 produced	10.44 ± 2.51	5.95 ± 2.51	4.49 ± 3.55
Kg of CO_2e/ GJ heat produced	172.79 ± 23.04	74.93 ± 11.40	97.86 ± 25.71

Table 2. LCA Sensitivity Analysis results of the CarbinX ™ heat exchanger efficiencies

	Heat Exchanger Efficiency	
Parameter	79%	65%
Heat Recovery	266 GJ/year	219 GJ/year
Natural Gas Volume Used	323-2,173 GJ/year	393-2,243 GJ/year
GHG emissions	5.95 ± 2.51 kg $CO_2e/kg\ K_2CO_3$ (average)	6.31 ± 2.52 kg $CO_2e/kg\ K_2CO_3$ (average)

Literature Review – Opportunities for Potassium Carbonate Product

- Potassium Carbonate has many uses in the manufacturing of multiple products. The market opportunity for potassium carbonate is huge, and the U.S. potassium carbonate market is expected to reach a market value of $500 million by 2025.

Common end uses for potassium carbonate are listed below:

- Soaps, Detergents & Cleaning Products
- Agrochemicals
- Food & Beverage Processing
- Personal Care Products
- Glass
- Paper
- Dyes & Inks
- Fire Suppression Products
- Water Treatment

Literature Review – Carbon Capture Credits

- The Section 45Q Tax Credit for Carbon Sequestration is computed per metric ton of qualified carbon oxide captured and sequestered.
- To claim a tax credit, the carbon oxide emissions must be measured at the point of capture as well as at the point of disposal, injection, or other use.
- The Inflation Reduction Act (IRA) of 2022 has recently modified and extended Section 45Q to allow a larger credit for qualified facilities or carbon capture equipment that meet certain wage and apprenticeship requirements.
- The IRA has also extended eligibility to claim credit to certain nonprofits and entities without ownership interests.
- However, this market study found that tax credits or incentives for MCCU's do not yet exist.
- Figure 3.0 summarizes the equipment eligibility.

Equipment Placed in Service after 2/8/2018 and before 1/1/2023	Equipment Placed in Service after 12/31/2022 and Construction Beginning Prior to 1/1/2033
Credit Amount (per Metric Ton of CO_2)	
Geologically Sequestered CO_2	
$40.89 per Metric Ton of CO_2 in 2023. Increasing ratably to $50 by 2026, then inflation-adjusted.	Base credit of $17 per Metric Ton of CO_2 ($36 for DAC), increased to $85 ($180 for DAC) for facilities that pay prevailing wages during the construction phase and during the first 12 years of operation and meet registered apprenticeship requirements. Amounts adjusted for inflation after 2026.
Geologically Sequestered CO_2 with EOR	
$27.61 in 2023. Increasing ratably to $35 by 2026, then inflation-adjusted.	Base credit of $12 ($26 for DAC), increased to $60 ($130) for facilities that pay prevailing wages during the construction phase and during the first 12 years of operation and meet registered apprenticeship requirements. Amounts adjusted for inflation after 2026.
Other Qualified Use of CO_2	
$27.61in 2023. Increasing ratably to $35 by 2026, then inflation-adjusted.	Base credit of $12 ($26 for DAC), increased to $60 ($130) for facilities that pay prevailing wages during the construction phase and during the first 12 years of operation and meet registered apprenticeship requirements. Amounts adjusted for inflation after 2026.
Claim Period	
12-year period once facility is placed in service.	12-year period once facility is placed in service, reduced to 5-year period if transferred.
Annual Capture Requirements	
Power plants: Capture at least 500,000 metric tons. *Facilities that emit no more than 500,000 metric tons per year:* Capture at least 25,000 metric tons. *DAC and other capture facilities:* Capture at least 100,000 metric tons.	*Power plants:* Capture at least 18,750 metric tons and a capture design capacity not less than 75% of baseline emissions. *DAC facilities:* capture at least 1,000 metric tons. *Other capture facilities:* capture at least 12,500 metric tons.
Eligibility to Claim Credit	
Entity who owns the capture equipment and physically or contractually ensures the disposal, utilization, or use as a tertiary injectant of the CO_2.	Entity who owns the capture equipment and physically or contractually ensures the disposal, utilization, or use as a tertiary injectant of the CO_2. Certain tax-exempt entities can claim the tax credit through "direct pay" and other entities are allowed a one-time transfer to another entity.

Source: CRS analysis of IRC Section 45Q, 26 U.S.C. §45Q.

Notes: After 2017, the credit can be claimed for all carbon oxides, not just CO_2. Equipment placed in service prior to February 8, 2018, is no longer eligible for the 45Q tax credit.

Figure 3.0 Section 45Q Tax Credit

Survey Tool

Survey Tool

Three separate survey tools were developed to target potential customers, Clean O2 executives, and EE program managers.

Survey Tool #1 Clean O2	Survey Tool #2 Program Managers	Survey Tool #3 Potential Customers
• Questions about opportunities and barriers on the CarbinX Unit from Clean O2s perspective • Gather input on market ideas • Lessons learned from previous installations • Opportunities for potassium carbonate	• Obtain information from PMs to identify feasibility of including the CarbinX unit as a measure offering	• Potential customers were surveyed on drivers and opportunities to install a CarbinX unit. • Surveys participant were offered a $50 Amazon Gift Card Incentive

Interview and Survey Results

Clean O2 Interview Summary

- Clean O2 had expressed market opportunities for the CarbinX™ unit such as single detached homes, heavy commercial and light industrial applications for industries bigger than a hotel
- The goal for the company in the future is to eventually move away from being an auxiliary device to becoming a primary device and manufacturing items such as boilers and furnaces with the imbedded carbon capture technology
- Several key lessons that the company has learned from prior CarbinX™ installations include how to technically solve the issue of moisture build up in the reaction chamber.
- Clean O2 hopes to move into the direction of offering Decarbonization as a Service (DAAS), where the CarbinX™ unit is offered as an operating expense where the unit is provided at low to zero cost, but there is an ongoing fee that the customer is charged
- Clean O2 hopes to focus more on the agriculture sector and is interested in leveraging the potassium carbonate to develop fertilizers. Other opportunities noted include textiles, pharmaceuticals, food preparation, and production of rubber materials.

Program Manager Interview Summary

- Individuals from both the SCG Multifamily and Business Programs for Energy Efficiency Rebates were interviewed to learn more about how feasible it is for these programs to offer the CarbinX™ unit as a measure
- When determining what measure to implement into a program, they evaluate both the cost effectiveness and incentive level pricing for the program to consider it.
- Given that the current plan is to evaluate the CarbinX™ unit in a hospitality setting, the multifamily PM has called for further tests to be conducted at a multifamily site in order to bring this technology into multifamily programs. The programs would also need to see a workpaper developed to offer this technology at a downstream level.
- When asked about if any EE program would be able to able to claim credit for carbon capture savings associated with the CarbinX™ unit, the PMs were not sure if carbon capture credits could be claimed through the program. They stated they can only incentivize on the energy efficiency side of the technology.

Type of Facility	Count of Customers	Sum of Boilers	Sum of Boiler Equipment Load (MBTUH)	Sum of Boiler Equipment Load (Therms)	Potential Energy Savings with CarbinX (Therms)	Potential CO_2 removal (lbs)
Assisted Living Facilities for the Elderly	74	163	86,709	867,090	173,418	2,028,991
Beauty Salons	16	30	16,507	165,070	33,014	386,264
Casino Hotels	2	10	26,929	269,290	53,858	630,139
Coin-Operated Laundries and Drycleaners	380	991	524,598	5,245,980	1,049,196	12,275,593
Colleges, Universities, and Professional Schools	201	370	1,336,434	13,364,340	2,672,868	31,272,556
Consumer Electronics and Appliances Rental	4	5	2,572	25,720	5,144	60,185
Continuing Care Retirement Communities	58	125	81,070	810,700	162,140	1,897,038
Correctional Institutions	11	57	232,300	2,323,000	464,600	5,435,820
Cosmetology and Barber Schools	4	4	3,439	34,390	6,878	80,473
Courts	11	49	74,547	745,470	149,094	1,744,400
Drycleaning and Laundry Services (except Coin-Operated)	314	647	525,555	5,255,550	1,051,110	12,297,987
Elementary and Secondary Schools	540	934	888,472	8,884,720	1,776,944	20,790,245
Fire Protection	22	29	16,171	161,710	32,342	378,401
General Medical and Surgical Hospitals	164	316	1,363,139	13,631,390	2,726,278	31,897,453
Hotels (except Casino Hotels) and Motels	541	1,238	834410	8,344,100	1,668,820	19,525,194
Industrial Launderers	12	26	110,130	1,101,300	220,260	2,577,042
Junior Colleges	52	88	123,024	1,230,240	246,048	2,878,762
Lessors of Nonresidential Buildings (except Miniwarehouses)	500	1,091	2,607,427	26,074,270	5,214,854	61,013,792
Lessors of Real Estate	36	62	100,869	1,008,690	201,738	2,360,335
Lessors of Residential Buildings and Dwellings	58	136	76,442	764,420	152,884	1,788,743
Linen Supply	8	16	96,821	968,210	193,642	2,265,611
Nail Salons	10	22	9,867	98,670	19,734	230,888
Nonresidential Property Managers	60	182	738,919	7,389,190	1,477,838	17,290,705
Nursing Care Facilities (Skilled Nursing Facilities)	24	63	30,080	300,800	60,160	703,872
Offices of Real Estate Agents and Brokers	80	151	151,590	1,515,900	303,180	3,547,206
Other Activities Related to Real Estate	41	67	96,874	968,740	193,748	2,266,852
Other Commercial and Industrial Machinery and Equipment Rental and Leasing	3	4	3,950	39,500	7,900	92,430
Other Personal Care Services	10	25	8,758	87,580	17,516	204,937
Other Technical and Trade Schools	3	5	2,329	23,290	4,658	54,499
Parking Lots and Garages		1	440	4,400	880	10,296
Pet Care (except Veterinary) Services	7	11	5,285	52,850	10,570	123,669
Police Protection	24	40	33,027	330,270	66,054	772,832
Psychiatric and Substance Abuse Hospitals	10	20	128,982	1,289,820	257,964	3,018,179
Rooming and Boarding Houses, Dormitories, and Workers' Camps	14	19	21,115	211,150	42,230	494,091
RV (Recreational Vehicle) Parks and Campgrounds	12	20	5,432	54,320	10,864	127,109

Greenhouse Gas Equivalencies

~243,046,078 lbs CO_2 emissions avoided

This is equivalent to CO_2 emissions from:

- 26,238 gasoline-powered passenger vehicles driven for one year
- 14,377 homes energy use for one year
- 7,277,960,148 smartphones charged

This is equivalent to carbon sequestered by:

- 1,822,898 tree seedlings grown for 10 years
- 128,713 acres of U.S. forests in one year
- 707 acres of U.S. forests preserved from conversion to cropland in one year

Survey Responses

- A total of 53 customers participated in the voluntary survey

Sector	Number of Survey Participants
Coin-Operated Laundries and Drycleaners	22
Lessors of Nonresidential Buildings (except Miniwarehouses)	9
Elementary and Secondary Schools	8
Other	6
Hotels (except Casino Hotels) and Motels	2
Offices of Real Estate Agents and Brokers	2
Colleges, Universities, and Professional Schools	2
Homeless Shelter	1
Continuing Care Retirement Communities	1
Total	53

Survey Responses – Question 1

Are there any barriers preventing you from installing a CarbinX™ unit at your facility?

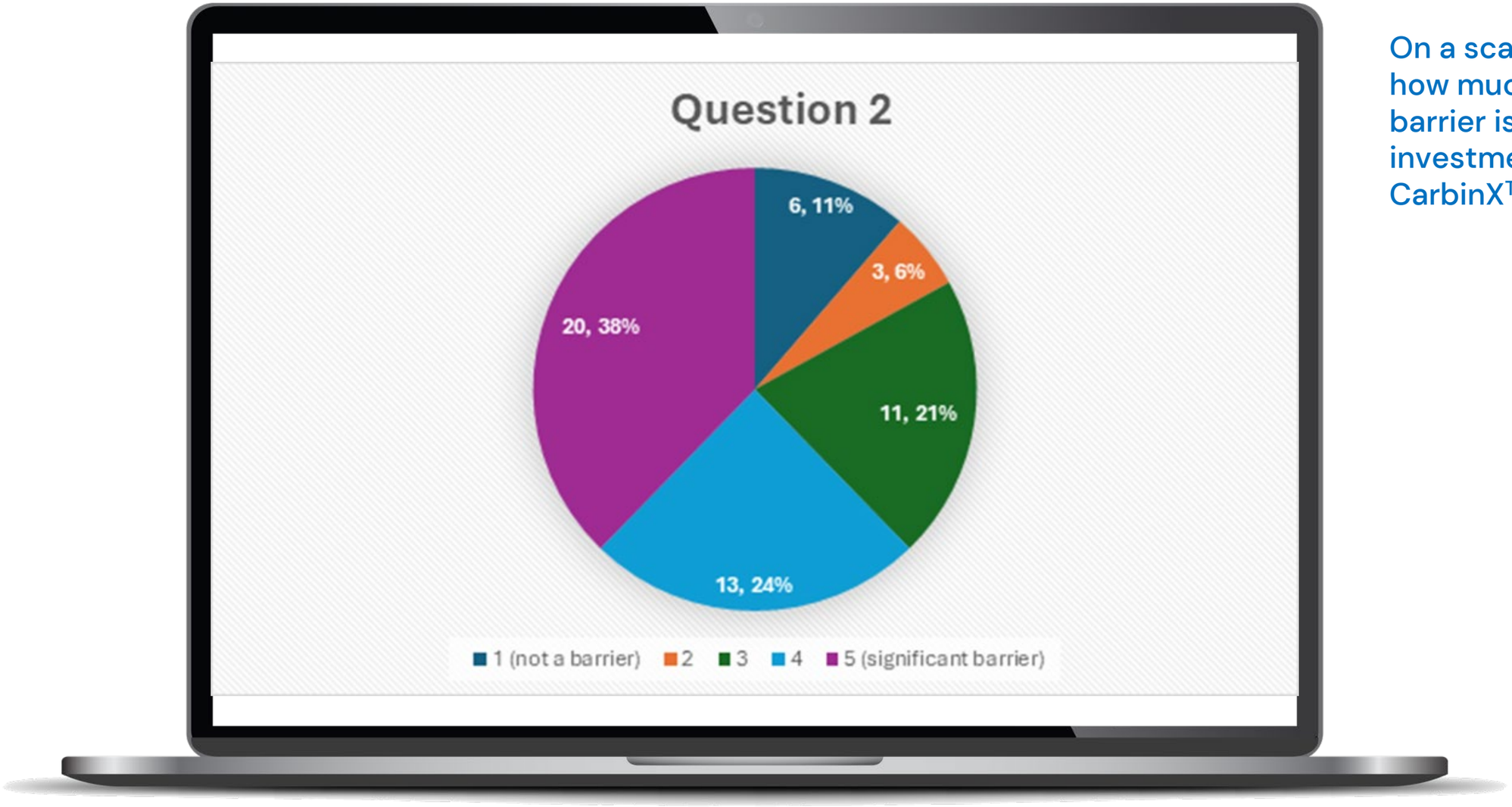
This was an open-ended question, and the key responses include the following:

- 22% of customers answered “cost”
- 30% said no barriers.
- Some stated that the space and size of the unit would be a
- barrier
- Some claimed that the return on investment was a barrier
- Some have never heard of the product or don’t know anyone

who has used it. Thus, the lack of awareness.

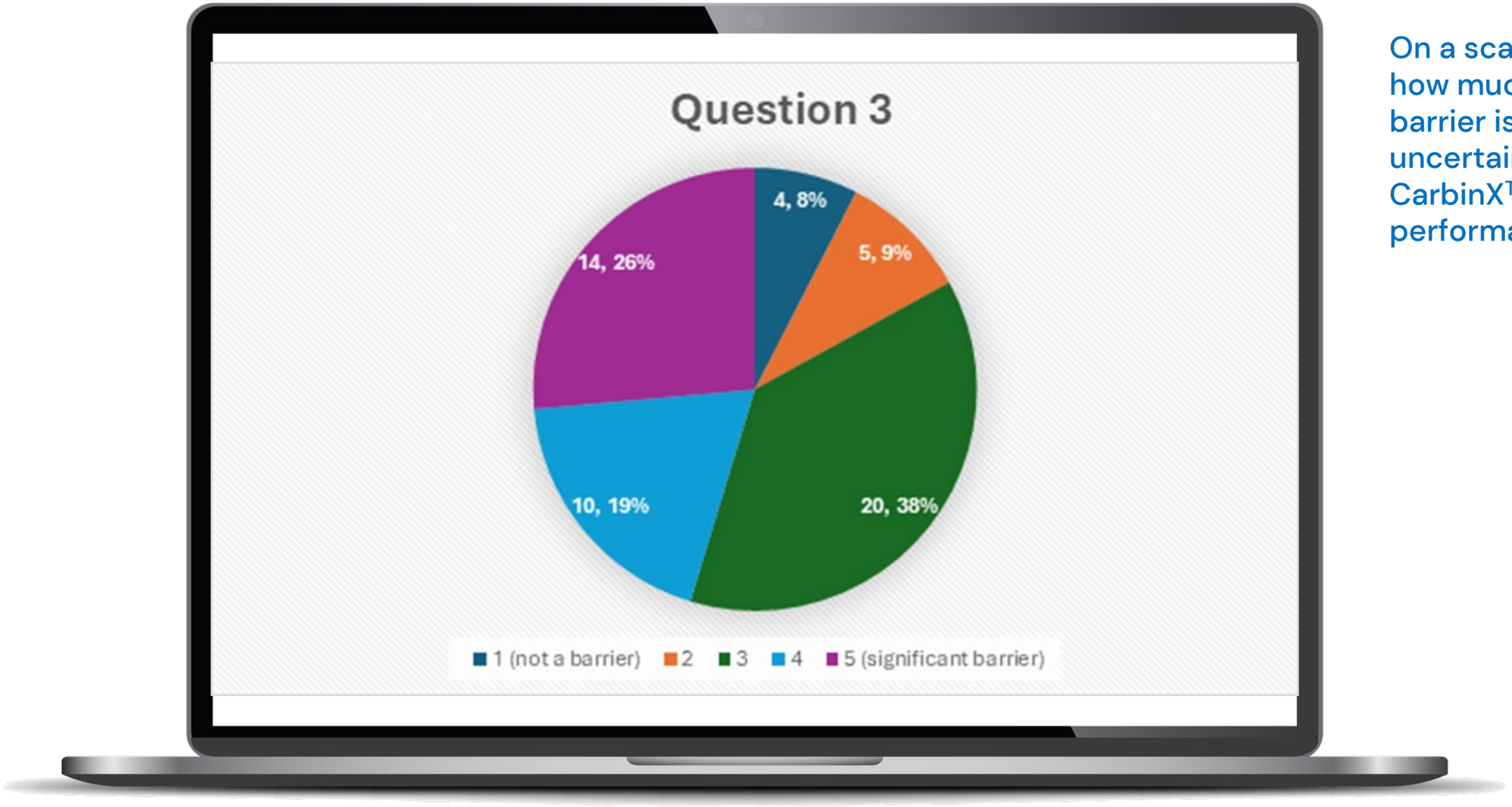
- Some stated that corporate approval was a barrier.

Survey Responses – Question 2



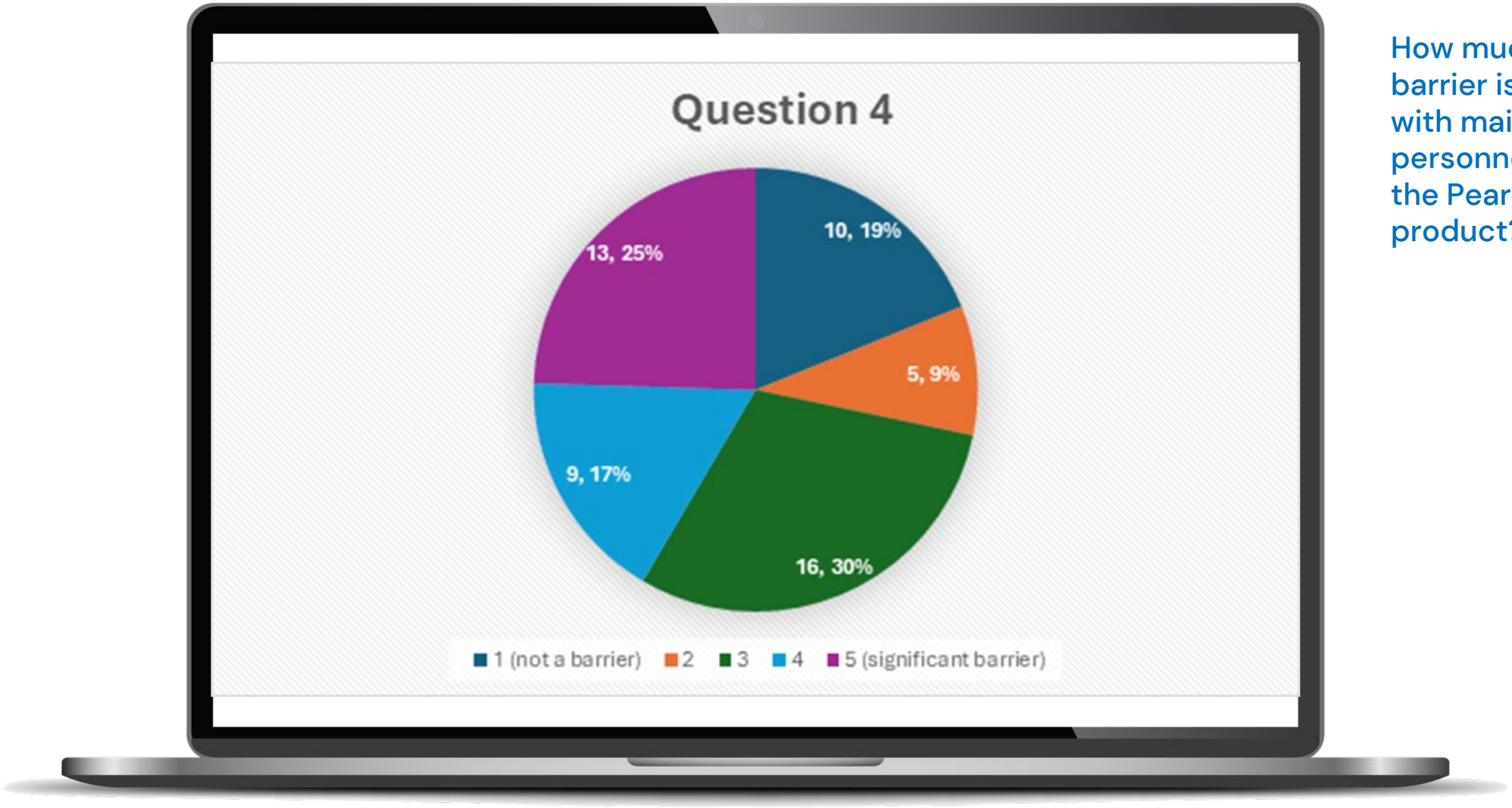
On a scale of 1-5, how much of a barrier is the initial investment of the CarbinX™ unit?

Survey Responses – Question 3



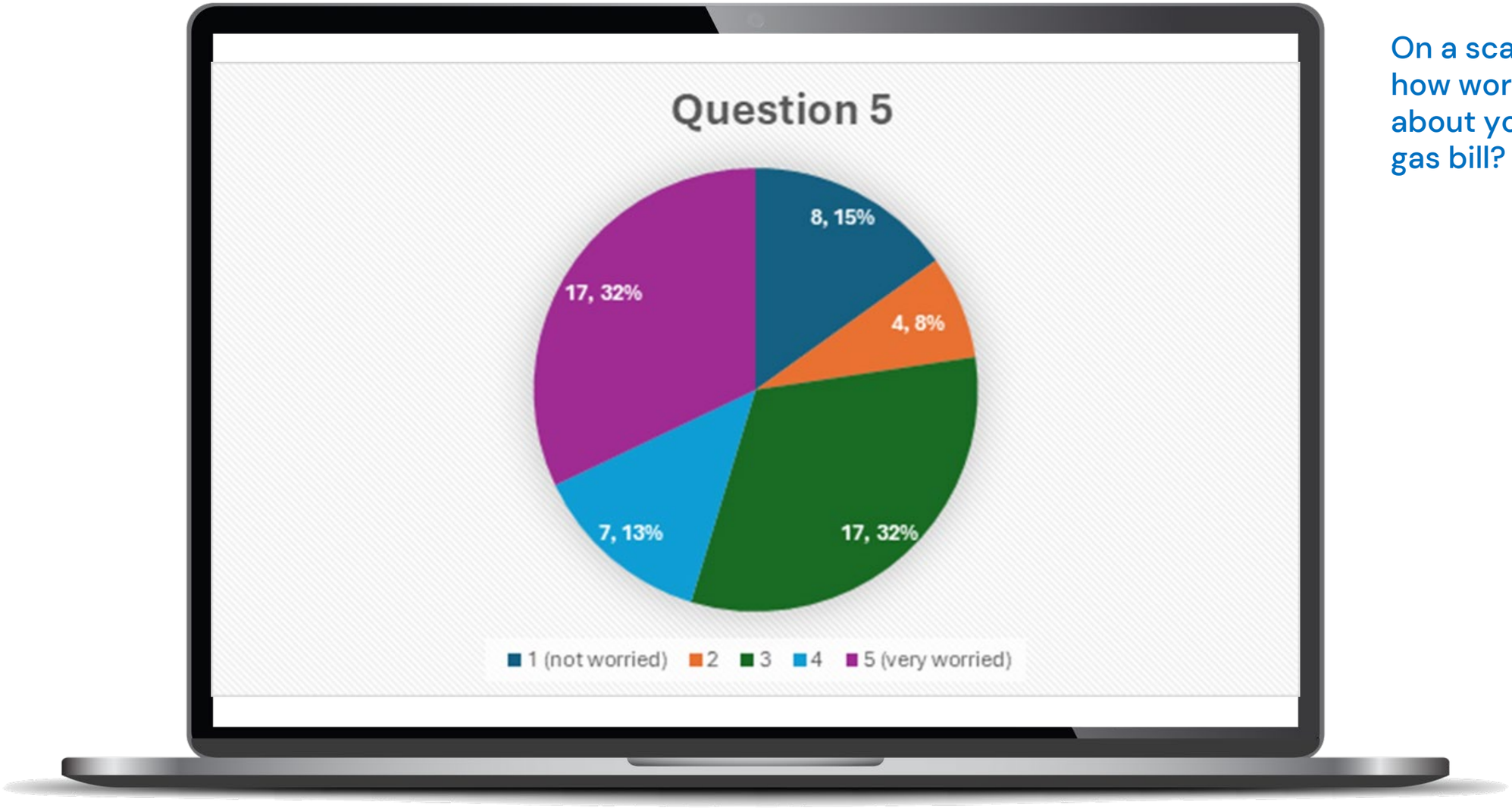
On a scale of 1-5, how much of a barrier is the uncertainty of the CarbinX™ unit's performance?

Survey Responses – Question 4



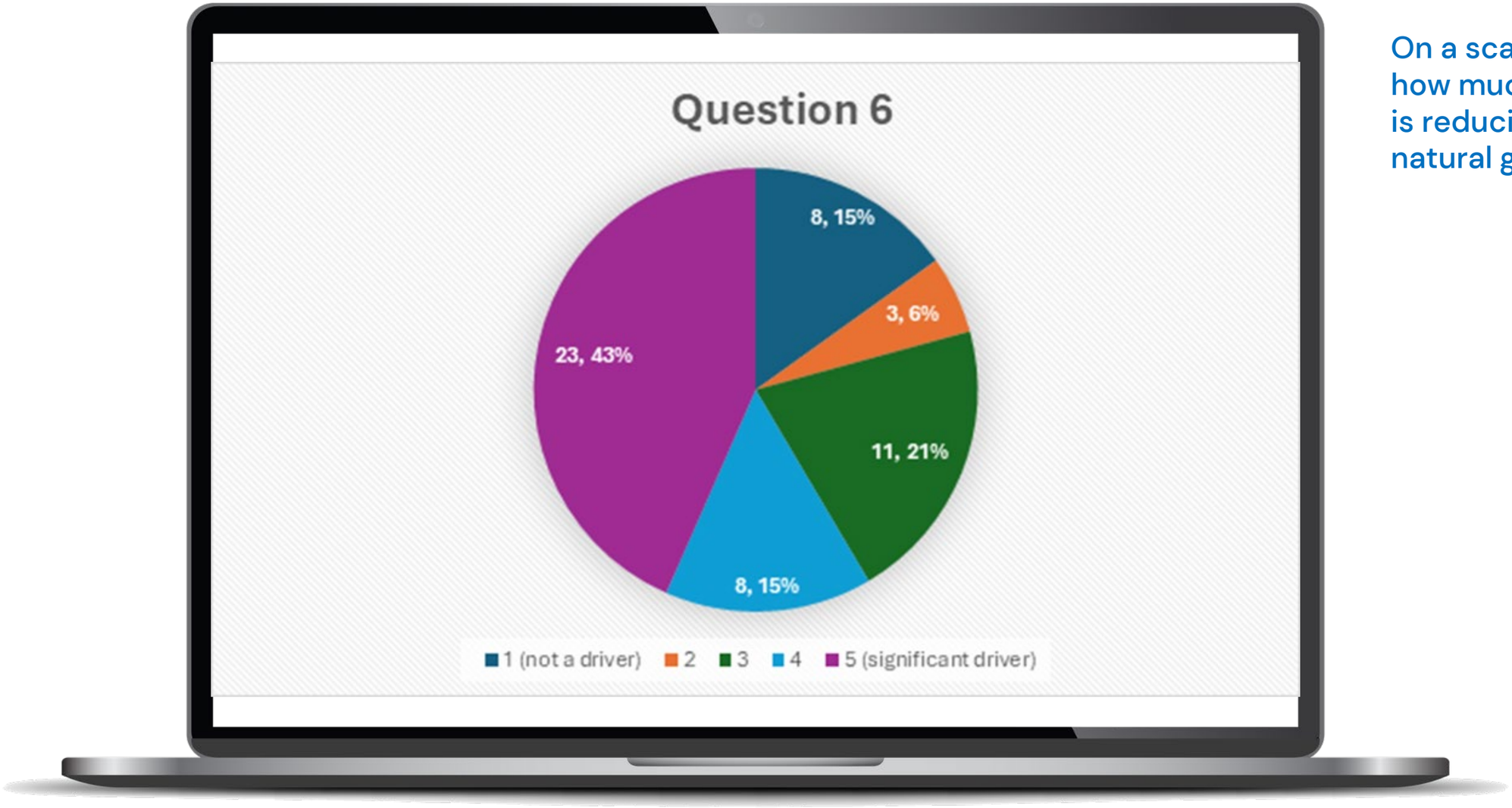
How much of a barrier is dealing with maintenance personnel removing the Pearl Ash product?

Survey Responses – Question 5



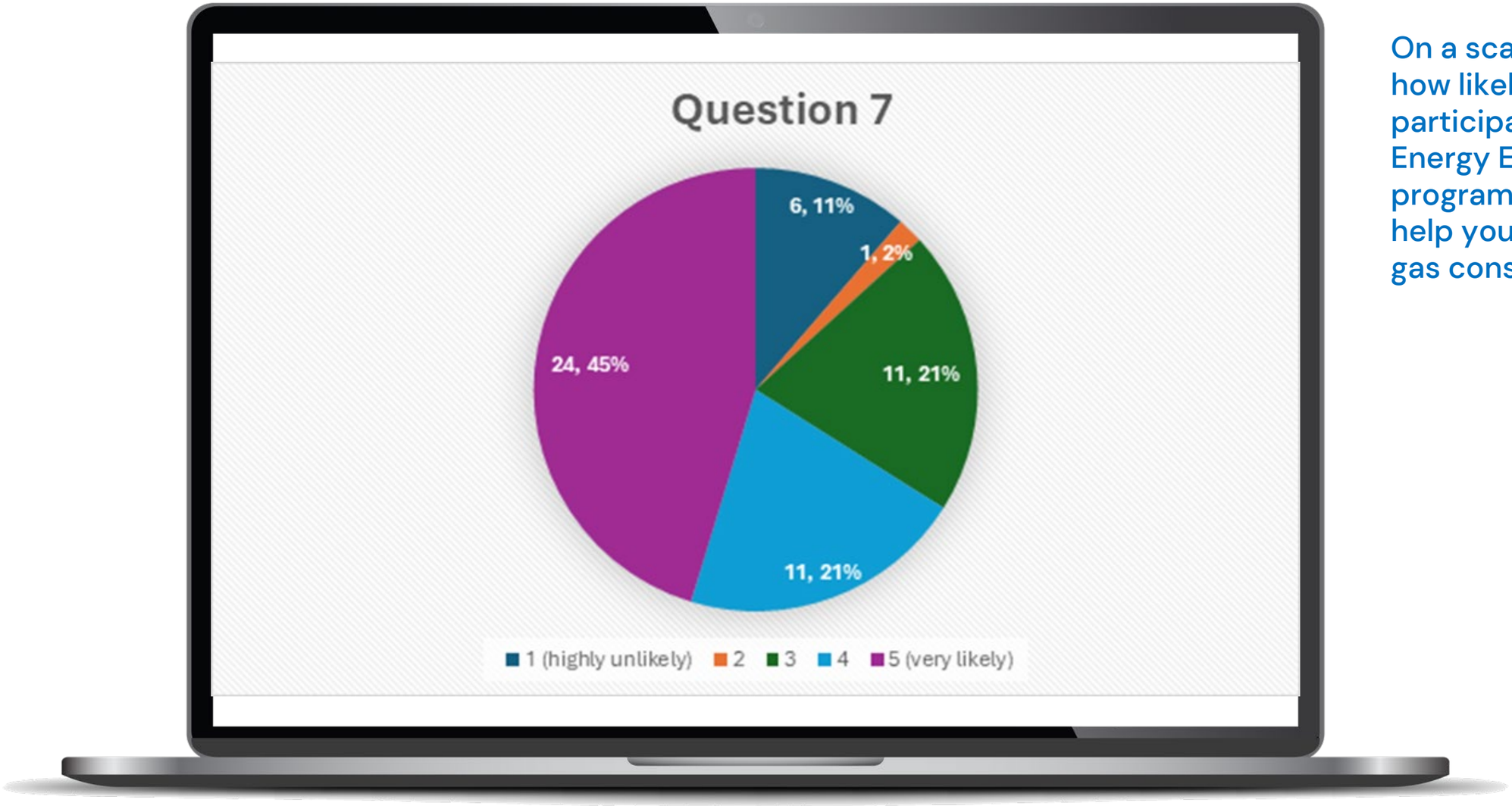
On a scale of 1-5, how worried are you about your natural gas bill?

Survey Responses – Question 6



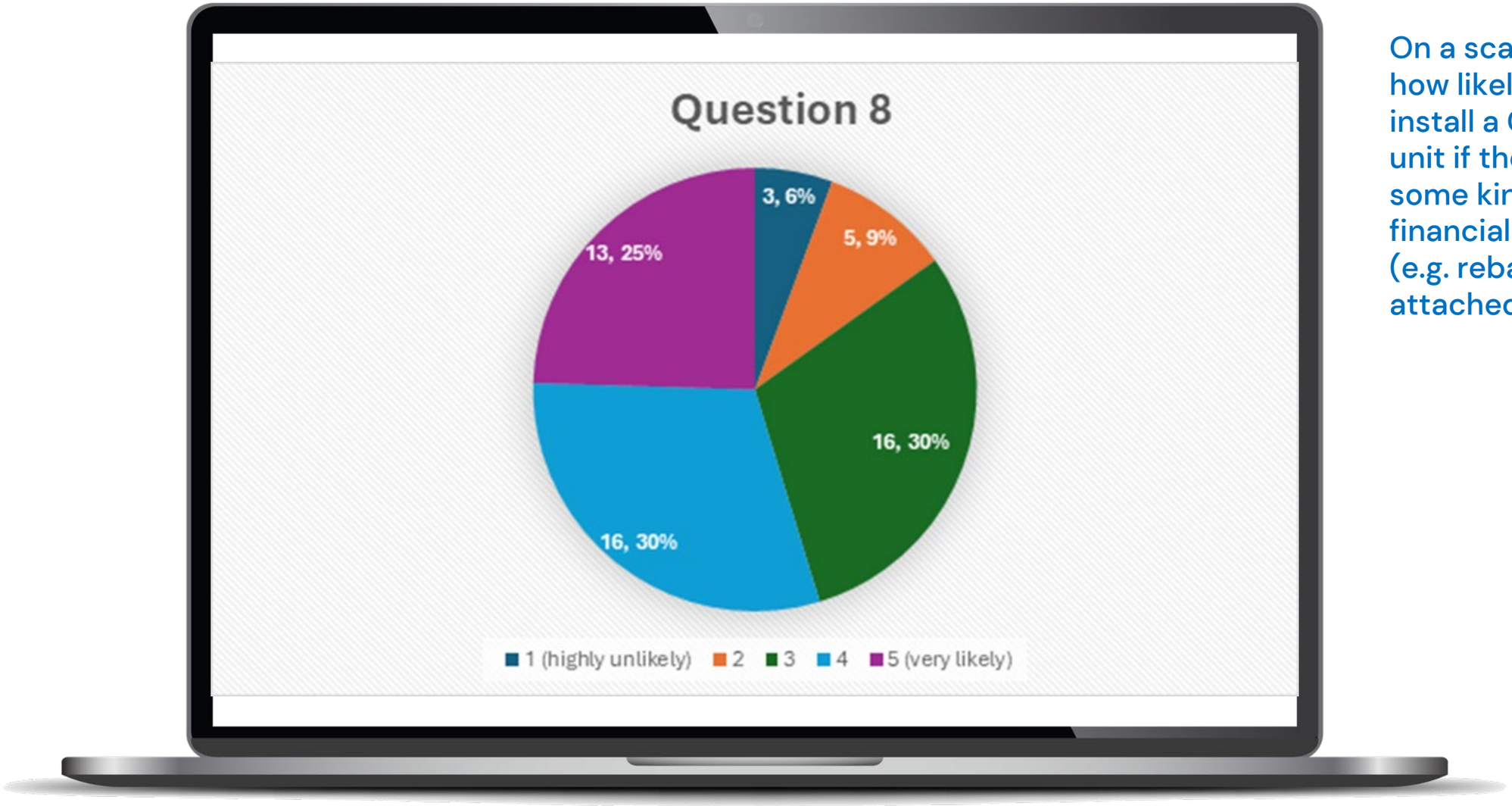
On a scale of 1-5, how much of a driver is reducing your natural gas bill?

Survey Responses – Question 7



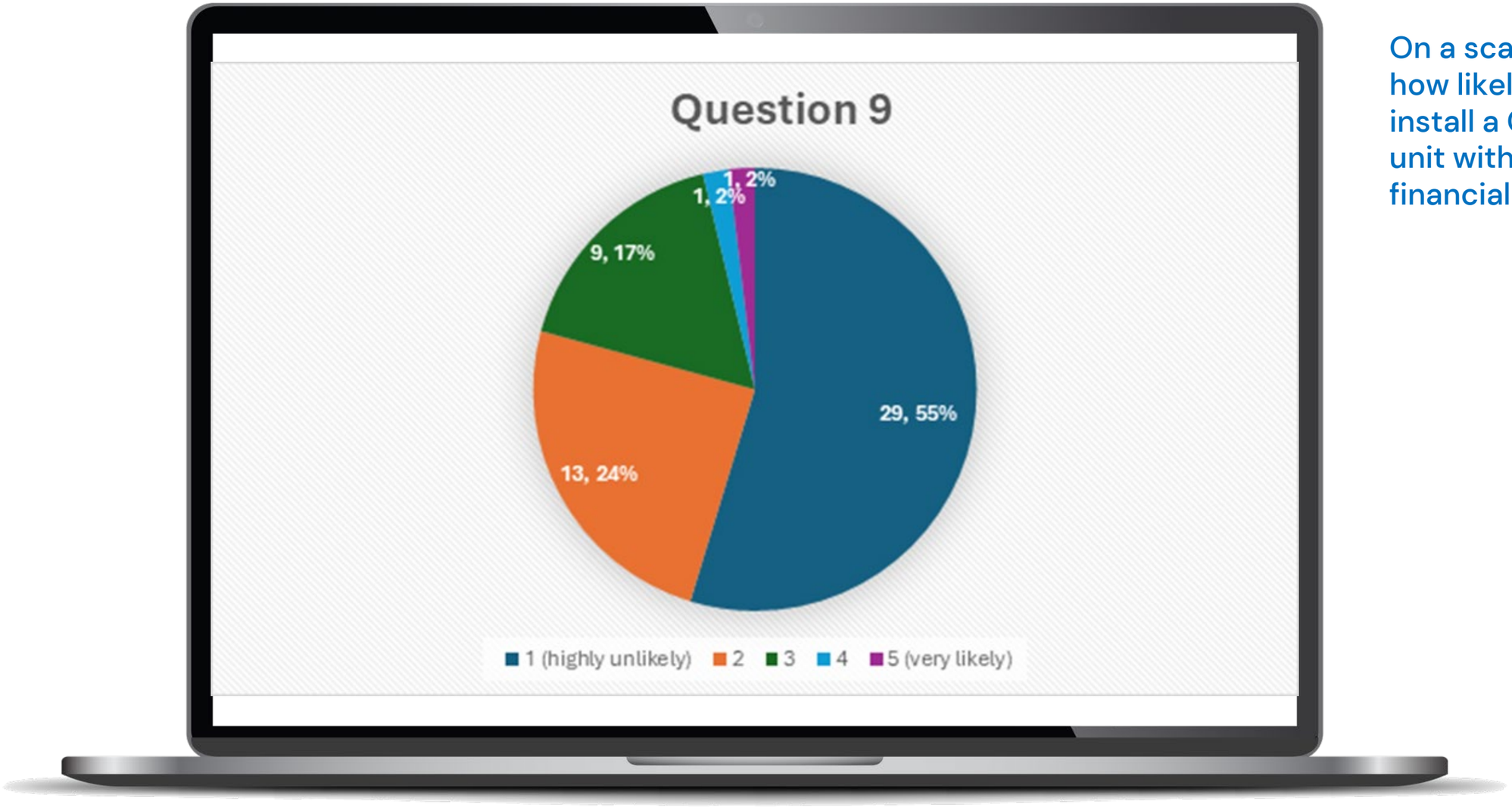
On a scale of 1-5, how likely are you to participate in an Energy Efficiency program that could help you lower your gas consumption?

Survey Responses – Question 8



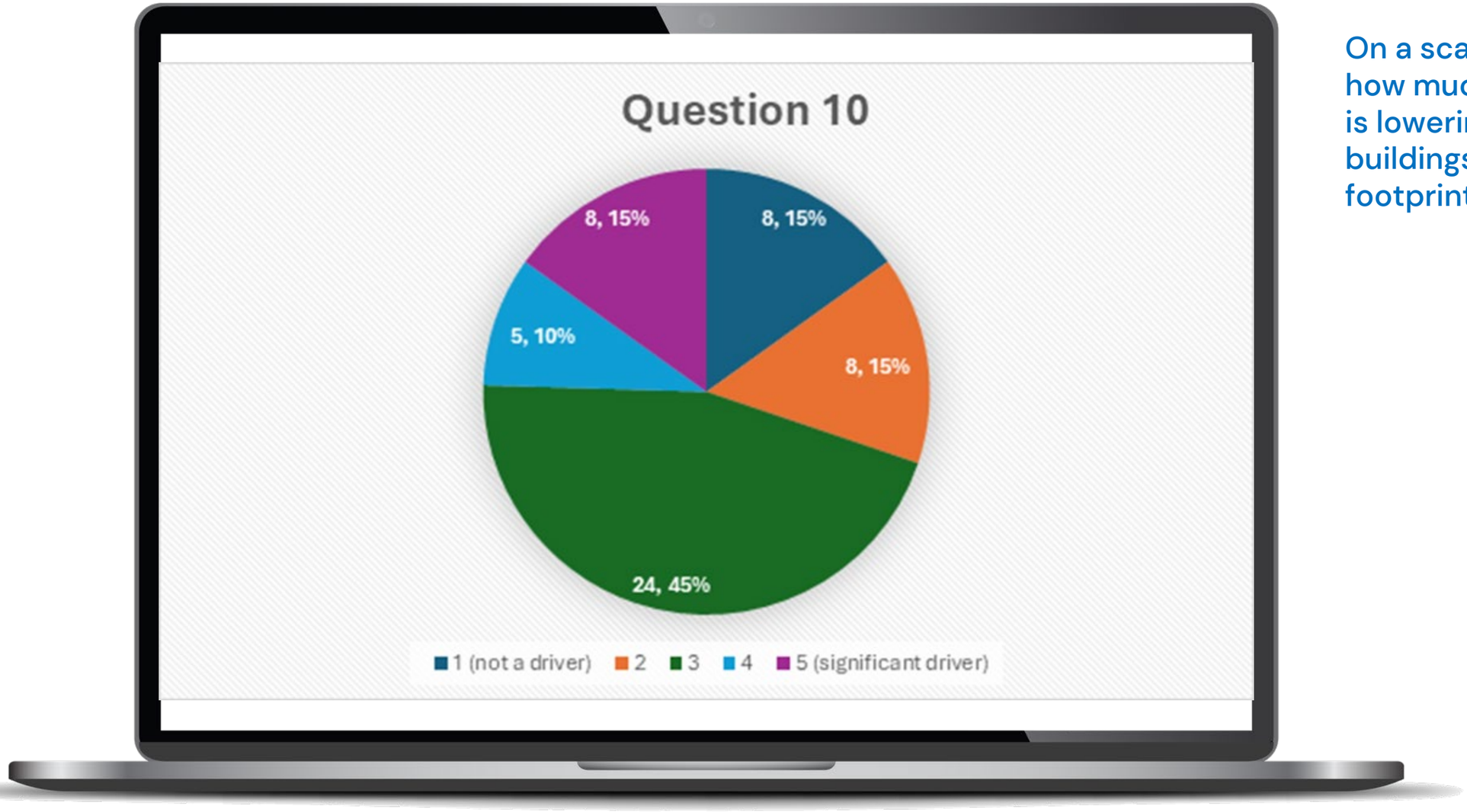
On a scale of 1-5, how likely are you to install a CarbinX™ unit if there was some kind of financial incentive (e.g. rebate) attached to it?

Survey Responses – Question 9



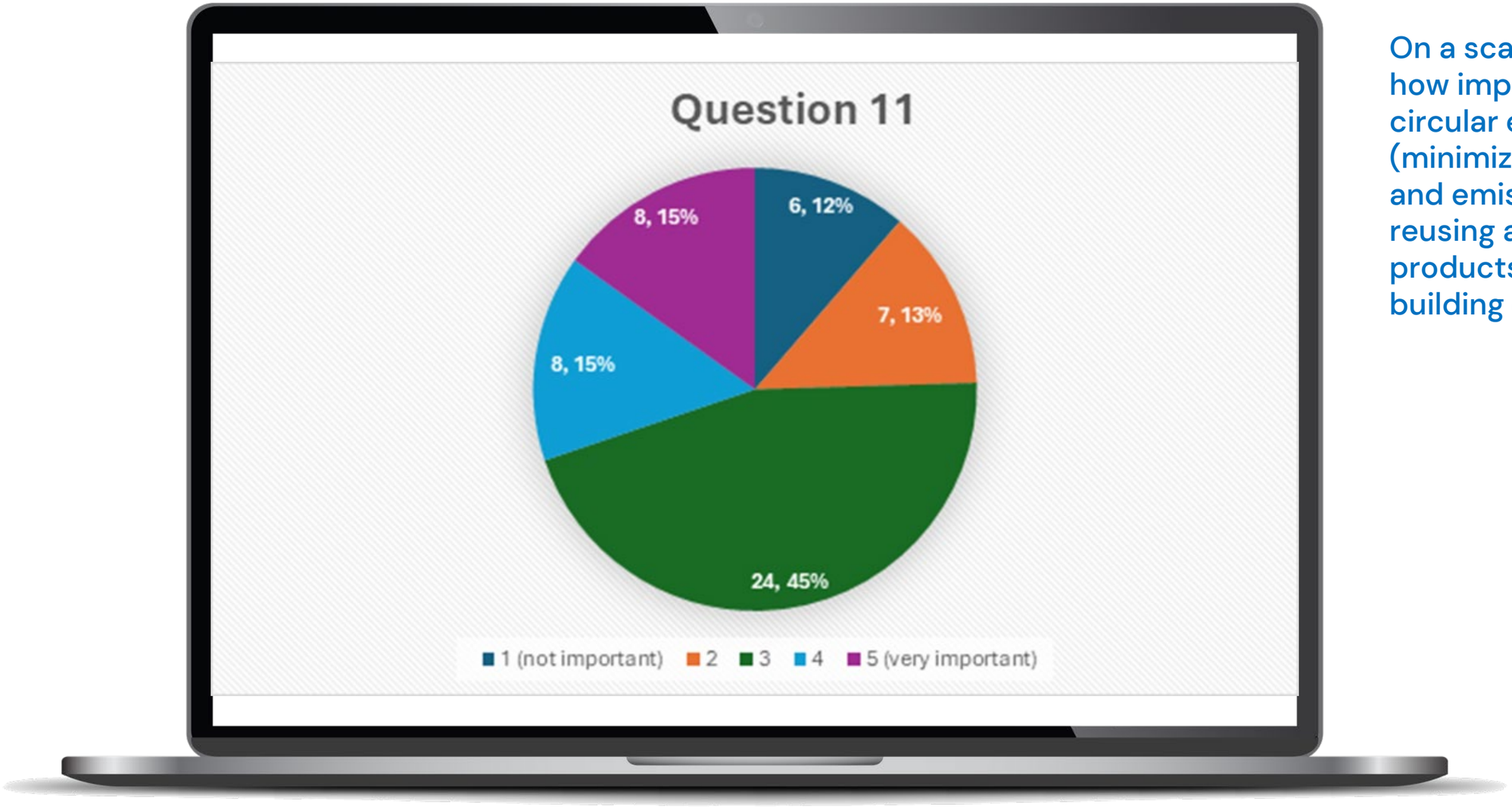
On a scale of 1-5, how likely are you to install a CarbinX™ unit without any financial incentive?

Survey Responses – Question 10



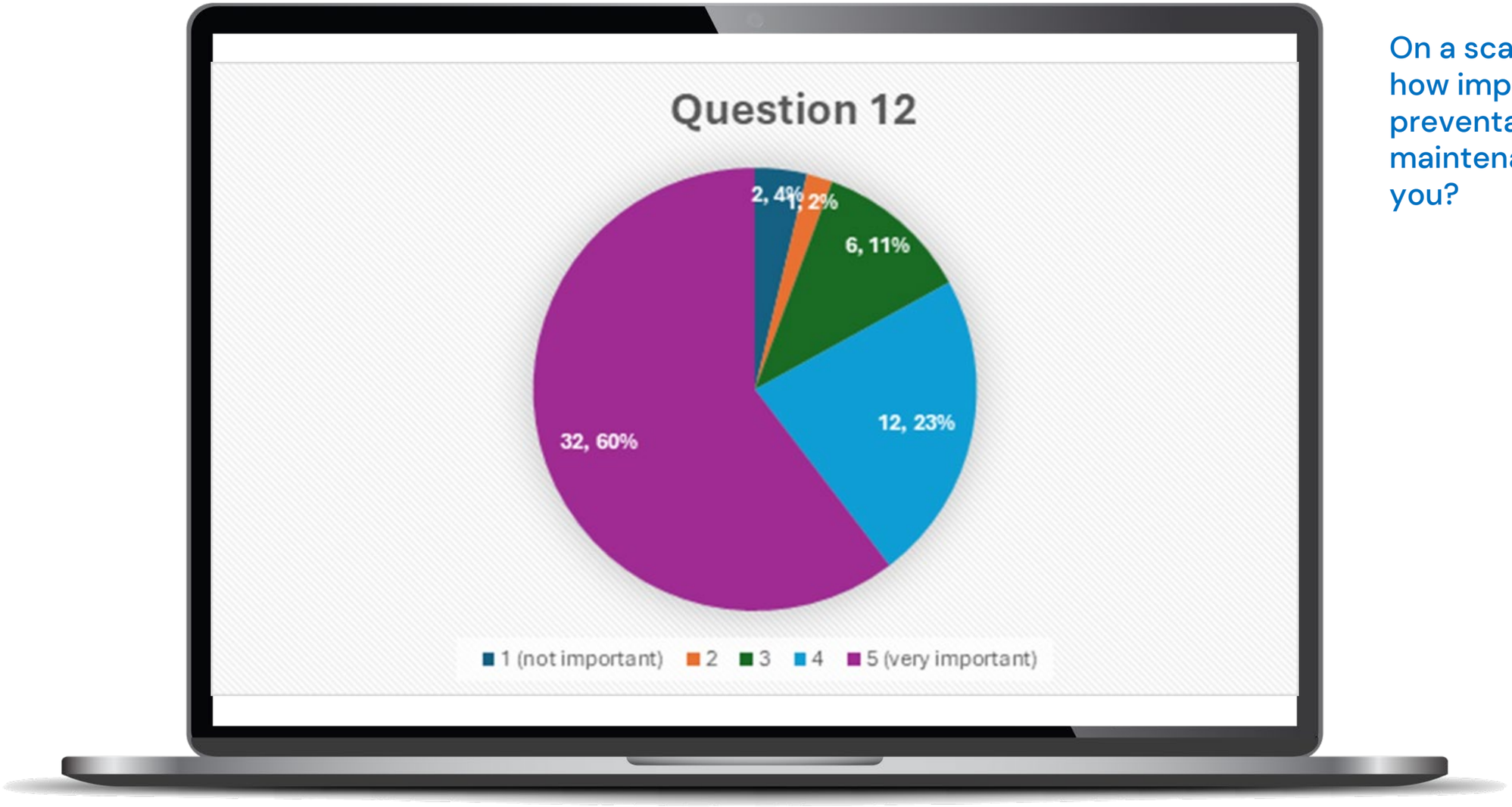
On a scale of 1-5, how much of a driver is lowering your buildings carbon footprint?

Survey Responses – Question 11



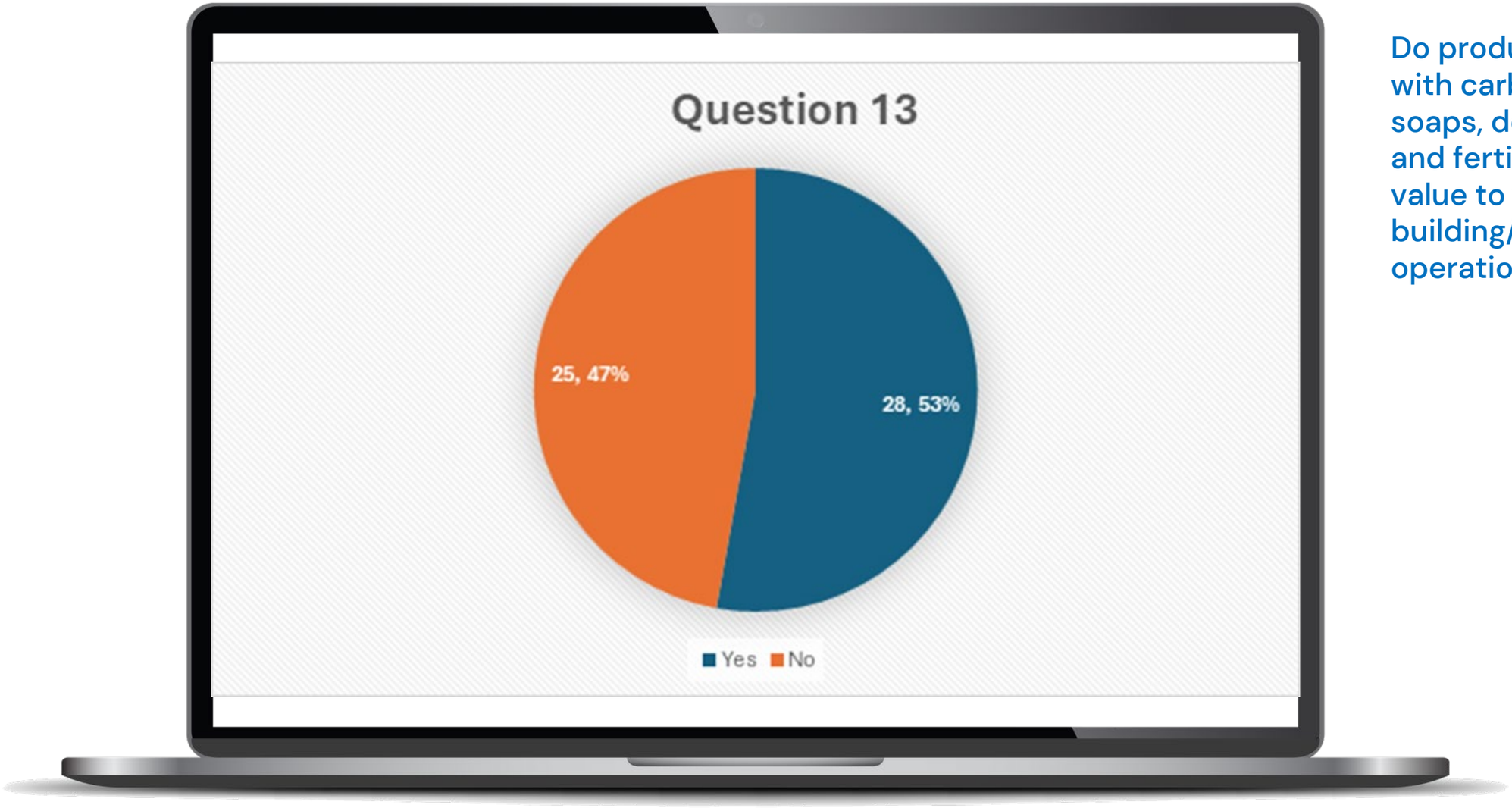
On a scale of 1-5, how important is the circular economy (minimizing waste and emissions by reusing and recycling products) to your building operations?

Survey Responses – Question 12



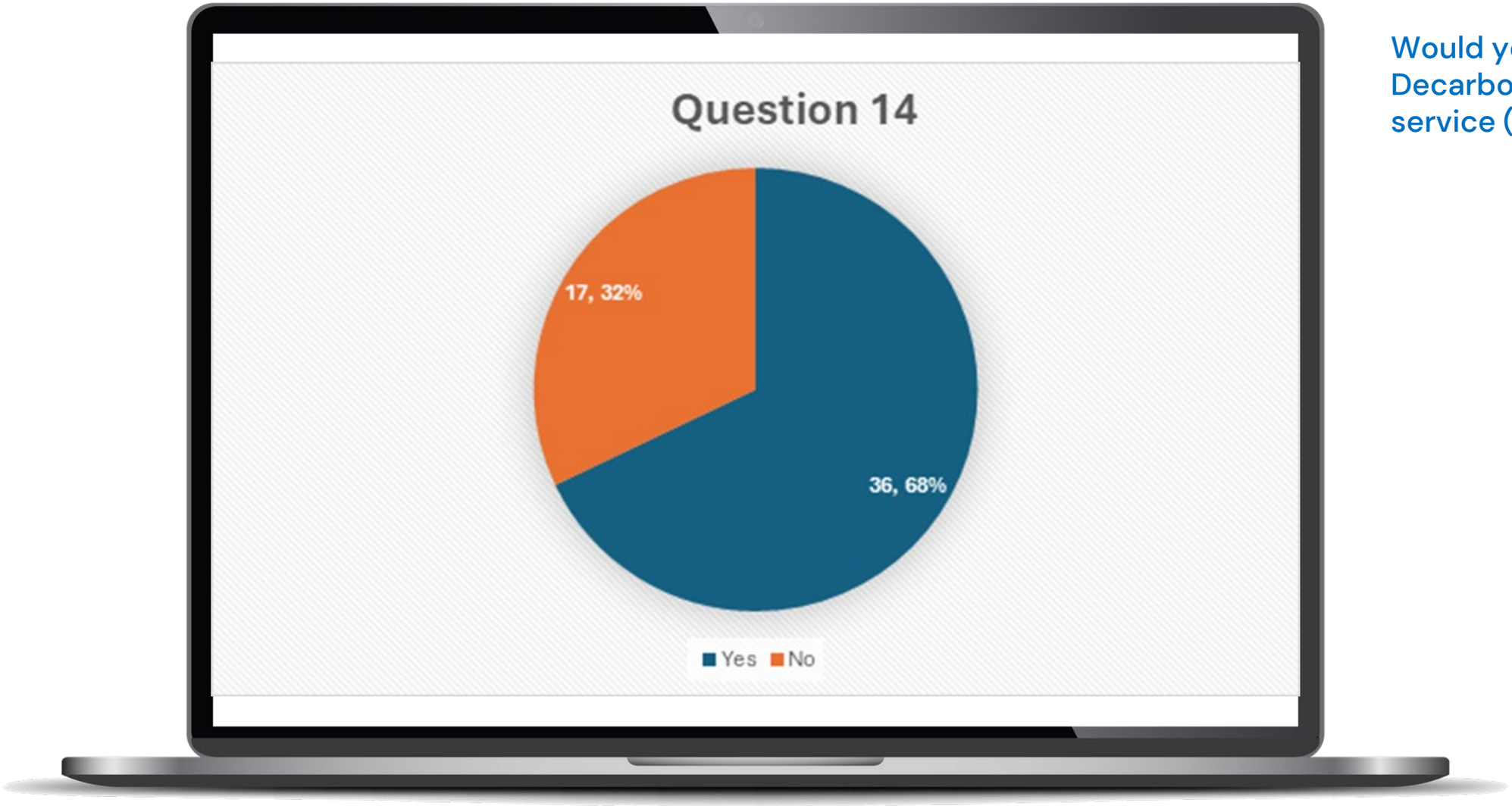
On a scale of 1-5, how important is free preventative maintenance to you?

Survey Responses – Question 13



Do products made with carbon such as soaps, detergents, and fertilizers add value to your building/business operations?

Survey Responses – Question 14



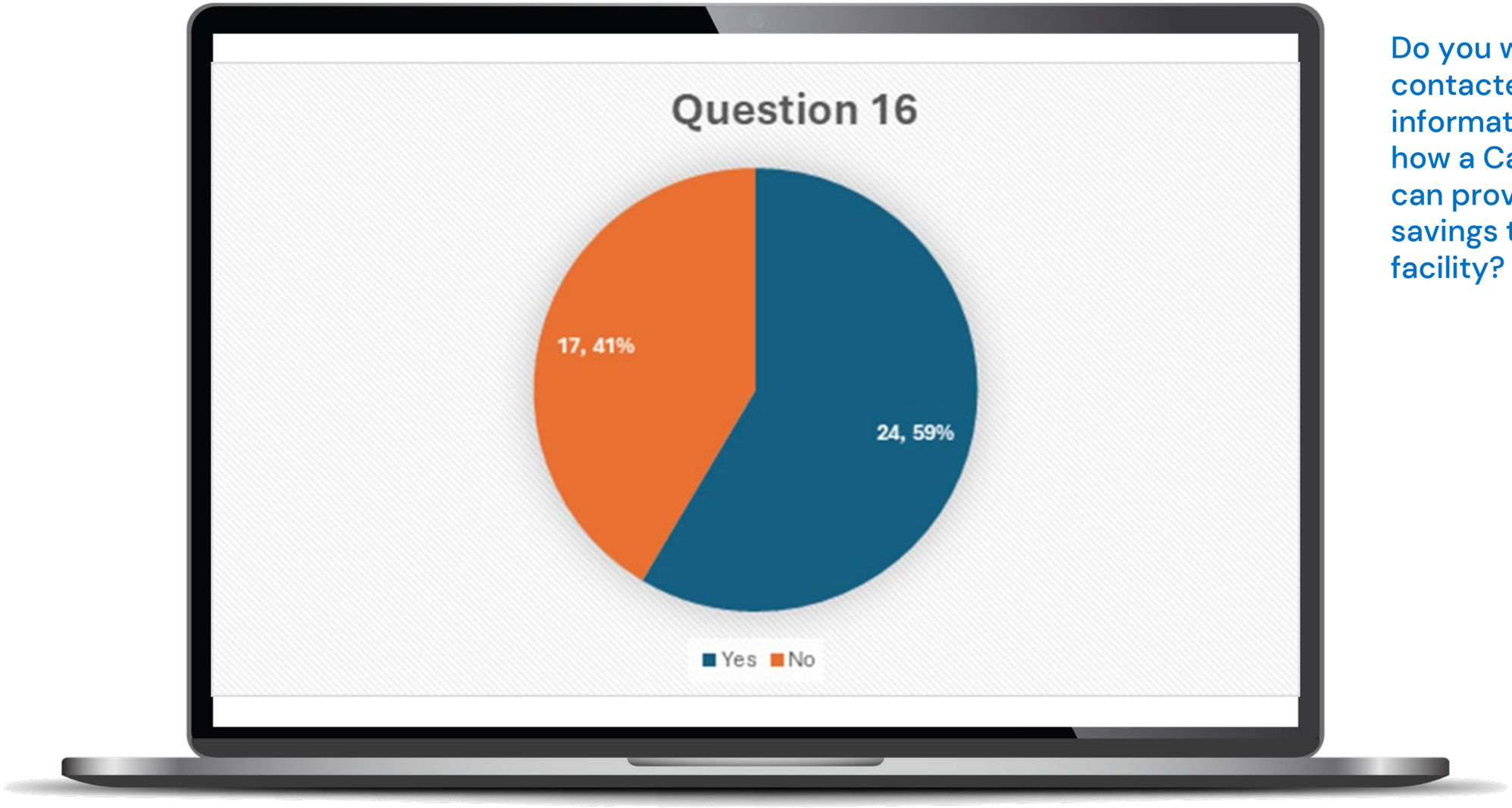
Would you support Decarbonization as a service (DAAS)?

Survey Responses – Question 15

What are your buildings' natural gas boiler/hot water loads? (BTU/hr)

- 54% were unsure about the loads, and some stated that it varied based on their facility.

Survey Responses – Question 16



Do you want to be contacted with more information about how a CarbinX™ unit can provide energy savings to your facility?

Conclusion

Conclusion

- The CarbinX™ unit has the potential to significantly reduce building heating needs while acting as a MCCU on the side.
- The market study has found that there is significant interest at the SoCalGas program level to investigate this technology within the IOU's territory and evaluate its energy savings.
- Customer responses to this technology have been mostly positive, with a significant number of customers in the commercial sector, mostly laundromats and schools taking an interest to this MCCU.
- Clean O2 has also expressed interest in exploring various opportunities to demonstrate their CarbinX™ MCCU technology across different sectors, however costs, ROI concerns, and unfamiliarity of the unit are some market barriers that the company will have to overcome when it comes to engaging customers.
- Ultimately, a series of demonstration projects within the California IOU territory that can verify energy savings and emissions reductions will be essential in determining how the technology gets adopted by EE programs.

Recommendations

Project Recommendations

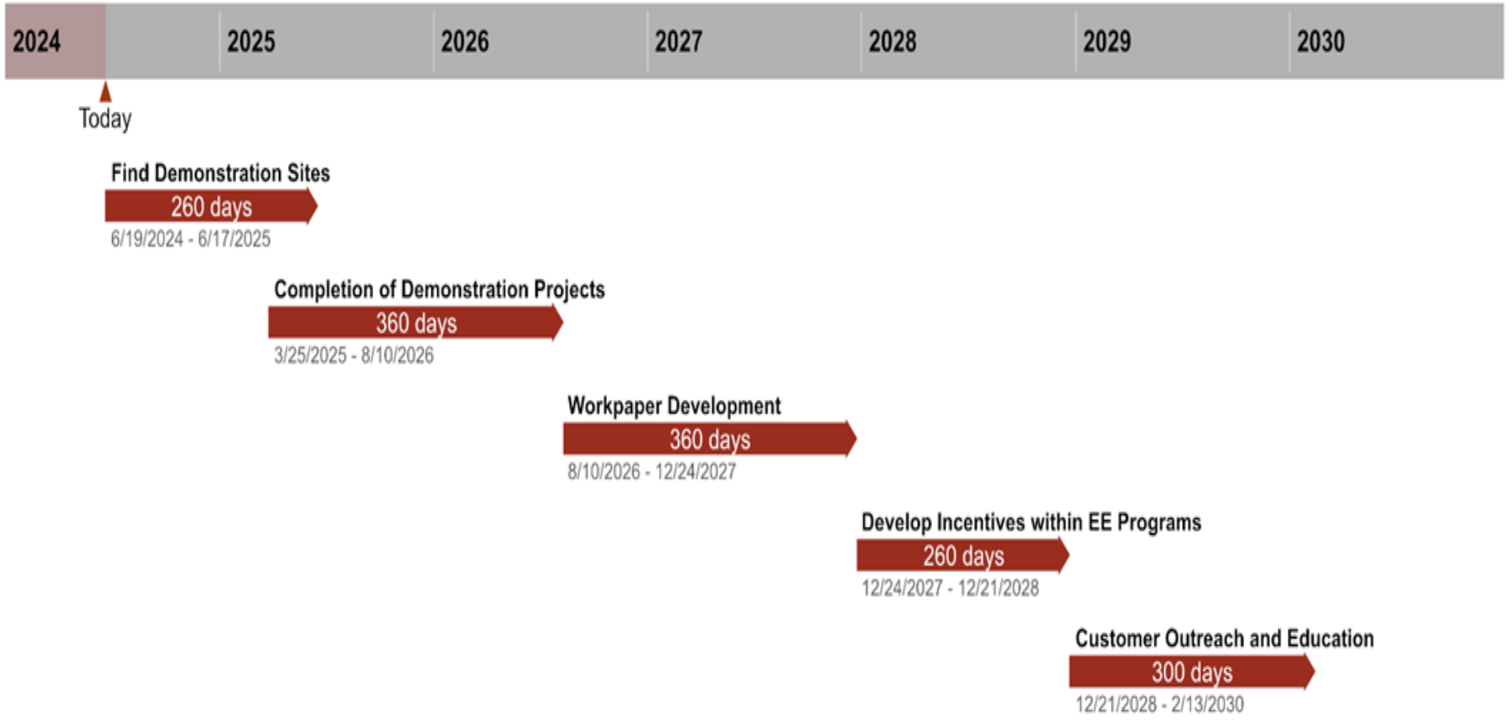


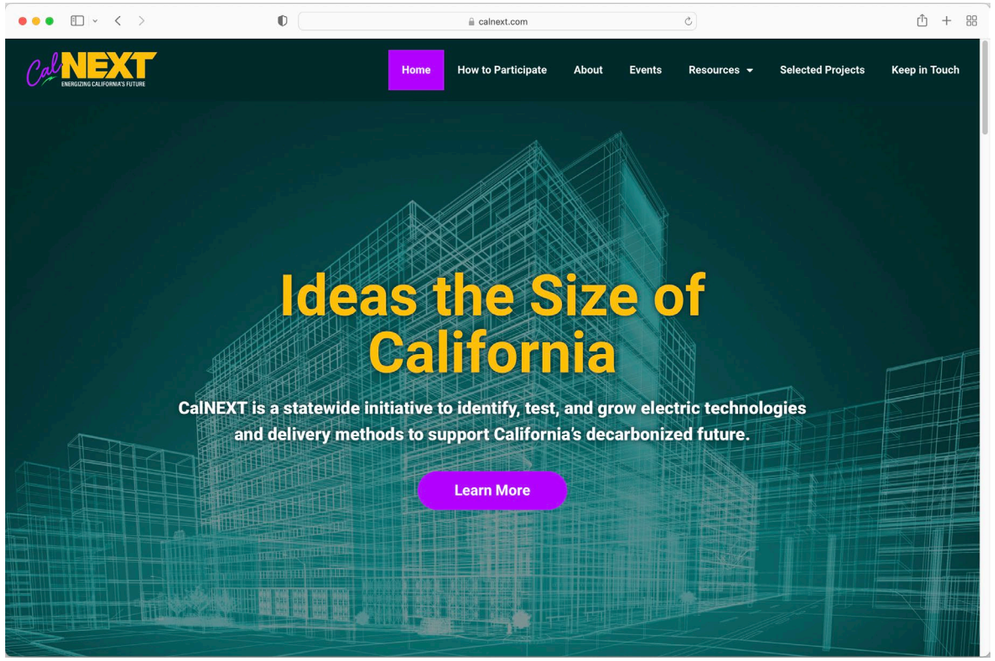
Figure 3. Roadmap

1. First, utilities need to engage implementors to find feasible sites to demonstrate the CarbinX™ unit in California. Examples include multifamily, agriculture, laundromats, schools/universities, hospitals, and even offices.
2. A series of demonstration projects need to be implemented and completed with sufficient data showing customer energy savings.
3. IOU's engage engineers to develop a measure package about the CarbinX™ technology, based on the data gathered from the demonstration projects.
4. Following the measure package and inclusion of the CarbinX™ unit into the California measure portfolio, EE programs such as the Multifamily, Agriculture, and Non-Residential Business Programs can develop an incentive and rebate structure for customers.
5. EE programs should engage in customer outreach and education to implement the CarbinX™ unit statewide.

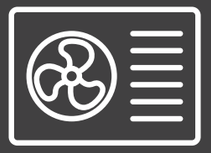
CalNEXT

CalNEXT's vision is to identify emerging electric technologies across six priority areas and bring them to the IOU energy efficiency programs portfolio.

To learn more and sign up for our email list, please visit **calnext.com**

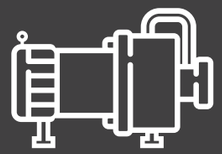


Appliances & Plug Loads



HVAC

Lighting



Process Loads

Water Heating

Whole Buildings

Q&A

Next Event:

2025 Research Plan

Thursday, December 12, 2024 1:00–2:00 P.M. PDT

Registration link to be sent

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