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Measuring the Current Practices of Total Cost of Ownership (TCO) Principles Used in the Procurement of Flooring in Education Environments

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Introduction

This study looks at a single facility component, flooring, and identifies the importance of Total Cost of Ownership (TCO) and its implications in the education market. It describes TCO and the current market implications and demonstrates how it applies to flooring so facilities management can feel confident in the selection and standardization around high performance products. Multiple graphs are used to explain how the application of these tools can be easily understood and used in facility planning decisions.

Summary

Facility managers are expected to provide a safe and healthy environment for facility users. One method to ensure informed selection, maintenance, and renewal of flooring is TCO. There are many components in a facility that affect the health, safety, and well-being of facility users. Some of these components are seen by the users and perceived to be inert and mostly cosmetic in nature. However, one cosmetic component in educational facilities plays a major role in the health and safety of users and requires regular maintenance. Flooring gathers and retains dirt and other contaminants brought in from the outside or generated by facility occupants. Flooring that is not maintained well can become a hazard with rips, tears, voids, and protrusions due to wear often resulting from inadequate floor care. Providing cost-effective maintenance is needed to ensure flooring retains both cosmetic and health-promoting characteristics.

This study, based on a survey of more than 340 facilities managers, planners, and architects across the U.S. and Canada, reviews the external factors affecting flooring conditions, reasons to maintain flooring to protect facility occupants, and applies the total cost of ownership of a well-maintained flooring system compared to choosing perceived cheaper methods of reduced maintenance and evaluating different performance levels of products. The study concludes with a recommended method to evaluate flooring considering initial, maintenance, renewal, and end-of-life costs. The recommended method can be applied easily and used to support expenditures for new or replacement flooring and demonstrate total cost of ownership in decision-making.

TCO and the Maintenance of Facility Components

The accumulation of deferred capital renewal needs creates a significant financial obligation for educational institutions; it was documented almost 20 years ago by Rodney Rose, Douglas

Christensen,[2] and others. Deferred capital renewal concerns were largely ignored due to the resilience and durability of the facilities in question and the limitation of capital renewal funds. Individual organizations addressed the capital renewal backlog on an ad hoc basis, resolving selected problems when organizational goals were demanded. Resolution of some capital renewal needs can be accomplished by removing a facility from the organization by sale or demolition. Removing a building from the inventory eliminates the obligation to keep the facility up to date—components renewed and operating as expected, including energy consuming components. Ignoring capital renewal needs can easily cost the organization more than if funds are reserved for future capital renewal projects. A clear analysis method that identifies capital renewal needs is required to understand all facility decisions and costs.

Most organizations look at the cost of a facility based on its initial cost despite a plan to own and operate the facility for 50 or more years. Looking at expenditures that may only span two or three years ignores operating, energy, capital renewal, and end-of-life costs. The same logic applies to specific maintenance, physical upgrades, or renovations to the facility. In 2020, APPA published a standard for Total Cost of Ownership (TCO)[3], APPA-1000. Part 2 of the standard[4] provided additional rationale and options allowing for gradual implementation. The TCO standard describes how to account for all the costs associated with a facility beginning with the first cost of construction, operating and maintaining, providing the energy and utilities, funding capital renewal, and the end-of-life costs (demolition, sale, adaptive reuse, etc.).

The process also applies to physical upgrades and renovations as well. The standard describes how to gather, manage, and monitor data to keep informed about the value of the facility and recognize opportunities for additional capital renewal/renovations. The APPA Total Cost of Ownership standard provides an excellent way to identify the real, long-term costs of an entire facility down to decisions about individual building components. Knowing the costs, a facility owner can make better-informed decisions to create a more robust asset protection strategy.

When comparing traditional low-bid procurement and TCO, the analyst will understand the annual maintenance and operating costs to keep the component or facility functioning as intended, the capital renewal costs for future major maintenance or replacement of the component at the conclusion of its useful life, and the future cost to dispose of the component when the owner no longer needs the component. (This may also be the income derived from the salvage value of the component.)

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[2] *Buildings … The Gifts That Keep on Taking: A Framework for Integrated Decision Making*, Rose, et al., APPA, 2007.
[3] APPA 1000-1, Total Cost of Ownership for Facilities Asset Management (TCO) – Part 1: Key Principles.
[4] APPA 1000-2, Total Cost of Ownership for Facilities Asset Management (TCO) – Part 2: Implementation and Data Elements.

TCO is a better way to analyze the cost of a component because it considers all the costs associated with the owner's goals, having the component function as desired. TCO is also dynamic, if the initial assumptions were incorrect, too high or low, a regular review of the component condition and annual costs (maintenance and utilities) can be adjusted against assumptions including the component life cycle. The formula to determine TCO is:

$$\text{TCO} = \sum C_a + \sum C_b + \sum C_c + \sum C_d + \sum C_e \quad [1]$$

Where:
C_a is the initial cost, one-time
C_b is the maintenance & operations cost, annual
C_c is the energy/utility cost, annual
C_d is the capital renewal cost, periodic
C_e is the end-of-life cost, one-time

The *APPA Operational Guidelines – Custodial*[5] can be used to develop a custodial maintenance plan describing occupant expectations and providing a means to determine likely staffing to address the expectations. The *Guidelines* gave an example of staffing on fictitious "Barton Hall." The example shows how APPA guidelines lead to staff FTEs (full-time equivalents) spent on cleaning tasks including flooring and other activities. In the Barton Hall example, the minimum of 74% of the FTE allocation was specifically spent on flooring maintenance activities. This fictitious example illustrates the importance and burden flooring has on the consistent maintenance of a building. Therefore, flooring contributes a significant portion of the annual maintenance, a component of the TCO analysis.

Flooring is typically replaced more than once over the life of a facility, 50 years. When the flooring is not maintained well it can degrade faster than expected resulting in more frequent replacement to provide functionality for the organization and occupants. The impact of reducing renewal processes on facilities planning and management should also be taken into consideration. Flooring replacement is also a component of the TCO analysis. This study looks at the balance between flooring type, annual maintenance, renewal, and end-of-life costs as measured using the TCO standard.

"The initial capital cost of facilities is just the beginning. … The bulk of the costs of facilities and infrastructure is the necessary investment in ongoing maintenance, major repairs and replacement of systems …".[6] Using the TCO method and formula allows for different scenarios to be compared that include all the costs of owning and operating a facility while providing an opportunity to select the scenario that most serves the organization's goals or to demonstrate the more effective use of money (greater value). Knowing the TCO also provides the owner

[5] *Operational Guidelines for Educational Facilities – Custodial, 4th Ed*, 2023.
[6] Rose, ibid.

with the information necessary to plan for and budget the high cost associated with renewal/replacement of the component or to decide to defer the renewal/replacement. When the component is renewed, functionality of the component can be maintained. If the renewal/replacement costs are unknown or unplanned, the owner will experience a loss of component functionality or lose some other anticipated benefit, such as health and safety, due to reallocation of funds.

Data

This study used five product categories—Vinyl Composite Tile, Luxury Vinyl Tile, Standard Carpet Tile, Hybrid Carpet, and Polished Concrete—to analyze the components based on these materials covering the largest floor space within education.

- **Vinyl Composite Tile (VCT)** was introduced in the mid-1930s and is still heavily used today due to its low initial cost. Over the past decade alternative resilient products have replaced VCT due to its significant maintenance cost and insignificant contribution to the student experience.
- **Luxury Vinyl Tile (LVT)** was widely adopted in the early 2000s and is the fastest growing product category in the market due to its factory applied finish. In addition to its low maintenance cost compared to VCT, this category has different performance levels where users have sometimes been disappointed with problems of scratching. This then introduced the use of applying wax to the LVT to solve the problem creating a VCT maintenance regimen when not maintained frequently.
- **Standard Carpet Tile (CT)** was introduced into the U.S. in 1968 and quickly became popular a decade later due to the need to access the floor for electrical and HVAC. There are different performance variables in performance face fiber as well as over emphasizing a maintenance strategy of replacing a tile when worn or damaged. The industry suggesting replacing carpet tile when dirty is an ineffective strategy and does not happen frequently or at all. Low-performing fibers and problems with spills between seams have also discouraged users from continuing the use of soft surface floor coverings even with the benefits to students with comfort and acoustics.
- **Hybrid Carpet (HC)** (Soft Surface floorcovering engineered with a closed cell resilient base with a tufted textile wear layer) was introduced into the market in 1969. It has been widely used as a high-performance alternative to carpet tile due to its ability to be cleaned easily and its highly durable and long-lasting performance. The unique performance is due to how the product is engineered through bonding materials with heat and pressure. The installation process of taking 6’ rolls and welding the seams together creates a moisture barrier over the subfloor, eliminating the passage of spills or

even floods. Its cushion also enhances acoustics and comfort for the student experience.

- **Polished Concrete (PC)** is a multi-step process where a concrete floor is mechanically ground (minimum 1600 grit), polished, and frequently adding dyes for aesthetics. It entered the market as an alternative to terrazzo, ceramic, VCT, and other resilient surfaces. It still has questionable variables of new construction and renovation floor preparation and sealing it properly for long-term maintenance outcomes. Polished concrete is a durable product if installed correctly, but it requires a sealant to prevent permanent staining due to its porous nature. It also has a highly reflective surface contributing to both structure and airborne noise.

The process used in this study can be applied to the other large contributors to overall educational facility flooring volume—Sheet Vinyl, Rubber, Linoleum, Broadloom, Ceramic, Linoleum, and Natural Stone.

This study also utilized the *APPA Operational Guidelines – Custodial* as the standard for analysis of cleaning times. The *Guidelines* address 23 different space types requiring floor care for two different floor types (hard and soft). The *Guidelines* provide data in the form of time (minutes) to deliver the specified service. The *Guidelines* also provide five different levels of service delivery to recognize organizational capacity and goals varied. Service levels are described in lay terms so non-facilities administrators and users can understand what to expect, and managers and supervisors can have some simple means to recognize employee achievement of specified goals. Finally, in the most recent edition, some simple spreadsheets are available so additional customization can be made including addition or deletion of different tasks. The *Guidelines* are expressed using some simple descriptions: 1 - Orderly Spotlessness, 2 - Ordinary Tidiness, 3 – Casual Inattention, 4 – Moderate Dinginess, and 5 – Unkempt Neglect.

While there are five APPA levels, the study considered only three levels since very few organizations use the extremes levels 1 or 5. Those levels are:

- *Ordinary Tidiness (Comprehensive Care)*, where the facility manager follows a consistent plan to maintain the facility using preventive, predictive, or reliability-based maintenance systems and sets funds aside to replace components or systems when functionality degrades.
- *Casual Inattention (Managed Care),* where the facility manager maintains materials less well and allows for the build-up of dirt and stains, resulting in walking lanes and other indications of inattention.
- *Moderate Dinginess (Reactive)*, where maintenance is done when required resulting in rapid degrading of the component, causing it to stop functioning as intended and

requiring funds for component or system replacement be allocated on an ad hoc or emergency basis to restore functionality.

The tasks to maintain flooring (either soft or hard) used the frequencies in the *Guidelines*. Most facility users would prefer to work in a facility where there is comprehensive care, not reactive maintenance. A tenant expects their rent payment to include good stewardship of the leased facility.

This study looks at the costs associated with flooring, including the maintenance and operations, utility costs for maintenance were assumed near zero while the utility costs associated with occupant perception are ignored, renewal/replacement, and end-of-life costs. These are all real costs that will be carried over the life of the product even when the owner attempts to ignore the costs.

This research project was also part of a survey of more than 340 participants across the U.S. and Canada. Over 70% of the participants were from education facilities and planning, and 17% were from the architect and design profession. Some of the findings validated the need for reviewing TCO principles for flooring.

Limited knowledge of TCO principles.

- Only 3 in 10 decision makers (29%) have high understanding of TCO principles.
- TCO is underutilized. 63% of organizations follow TCO principles but only 47% do so for flooring.
- Unknown savings. 93% acknowledge the cost savings of TCO, but the amount is largely unknown.

Most important factors in flooring decisions among education professionals:

- Durability, Easy to Clean/Maintain, Long-Term Value, and Safety

Product Lifespan was seen as the number one reason a product was considered sustainable.

- Product Lifespan/How Long Product Lasts is further evidence of the important role that TCO has relating to sustainability initiatives
- Followed by Ultra-low VOCs which validates industries acceptance that materials and maintenance can have on building occupants.

Respondents also indicated that their top two products used in education spaces were Carpet Tile and LVT followed by VCT. There was no indicator in the survey on what performance levels of Carpet Tile or LVT used.

Another interesting question referred to how long they expected the flooring to last. There were 5 options given spanning between 0-5 yrs and more than 25 years. The answers were widely displayed and there was not a true winner. This variation points to some of our assumptions

that maintenance, gradations of performance within each product category, and even the variable of proper installation drove the wide gap in responses.

When asked about the top challenges and where they need assistance, the responses delivered a request for proof, performance, training, education, and partnership. Very few institutions have completely solved the problem and are struggling with TCO principles. Below is direct feedback when asked how the flooring industry can do better.

Figure 1

Maintenance & Cleaning	Durability & Longevity	Sustainability & Environmental Impact	Transparency & Education	Cost & Budget Constraints
"Assistance with true comparisons. Understand that everyone is looking to sell their products, but honest information about cost and wear comparisons would be beneficial."	*"Developing and providing quality, durable, easy-to-maintain, and clean sustainable flooring products."*	*"Reduce, eliminate, or reverse negative impacts to the planet and occupant health from material sourcing, manufacturing, installation, maintenance and end-of-life disposal/recycling."*	*"Education and knowledge are power. Next-level training experience for modern maintenance/ cleaning techniques for custodial and operations employees."*	*"Transparent pricing data, including actual installed costs."*
"Clearly describe cleaning and maintenance procedures."	*"Provide long-lasting, cost-efficient products that are easy to maintain."*	*"Provide more sustainable, attractive, easily maintained and affordable options."*	*"Educate professionals involved in design and selection of products about life cycle costs and sustainability."*	*"Balancing affordability with longevity."*
"Education and engagement for users/maintenance staff."	*"Recommend products that are most cost-effective for durability and maintenance."*	*"Develop resilient flooring that standardizes maintenance procedures/products and aligns with sustainability goals."*	*"Standardize product information presentation, specs, acceptable uses, etc., to make informed decisions easier."*	*"Cost-effective and low-maintenance flooring solutions."*
"Training experience for modern maintenance/cleaning techniques for custodial and operations employees."	*"Keep floors clean without any polish or finish on them."*	*"Ensure that every aspect of the product is sustainable and healthy, including natural sources, biodegradability and recyclability."*	*"Provide expert data on the products and educate architects and end-users about life cycle costs and sustainability."*	*"Affordable options that align with institutional costs and performance over time."*

Different materials have different first costs and different renewal/replacement cycles. The renewal/replacement cycle is also affected by the annual maintenance, typically in the form of time spent each week cleaning and periodic restoration such as rewaxing or deep cleaning. Utilization of the TCO formula can take these different factors into account and provide a single number to compare against the selection of material or the annual maintenance. The primary variable in annual maintenance is the number of hours expended.

To make the link between floor care tasks, which are provided in time to TCO, factors to convert time to cost were assumed and are shown in Table 1.

Table 1

Factor	Cost ($)
Labor (includes all financial benefits, 30%, per Hr)	13.41
Chemicals & water (hard surface, per SF)	0.02
Chemicals & water (soft surface, per SF)	0.01

Equipment used for maintenance follow ISSA recommendations for the specific floor materials. Adjustments should be made when local costs differ from the costs shown.

Analysis

The analysis considered five scenarios of different floor coverings maintained at three different APPA service levels, described above. The manufacturer provided first costs for each floor covering, estimated maintenance costs for annual maintenance including periodic restoration, and life cycles adjusted due to reduced annual maintenance. Values for each are shown in Table 2.

The TCO, in dollars ($) per square foot, for the flooring in each variation is shown in present value.

Table 2

Scenario	First Cost ($)	Annual Maint. ($)	APPA Level	Life (years)	Renewal ($)	TCO
VCT-2	2.53	1.29	2	10	5.01	85.25
VCT-3	2.53	0.26	3	8	5.01	42.21
VCT-4	2.53	0.11	4	6	5.01	43.25
CT-2	3.27	0.49	2	8	5.22	52.94
CT-3	3.27	0.10	3	6	5.22	41.58
CT-4	3.27	0.04	4	4	5.22	55.20
HC-2	3.86	0.49	2	30	11.43	33.62
HC-3	3.86	0.10	3	24	11.43	18.73
HC-4	3.86	0.04	4	18	11.43	15.87
PC-2	5.57	0.68	2	25	27.09	55.53
PC-3	5.57	0.14	3	20	27.09	41.29
PC-4	5.57	0.05	4	15	27.09	50.28
LVT-2	4.36	1.10	2	20	7.88	78.07
LVT-3	4.36	0.22	3	16	7.88	40.35
LVT-4	4.36	0.09	4	12	7.88	45.01

A sample of the detailed calculations arriving at these results is provided in the appendix.

Public Circulation was selected as the space type due to its proportion within most facilities. Maintenance (Dust mop/wet mop and spray-buff/burnish floors for hard surface and vacuum/spot-clean for soft surface) frequency between these three service levels were weekly, monthly, and quarterly. Project activities, restoration of the flooring, were quarterly, annually, and never. Essentially, for level 4 service, the regular maintenance for a hard surface floor was treated as a restoration task and the important task of restoration, to ensure the longevity of the floor material was ignored so the flooring was allowed to degrade requiring total replacement. At level 2, annual service was provided daily, level 3 weekly, and level 4 monthly. Degradation rates for the flooring, reduced life between replacements, due to reduced annual maintenance was 20% for level 3 and 40% for level 4. For example, VCT had a recommended annual maintenance cost of $1.29/sq ft., and replacement life of 10 years when maintained at level 2. The same material, when maintained at level 3 had an annual maintenance cost of $0.26/sq ft. ($1.29/5) and replacement life of 8 years. When maintained at level 4, VCT had an annual maintenance cost of $0.11/sq ft. ($1.29/20) and replacement life of 6 years.

Costs for energy/utilities are not included because the flooring selection is assumed to have a minimal influence on utilities consumed in the facility. Also, the end-of-life costs are included in the renewal/replacement cost. These outcomes are subject to multiple variables including foot

traffic and areas of a building. The projected life of the material is based on multiple inputs provided by reviewers, contributors, and through an APPA flooring survey of how long products last.

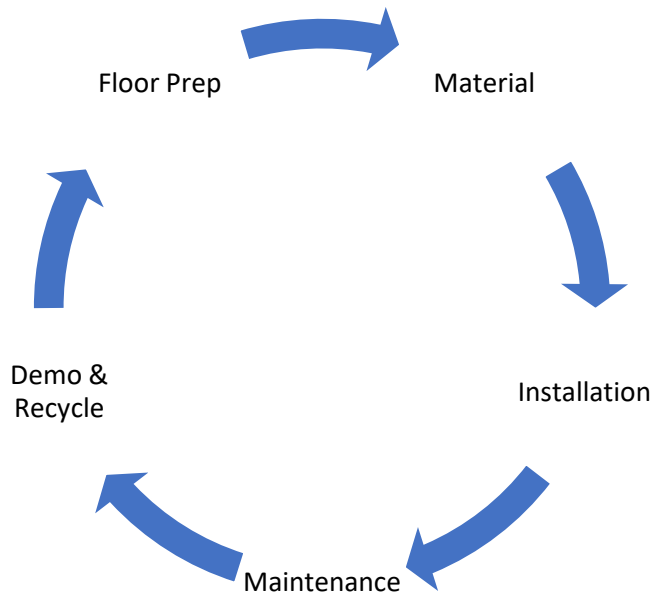
Results of the TCO analysis are summarized in Table 3, below.

Table 3
TCO results of three scenarios for five major floor types

Floor Type	Scenario Level 2	Scenario Level 3	Scenario Level 4
VCT	$85.25	$42.21	$43.25
CT	$52.94	$41.58	$55.20
HC	$33.62	$18.73	$15.87
PC	$55.53	$41.29	$50.28
LVT	$78.07	$40.35	$45.01

Looking at the Big Picture of a Flooring TCO

Figure 2
Flooring TCO sequence



The overall comparison of different product categories is how TCO is analyzed when selecting flooring products as well. Taking into consideration all the different costs of material, installation, maintenance and operations, take-up, demo and recycling, and floor prep for the cycle to start over again.

The expanded selection of flooring materials was analyzed per the manufacturers recommendations and used ISSA cleaning times to create the following analysis to show the overall cost of maintenance balanced with the expected life of the material. It is estimated that the average education facility is 75,000 sf and analysis for costs of materials and installation, maintenance,

and replacement should be determined on the minimal estimated life of a building at 50 years. We separated these into maintenance (Figure 3), materials and installation (Figure 4), and then combined them for a TCO (Figure 5).

Figure 3

Average education building of 75,000 sf cost of flooring maintenance for 50 yrs

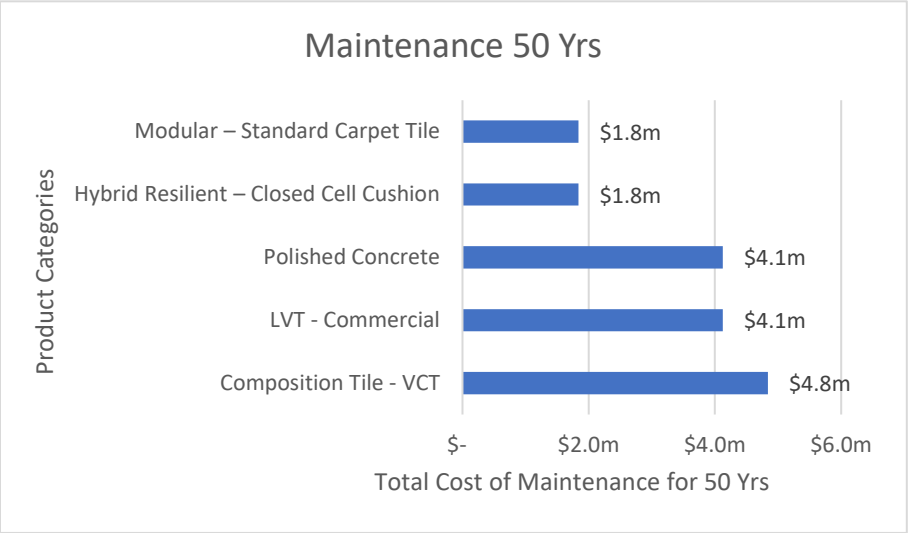


Figure 4

Cost of flooring material and installation for an average 75,000 sf education building analysis for 50 yr. This includes any needed replacement needs and or refinishing for that 50-year analysis.

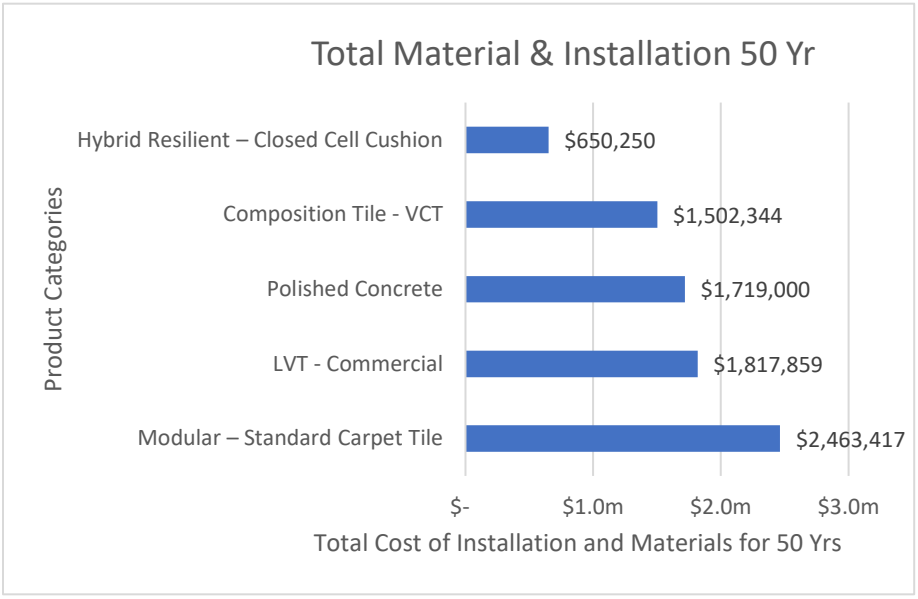
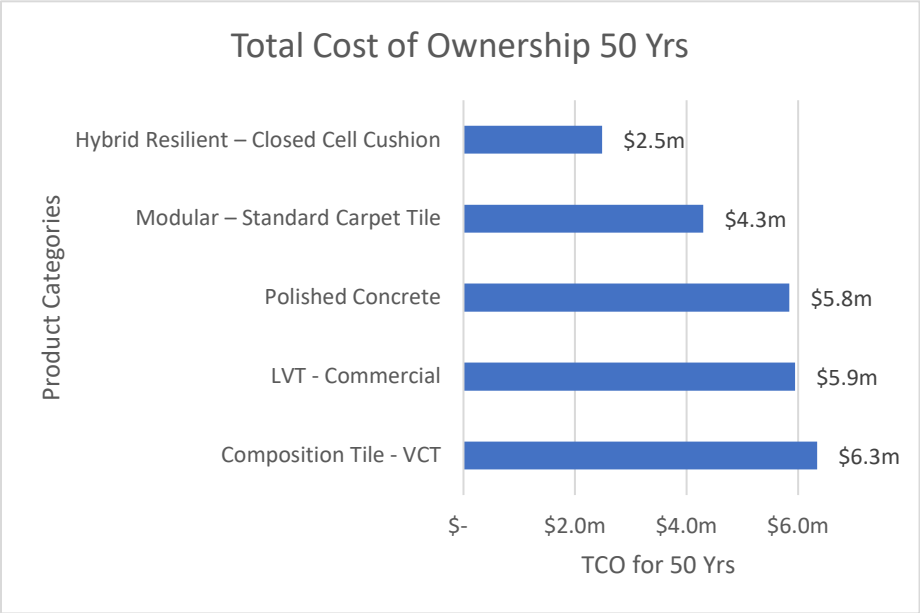


Figure 5

Full flooring TCO analysis includes cost of material, installation replacement, and maintenance for an average 75,000 sf education building with a 50-yr TCO.



There are several variables that can be implemented within these analyses, which include:

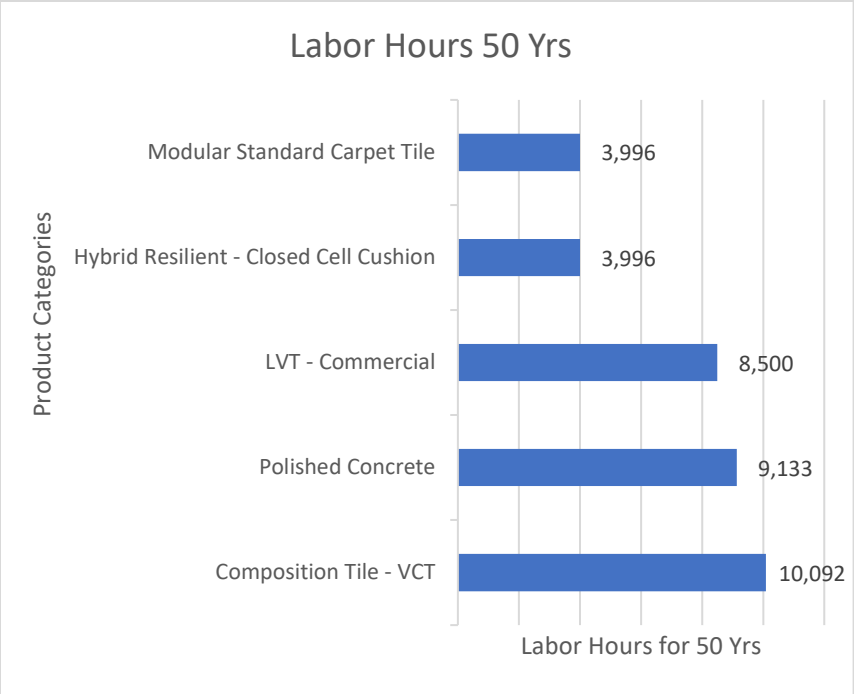
- Furniture removal: This can be a variable of more than $5 per foot.
- Foot traffic: Some buildings receive greater foot traffic than other buildings.
- Material repairability: Some repairs can visibly be pleasing and others after minimal wear lend consideration to full replacement and ending the life much sooner than desired. Here are some examples of repairable flooring:
    - LVT – can be complicated to repair depending on the damage and wear of the surrounding products
    - Carpet Tile – this comes with controversy as replacing carpet tile has been proven to be a repairable feature but visibly pleasing after a few years of wear. High performance fiber and cushion can assist in this process and extend the appearance retention capabilities.
    - Hybrid Resilient – damaged spots can be cut with a circle cutter and replaced.
- Floor prep: Resilient material can vary depending on the amount of floor prep during each replacement.
- Sealing polished concrete can vary as an 800 grit was used for the analysis. The industry has also experienced quality issues with different sealants. It has been noted by the EPA around concerns with silica dust during maintenance where additional costs can be added for respiratory occupant and worker safety.

Assessment of Labor Hours

Consideration of labor needed to accomplish flooring maintenance can vary per product. An analysis using the ISSA cleaning recommendations were used to make the comparison. Space averages were used to create this analysis as the variance did not change the difference in overall product comparisons (Figure 6). The constant reduction in budgets and custodians have elevated this analysis as flooring maintenance is highly impacted by labor resources.

Figure 6

Total labor hours for maintenance of an average 75,000 sf education building



Results and Discussion

Five different floor surfaces were selected to investigate a range of typical floor types that are popular in educational facilities. Maintenance times were developed from ISSA and manufacturer recommendations. Frequency of maintenance was varied using APPA service levels that are most typically used by educational institutions. The capital renewal cycles varied based on the annual maintenance performed to recognize floor covering degrades at different rates when dirt is not removed regularly by using survey and industry expert recommendations. The total cost of ownership (TCO) was calculated using the APPA-1000 Standard.

The expectation from the analysis was to demonstrate the use of TCO to identify consistent support for most floor surfaces to perform annual maintenance activities at APPA level 2 service. The results shown in Table 2 indicate the answer is more complex. In one case, Hybrid Carpet, performing minimal maintenance is the lowest TCO. That is, cleaning the flooring material quarterly and allowing dirt and other destructive materials to degrade the flooring, despite having a 40% shortened component life, is the cheapest TCO solution on a per-square-foot basis. Hybrid Carpet had the lowest TCO when the material was maintained at all three APPA services levels and replaced/renewed at the studied life cycle. The other flooring materials had a higher TCO despite VCT and Carpet Tile having a lower first cost. It is highly recommended that when creating your Campus Design Standards or Standard Technical Guidelines there should be careful consideration to TCO principles for flooring.

What can be learned from this analysis? In many cases, selection of the flooring can be left to the designer based on a desired appearance. Alternatively, the decision can be made by an institutional standard for flooring in owned spaces. Maintaining the appearance of the flooring, while dependent on the maintenance frequency, may also be driven by cosmetic or visual factors and not on cost. When an executive looks for a recommendation on what flooring to approve, the executive may ask which material is more economical to maintain. Applying TCO, the Facility Manager can provide a clear recommendation based on APPA service levels and the cost-of-service delivery. This is where facilities planning, and facilities management must collaborate to establish standards based on TCO and document it in their design guidelines.

The majority of the flooring products used in education were also analyzed for a 50-year period on an average education facility of 75,000 square feet. The results showed that VCT was the highest cost for maintenance (Table 3) driven by the maintenance labor to execute (Table 6). This precedence of labor hours needed to execute followed with all other categories. The final analysis with TCO showed that an expected life of high-performance products plus the least amount of labor hours produced the Hybrid Carpet to be the lowest TCO.

Performing a TCO analysis will allow the owner to make better decisions through a combination of cost and cosmetic reasons rather than just one factor. The facility manager can make better operating and budgetary decisions based on current and future maintenance costs and demands for health and safety and the visual appearance of the facility. The analysis is not difficult when considering a single facility component such as floor covering and can be applied to other components in a similar manner. Finding that there are a few ways to run the analysis based on your assumption of APPA levels and staff resources creates opportunities to analyze the data. The opportunity to look at the overall TCO for a product for the life of a building also gives you a general idea of assumption.

Finally, a flooring TCO analysis reveals some important results that may change how an owner makes facility design and budget decisions. Rather than choose one factor, first costs, maintenance costs, appearance, or health and safety, applying TCO allows the owner to make better decisions early in the facility planning stage and increases the credibility of the facility manager when such analyses are performed. Cost savings can be predictable if you have the measurements to input for a flooring TCO calculation.

Conclusions

The expectation from the analysis was to demonstrate the use of TCO which would identify consistent support for most floor surfaces to perform annual maintenance activities at APPA level 2 service. The results shown in Table 3 indicate the answer is more complex. In one case, Hybrid Carpet, performing minimal maintenance is the lowest TCO. That is, cleaning the flooring material quarterly and allowing dirt and other destructive materials to degrade the flooring, despite having a 40% shortened component life, is the lowest TCO solution on a per-square-foot basis. VCT, frequently selected for low first cost, has a higher TCO for levels 2 and 3 than the other four materials.

Total Cost of Ownership is not intended to be a tool to find the least cost for a given component or facility. It is intended to provide the owner with more information in the decision process prior to selecting a component, such as flooring, or a complete facility. Since there are many other reasons to choose a flooring material other than cost, other decisions must be made. Similarly, the use of a facility due to occupancy may change over time. The APPA TCO standard provides guidance to keep abreast of the changing costs and be able to apply TCO for other decisions. Additional information can be gleaned from this study and suggests that additional research opportunities exist.

Additional research opportunities include studying the actual life cycle floor lasts based on the different APPA cleaning levels. Determining factors include foot traffic, flooring category, outside environment, and whether the floor can be restored to an acceptable appearance.

APPENDIX

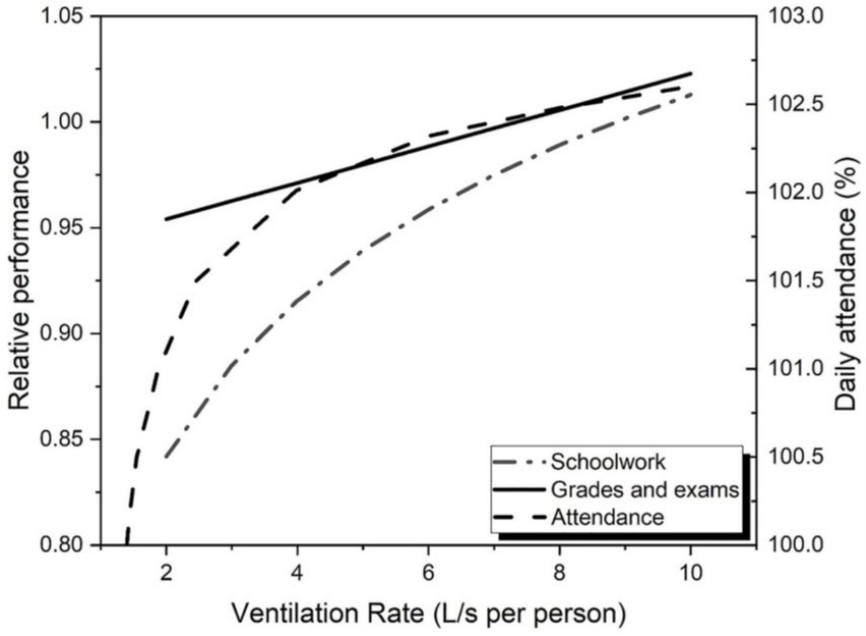
Impact of Flooring Maintenance on Occupant Health[7]

There should be consideration of maintaining the flooring for health in addition to maintenance impacting the performance and longevity of the flooring. Flooring maintenance does play a crucial role in occupant health, particularly in educational settings. Research done by Dr. Jeffrey Campbell showed that poor cleanliness of floors can exacerbate allergies, spread germs, and increase stress levels, which negatively affects student attendance and teacher retention. This problem contributes to over $11 billion in annual school absenteeism costs, with indoor air quality being a major factor. Cleaner air has been shown to enhance cognitive function by up to 101% shown in Figure 7.

Read an accompanying report on healthy flooring impacts.

Figure 7

Relationship between ventilation and student performance and health[8]



[7] https://aahid.org/wp-content/uploads/2022/02/how-flooring-supports-the-healthcare-built-environment-white-paper.pdf.

[8] Sasan Sadrizadeh, Runming Yao, Feng Yuan, Hazim Awbi, et al., Indoor air quality and health in schools: A critical review for developing the roadmap for the future school environment, *Journal of Building Engineering*, Volume 57, 2022, 104908, ISSN 2352-7102, https://doi.org/10.1016/j.jobe.2022.104908.

Research from the University of Tulsa confirms that well-maintained flooring directly impacts indoor air quality and health. Effective cleaning practices are essential. For instance, cleaning must precede sanitizing or disinfecting. Disinfection chemicals can worsen air quality if not used properly.

Key recommendations include:

1. **Flooring Types in which all carpets are not the same**:
    1. Non-porous flooring surfaces with welded seams reduce airborne dust. Avoid harsh cleaning agents.
    2. Avoid bonnet cleaning, which can stir up particulates.
2. **Flooring Maintenance**:
    1. Hybrid carpets, with their sealed seams, and resilient with welded seams show better results in maintaining cleanliness and reducing contamination compared to traditional carpets (modular and broadloom) and VCT.
3. **Entry Systems**:
    1. High-performance entry flooring can capture up to 85% of particulates, soil, and other contaminates tracked in from outside, thus extending the life of flooring and reducing maintenance costs.

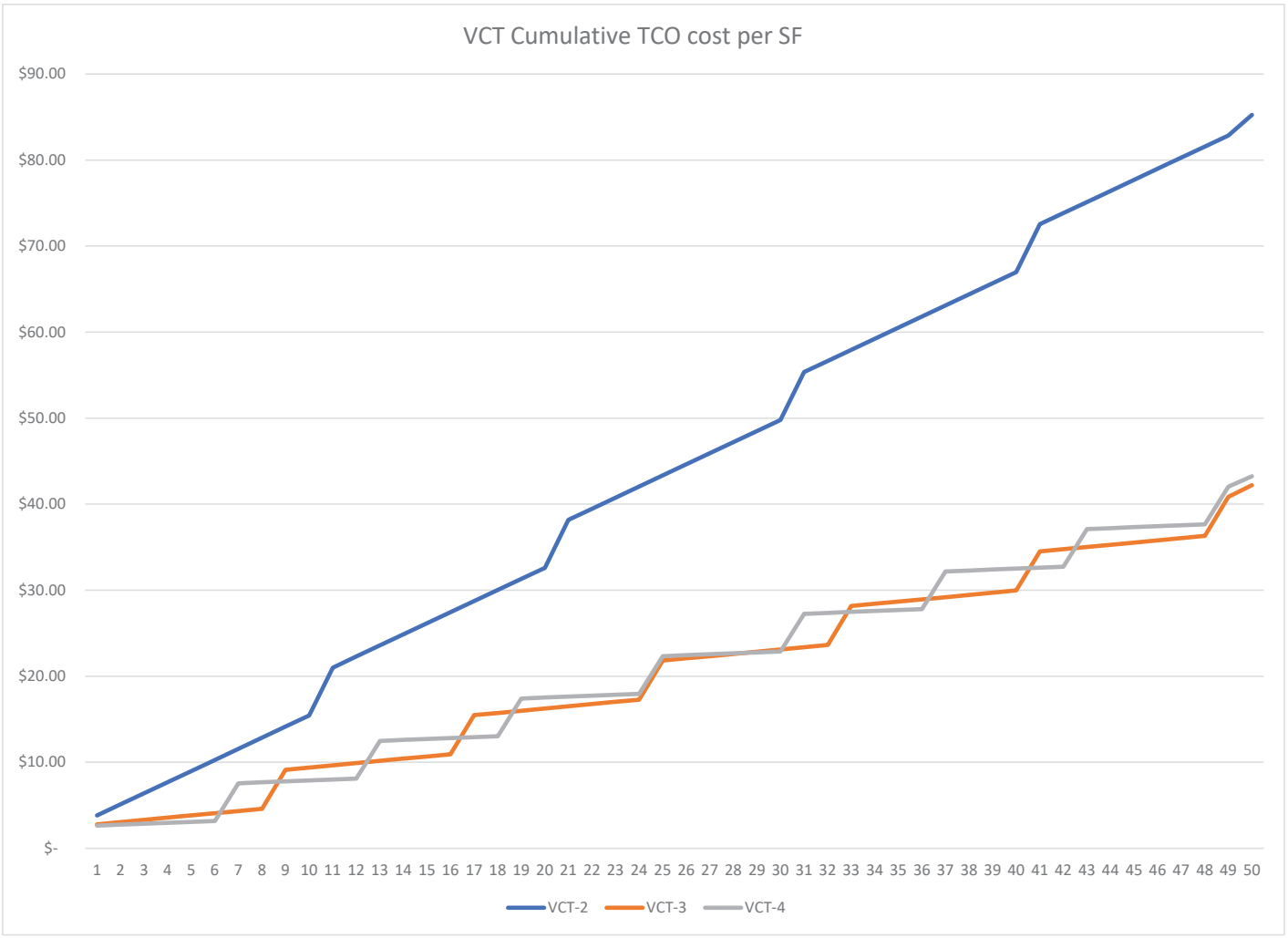
Summary

- Proper flooring maintenance improves indoor air quality and reduces absenteeism.
- Cleaning before sanitizing is crucial.
- Non-porous and hybrid carpets are more effective in managing contaminants.
- Entry flooring is essential for reducing soil and maintenance costs.
- Custodial training in proper maintenance practices is vital for occupant health.

Product Category	Description	Cost per square foot	Component	Notes
VCT	Common Vinyl Composition Tile	$ 2.53	is the initial cost, one-time	This is a new construction clean floor material + install + initial wax procedure
VCT	Common Vinyl Composition Tile	$ 1.29	is the maintenance & operations cost, annual	This is an annuallized cost per SF on dust mop, damp mop, scrubb and buff, strip and wax
VCT	Common Vinyl Composition Tile	N/A	is the energy/utility cost, annual	We do not have this readily available. I recommend we just note this as a fractionable variable which would include energy use of equipment like buffer, vacuum, and keeping the lights on in the building to perform the work. Unlike an HVAC unit where energy consumption is a much higher contributor to LCCA.
VCT	Common Vinyl Composition Tile	$ 4.28	is the capital renewal cost. Periodic (Yr 10 Expected Life)	Existing Removal + Floor Prep + Material + Install
VCT	Common Vinyl Composition Tile	$ 1.10	is the end-of-life cost, one-time	At end of life the only factor is removal of existing material and adhesive and disposal
Carpet Tile	Standard Non Cationic Topical Stain Resistance Fiber	$ 3.27	is the initial cost, one-time	This is a new construction clean floor material + install
Carpet Tile	Standard Non Cationic Topical Stain Resistance Fiber	$ 0.49	is the maintenance & operations cost, annual	This is an annuallized cost per SF vaccum + spot clean + interim + deep clean
Carpet Tile	Standard Non Cationic Topical Stain Resistance Fiber	N/A	is the energy/utility cost, annual	We do not have this readily available. I recommend we just note this as a fractionable variable which would include energy use of equipment like buffer, vacuum, and keeping the lights on in the building to perform the work. Unlike an HVAC unit where energy consumption is a much higher contributor to TCO.
Carpet Tile	Standard Non Cationic Topical Stain Resistance Fiber	$ 4.12	is the capital renewal cost. Periodic (Yr 8 Expected Life)	Existing Removal + Floor Prep + Material + Install
Carpet Tile	Standard Non Cationic Topical Stain Resistance Fiber	$ 0.55	is the end-of-life cost, one-time	At end of life the only factor is removal of existing material and adhesive and disposal
Hybrid Carpet	Closed Cell Cushion with Cationic Lifetime Stain Resistanct Fiber	$ 3.86	is the initial cost, one-time	This is a new construction clean floor material + install
Hybrid Carpet	Standard Non Cationic Topical Stain Resistance Fiber	$ 0.49	is the maintenance & operations cost, annual	This is an annuallized cost per SF vaccum + spot clean + interim + deep clean
Hybrid Carpet	Standard Non Cationic Topical Stain Resistance Fiber	N/A	is the energy/utility cost, annual	We do not have this readily available. I recommend we just note this as a fractionable variable which would include energy use of equipment like buffer, vacuum, and keeping the lights on in the building to perform the work. Unlike an HVAC unit where energy consumption is a much higher contributor to TCO.
Hybrid Carpet	Standard Non Cationic Topical Stain Resistance Fiber	$ 4.71	is the capital renewal cost. Periodic (Yr 30 Expected Life)	Existing Removal + Floor Prep + Material + Install
Hybrid Carpet	Standard Non Cationic Topical Stain Resistance Fiber	$ 0.55	is the end-of-life cost, one-time	At end of life the only factor is removal of existing material and any adhesive and disposal
Polished Concrete	Polished and Sealed Concrete	$ 5.57	is the initial cost, one-time	This is a new construction clean floor + stain + polish + seal
Polished Concrete	Polished and Sealed Concrete	$ 0.68	is the maintenance & operations cost, annual	This is an annuallized cost per SF on dust mop, damp mop, scrubb and buff, seal
Polished Concrete	Polished and Sealed Concrete	N/A	is the energy/utility cost, annual	We do not have this readily available. I recommend we just note this as a fractionable variable which would include energy use of equipment like buffer, vacuum, and keeping the lights on in the building to perform the work. Unlike an HVAC unit where energy consumption is a much higher contributor to TCO.
Polished Concrete	Polished and Sealed Concrete	$ 12.96	is the capital renewal cost. Periodic (Yr 25 Expected Life)	Existing Removal + Floor Prep + Material + Install
Polished Concrete	Polished and Sealed Concrete	$ 3.00	is the end-of-life cost, one-time	Any polished/sealed concrete sanded to remove the top coatings for any type of new flooring and disposed. Any additional floor preperation for the specific type would be additional costs.
LVT	Commercial Performance	$ 4.36	is the initial cost, one-time	This is a new construction clean floor material + install
LVT	Commercial Performance	$ 1.10	is the maintenance & operations cost, annual	This is an annuallized cost per SF on dust mop, damp mop, scrubb and buff
LVT	Commercial Performance	N/A	is the energy/utility cost, annual	We do not have this readily available. I recommend we just note this as a fractionable variable which would include energy use of equipment like buffer, vacuum, and keeping the lights on in the building to perform the work. Unlike an HVAC unit where energy consumption is a much higher contributor to TCO.
LVT	Commercial Performance	$ 8.68	is the capital renewal cost. Periodic (Yr 20 Expected Life)	Existing Removal + Floor Prep + Material + Install
LVT	Commercial Performance	$ 1.35	is the end-of-life cost, one-time	At end of life the only factor is removal of existing material and adhesive and disposal

Vinyl Composite Tile TOC Scenario Analysis

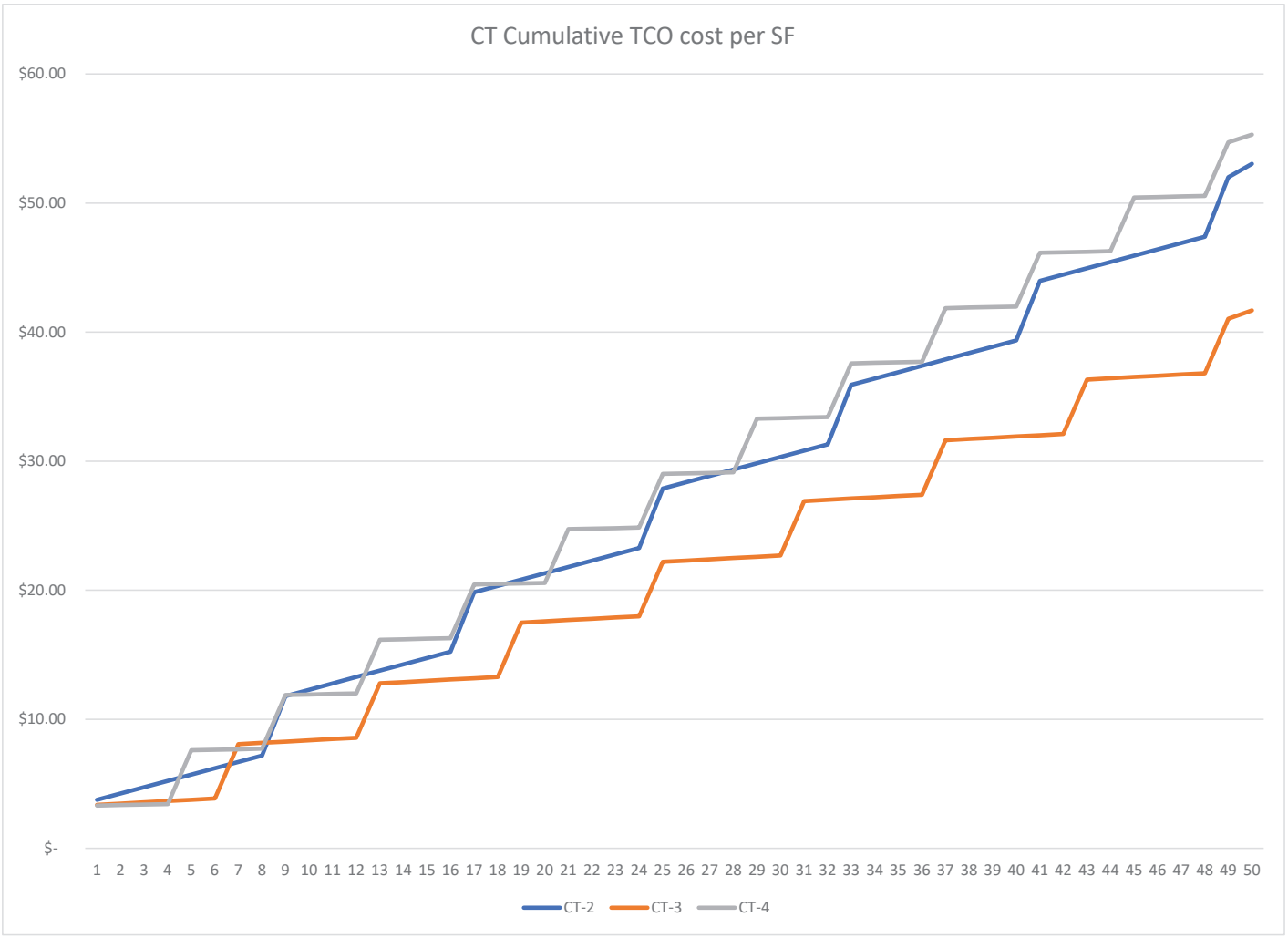
Year	Scenario	First Cost	Annual Maintenance	Remaining Life	Renewal Cost	Renewal	Expense	EOL	Cumm. TCO	Scenario	Annual Maintenance	Remaining Life	Renewal	Expense	Cumm. TCO	Scenario	Annual Maintenance	Remaining Life	Renewal	Expense	Cumm. TCO
1	VCT-2	$ 2.53	$ 1.29	10	$ 4.28		$ 3.82	$ 1.10	$ 3.82	VCT-3	$ 0.26	8		$ 2.79	$ 2.79	VCT-4	$ 0.11	6		$ 2.64	$ 2.64
2	VCT-2		$ 1.29	9	$ 4.28		$ 1.29		$ 5.11	VCT-3	$ 0.26	7		$ 0.26	$ 3.05	VCT-4	$ 0.11	5		$ 0.11	$ 2.75
3	VCT-2		$ 1.29	8	$ 4.28		$ 1.29		$ 6.40	VCT-3	$ 0.26	6		$ 0.26	$ 3.30	VCT-4	$ 0.11	4		$ 0.11	$ 2.85
4	VCT-2		$ 1.29	7	$ 4.28		$ 1.29		$ 7.69	VCT-3	$ 0.26	5		$ 0.26	$ 3.56	VCT-4	$ 0.11	3		$ 0.11	$ 2.96
5	VCT-2		$ 1.29	6	$ 4.28		$ 1.29		$ 8.98	VCT-3	$ 0.26	4		$ 0.26	$ 3.82	VCT-4	$ 0.11	2		$ 0.11	$ 3.07
6	VCT-2		$ 1.29	5	$ 4.28		$ 1.29		$ 10.27	VCT-3	$ 0.26	3		$ 0.26	$ 4.08	VCT-4	$ 0.11	1		$ 0.11	$ 3.18
7	VCT-2		$ 1.29	4	$ 4.28		$ 1.29		$ 11.56	VCT-3	$ 0.26	2		$ 0.26	$ 4.34	VCT-4	$ 0.11	6	$ 4.28	$ 4.39	$ 7.56
8	VCT-2		$ 1.29	3	$ 4.28		$ 1.29		$ 12.85	VCT-3	$ 0.26	1		$ 0.26	$ 4.59	VCT-4	$ 0.11	5		$ 0.11	$ 7.67
9	VCT-2		$ 1.29	2	$ 4.28		$ 1.29		$ 14.14	VCT-3	$ 0.26	8	$ 4.28	$ 4.54	$ 9.13	VCT-4	$ 0.11	4		$ 0.11	$ 7.78
10	VCT-2		$ 1.29	1	$ 4.28		$ 1.29		$ 15.43	VCT-3	$ 0.26	7		$ 0.26	$ 9.39	VCT-4	$ 0.11	3		$ 0.11	$ 7.89
11	VCT-2		$ 1.29	10	$ 4.28	$ 4.28	$ 5.57		$ 21.00	VCT-3	$ 0.26	6		$ 0.26	$ 9.65	VCT-4	$ 0.11	2		$ 0.11	$ 7.99
12	VCT-2		$ 1.29	9	$ 4.28		$ 1.29		$ 22.29	VCT-3	$ 0.26	5		$ 0.26	$ 9.91	VCT-4	$ 0.11	1		$ 0.11	$ 8.10
13	VCT-2		$ 1.29	8	$ 4.28		$ 1.29		$ 23.58	VCT-3	$ 0.26	4		$ 0.26	$ 10.16	VCT-4	$ 0.11	6	$ 4.28	$ 4.39	$ 12.49
14	VCT-2		$ 1.29	7	$ 4.28		$ 1.29		$ 24.87	VCT-3	$ 0.26	3		$ 0.26	$ 10.42	VCT-4	$ 0.11	5		$ 0.11	$ 12.60
15	VCT-2		$ 1.29	6	$ 4.28		$ 1.29		$ 26.16	VCT-3	$ 0.26	2		$ 0.26	$ 10.68	VCT-4	$ 0.11	4		$ 0.11	$ 12.70
16	VCT-2		$ 1.29	5	$ 4.28		$ 1.29		$ 27.45	VCT-3	$ 0.26	1		$ 0.26	$ 10.94	VCT-4	$ 0.11	3		$ 0.11	$ 12.81
17	VCT-2		$ 1.29	4	$ 4.28		$ 1.29		$ 28.74	VCT-3	$ 0.26	8	$ 4.28	$ 4.54	$ 15.48	VCT-4	$ 0.11	2		$ 0.11	$ 12.92
18	VCT-2		$ 1.29	3	$ 4.28		$ 1.29		$ 30.03	VCT-3	$ 0.26	7		$ 0.26	$ 15.73	VCT-4	$ 0.11	1		$ 0.11	$ 13.03
19	VCT-2		$ 1.29	2	$ 4.28		$ 1.29		$ 31.32	VCT-3	$ 0.26	6		$ 0.26	$ 15.99	VCT-4	$ 0.11	6	$ 4.28	$ 4.39	$ 17.41
20	VCT-2		$ 1.29	1	$ 4.28		$ 1.29		$ 32.61	VCT-3	$ 0.26	5		$ 0.26	$ 16.25	VCT-4	$ 0.11	5		$ 0.11	$ 17.52
21	VCT-2		$ 1.29	10	$ 4.28	$ 4.28	$ 5.57		$ 38.18	VCT-3	$ 0.26	4		$ 0.26	$ 16.51	VCT-4	$ 0.11	4		$ 0.11	$ 17.63
22	VCT-2		$ 1.29	9	$ 4.28		$ 1.29		$ 39.47	VCT-3	$ 0.26	3		$ 0.26	$ 16.77	VCT-4	$ 0.11	3		$ 0.11	$ 17.74
23	VCT-2		$ 1.29	8	$ 4.28		$ 1.29		$ 40.76	VCT-3	$ 0.26	2		$ 0.26	$ 17.02	VCT-4	$ 0.11	2		$ 0.11	$ 17.84
24	VCT-2		$ 1.29	7	$ 4.28		$ 1.29		$ 42.05	VCT-3	$ 0.26	1		$ 0.26	$ 17.28	VCT-4	$ 0.11	1		$ 0.11	$ 17.95
25	VCT-2		$ 1.29	6	$ 4.28		$ 1.29		$ 43.34	VCT-3	$ 0.26	8	$ 4.28	$ 4.54	$ 21.82	VCT-4	$ 0.11	6	$ 4.28	$ 4.39	$ 22.34
26	VCT-2		$ 1.29	5	$ 4.28		$ 1.29		$ 44.63	VCT-3	$ 0.26	7		$ 0.26	$ 22.08	VCT-4	$ 0.11	5		$ 0.11	$ 22.45
27	VCT-2		$ 1.29	4	$ 4.28		$ 1.29		$ 45.92	VCT-3	$ 0.26	6		$ 0.26	$ 22.34	VCT-4	$ 0.11	4		$ 0.11	$ 22.55
28	VCT-2		$ 1.29	3	$ 4.28		$ 1.29		$ 47.21	VCT-3	$ 0.26	5		$ 0.26	$ 22.59	VCT-4	$ 0.11	3		$ 0.11	$ 22.66
29	VCT-2		$ 1.29	2	$ 4.28		$ 1.29		$ 48.50	VCT-3	$ 0.26	4		$ 0.26	$ 22.85	VCT-4	$ 0.11	2		$ 0.11	$ 22.77
30	VCT-2		$ 1.29	1	$ 4.28		$ 1.29		$ 49.79	VCT-3	$ 0.26	3		$ 0.26	$ 23.11	VCT-4	$ 0.11	1		$ 0.11	$ 22.88
31	VCT-2		$ 1.29	10	$ 4.28	$ 4.28	$ 5.57		$ 55.36	VCT-3	$ 0.26	2		$ 0.26	$ 23.37	VCT-4	$ 0.11	6	$ 4.28	$ 4.39	$ 27.26
32	VCT-2		$ 1.29	9	$ 4.28		$ 1.29		$ 56.65	VCT-3	$ 0.26	1		$ 0.26	$ 23.63	VCT-4	$ 0.11	5		$ 0.11	$ 27.37
33	VCT-2		$ 1.29	8	$ 4.28		$ 1.29		$ 57.94	VCT-3	$ 0.26	8	$ 4.28	$ 4.54	$ 28.16	VCT-4	$ 0.11	4		$ 0.11	$ 27.48
34	VCT-2		$ 1.29	7	$ 4.28		$ 1.29		$ 59.23	VCT-3	$ 0.26	7		$ 0.26	$ 28.42	VCT-4	$ 0.11	3		$ 0.11	$ 27.59
35	VCT-2		$ 1.29	6	$ 4.28		$ 1.29		$ 60.52	VCT-3	$ 0.26	6		$ 0.26	$ 28.68	VCT-4	$ 0.11	2		$ 0.11	$ 27.69
36	VCT-2		$ 1.29	5	$ 4.28		$ 1.29		$ 61.81	VCT-3	$ 0.26	5		$ 0.26	$ 28.94	VCT-4	$ 0.11	1		$ 0.11	$ 27.80
37	VCT-2		$ 1.29	4	$ 4.28		$ 1.29		$ 63.10	VCT-3	$ 0.26	4		$ 0.26	$ 29.20	VCT-4	$ 0.11	6	$ 4.28	$ 4.39	$ 32.19
38	VCT-2		$ 1.29	3	$ 4.28		$ 1.29		$ 64.39	VCT-3	$ 0.26	3		$ 0.26	$ 29.45	VCT-4	$ 0.11	5		$ 0.11	$ 32.30
39	VCT-2		$ 1.29	2	$ 4.28		$ 1.29		$ 65.68	VCT-3	$ 0.26	2		$ 0.26	$ 29.71	VCT-4	$ 0.11	4		$ 0.11	$ 32.40
40	VCT-2		$ 1.29	1	$ 4.28		$ 1.29		$ 66.97	VCT-3	$ 0.26	1		$ 0.26	$ 29.97	VCT-4	$ 0.11	3		$ 0.11	$ 32.51
41	VCT-2		$ 1.29	10	$ 4.28	$ 4.28	$ 5.57		$ 72.54	VCT-3	$ 0.26	8	$ 4.28	$ 4.54	$ 34.51	VCT-4	$ 0.11	2		$ 0.11	$ 32.62
42	VCT-2		$ 1.29	9	$ 4.28		$ 1.29		$ 73.83	VCT-3	$ 0.26	7		$ 0.26	$ 34.77	VCT-4	$ 0.11	1		$ 0.11	$ 32.73
43	VCT-2		$ 1.29	8	$ 4.28		$ 1.29		$ 75.12	VCT-3	$ 0.26	6		$ 0.26	$ 35.02	VCT-4	$ 0.11	6	$ 4.28	$ 4.39	$ 37.11
44	VCT-2		$ 1.29	7	$ 4.28		$ 1.29		$ 76.41	VCT-3	$ 0.26	5		$ 0.26	$ 35.28	VCT-4	$ 0.11	5		$ 0.11	$ 37.22
45	VCT-2		$ 1.29	6	$ 4.28		$ 1.29		$ 77.70	VCT-3	$ 0.26	4		$ 0.26	$ 35.54	VCT-4	$ 0.11	4		$ 0.11	$ 37.33
46	VCT-2		$ 1.29	5	$ 4.28		$ 1.29		$ 78.99	VCT-3	$ 0.26	3		$ 0.26	$ 35.80	VCT-4	$ 0.11	3		$ 0.11	$ 37.44
47	VCT-2		$ 1.29	4	$ 4.28		$ 1.29		$ 80.28	VCT-3	$ 0.26	2		$ 0.26	$ 36.06	VCT-4	$ 0.11	2		$ 0.11	$ 37.54
48	VCT-2		$ 1.29	3	$ 4.28		$ 1.29		$ 81.57	VCT-3	$ 0.26	1		$ 0.26	$ 36.31	VCT-4	$ 0.11	1		$ 0.11	$ 37.65
49	VCT-2		$ 1.29	2	$ 4.28		$ 1.29		$ 82.86	VCT-3	$ 0.26	8	$ 4.28	$ 4.54	$ 40.85	VCT-4	$ 0.11	6	$ 4.28	$ 4.39	$ 42.04
50	VCT-2		$ 1.29	1	$ 4.28		$ 2.39	$ 1.10	$ 85.25	VCT-3	$ 0.26	7		$ 1.36	$ 42.21	VCT-4	$ 0.11	5		$ 1.21	$ 43.25
	TCO	**$ 2.53**	**$ 64.50**			**$ 17.12**		**$ 1.10**	**$ 85.25**		$ 12.90		$ 25.68		**$ 42.21**		$ 5.38		$ 34.24		**$ 43.25**


VCT Cumulative TCO cost per SF
$90.00
$80.00
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
VCT-2
VCT-3
VCT-4

CFaR036-17

Carpet Tile TCO Scenario Analysis

Year	Scenario	First Cost	Annual Maintenance	Remaining Life	Renewal Cost	Renewal	EOL	Expense	Cumm. TCO	Scenario	Annual Maintenance	Remaining Life	Renewal	Expense	Cumm. TCO	Scenario	Annual Maintenance	Remaining Life	Renewal	Expense	Cumm. TCO
1	CT-2	$ 3.27	$ 0.49	8	$ 4.12			$ 3.76	$ 3.76	CT-3	$ 0.10	6		$ 3.37	$ 3.37	CT-4	$ 0.04	4		$ 3.31	$ 3.31
2	CT-2		$ 0.49	7	$ 4.12			$ 0.49	$ 4.25	CT-3	$ 0.10	5		$ 0.10	$ 3.47	CT-4	$ 0.04	3		$ 0.04	$ 3.35
3	CT-2		$ 0.49	6	$ 4.12			$ 0.49	$ 4.74	CT-3	$ 0.10	4		$ 0.10	$ 3.56	CT-4	$ 0.04	2		$ 0.04	$ 3.39
4	CT-2		$ 0.49	5	$ 4.12			$ 0.49	$ 5.23	CT-3	$ 0.10	3		$ 0.10	$ 3.66	CT-4	$ 0.04	1		$ 0.04	$ 3.43
5	CT-2		$ 0.49	4	$ 4.12			$ 0.49	$ 5.72	CT-3	$ 0.10	2		$ 0.10	$ 3.76	CT-4	$ 0.04	4	$ 4.12	$ 4.16	$ 7.59
6	CT-2		$ 0.49	3	$ 4.12			$ 0.49	$ 6.21	CT-3	$ 0.10	1		$ 0.10	$ 3.86	CT-4	$ 0.04	3		$ 0.04	$ 7.64
7	CT-2		$ 0.49	2	$ 4.12			$ 0.49	$ 6.70	CT-3	$ 0.10	6	$ 4.12	$ 4.22	$ 8.08	CT-4	$ 0.04	2		$ 0.04	$ 7.68
8	CT-2		$ 0.49	1	$ 4.12			$ 0.49	$ 7.19	CT-3	$ 0.10	5		$ 0.10	$ 8.17	CT-4	$ 0.04	1		$ 0.04	$ 7.72
9	CT-2		$ 0.49	8	$ 4.12	$ 4.12		$ 4.61	$ 11.80	CT-3	$ 0.10	4		$ 0.10	$ 8.27	CT-4	$ 0.04	4	$ 4.12	$ 4.16	$ 11.88
10	CT-2		$ 0.49	7	$ 4.12			$ 0.49	$ 12.29	CT-3	$ 0.10	3		$ 0.10	$ 8.37	CT-4	$ 0.04	3		$ 0.04	$ 11.92
11	CT-2		$ 0.49	6	$ 4.12			$ 0.49	$ 12.78	CT-3	$ 0.10	2		$ 0.10	$ 8.47	CT-4	$ 0.04	2		$ 0.04	$ 11.96
12	CT-2		$ 0.49	5	$ 4.12			$ 0.49	$ 13.27	CT-3	$ 0.10	1		$ 0.10	$ 8.57	CT-4	$ 0.04	1		$ 0.04	$ 12.00
13	CT-2		$ 0.49	4	$ 4.12			$ 0.49	$ 13.76	CT-3	$ 0.10	6	$ 4.12	$ 4.22	$ 12.78	CT-4	$ 0.04	4	$ 4.12	$ 4.16	$ 16.16
14	CT-2		$ 0.49	3	$ 4.12			$ 0.49	$ 14.25	CT-3	$ 0.10	5		$ 0.10	$ 12.88	CT-4	$ 0.04	3		$ 0.04	$ 16.20
15	CT-2		$ 0.49	2	$ 4.12			$ 0.49	$ 14.74	CT-3	$ 0.10	4		$ 0.10	$ 12.98	CT-4	$ 0.04	2		$ 0.04	$ 16.24
16	CT-2		$ 0.49	1	$ 4.12			$ 0.49	$ 15.23	CT-3	$ 0.10	3		$ 0.10	$ 13.08	CT-4	$ 0.04	1		$ 0.04	$ 16.28
17	CT-2		$ 0.49	8	$ 4.12	$ 4.12		$ 4.61	$ 19.84	CT-3	$ 0.10	2		$ 0.10	$ 13.18	CT-4	$ 0.04	4	$ 4.12	$ 4.16	$ 20.44
18	CT-2		$ 0.49	7	$ 4.12			$ 0.49	$ 20.33	CT-3	$ 0.10	1		$ 0.10	$ 13.27	CT-4	$ 0.04	3		$ 0.04	$ 20.49
19	CT-2		$ 0.49	6	$ 4.12			$ 0.49	$ 20.82	CT-3	$ 0.10	6	$ 4.12	$ 4.22	$ 17.49	CT-4	$ 0.04	2		$ 0.04	$ 20.53
20	CT-2		$ 0.49	5	$ 4.12			$ 0.49	$ 21.31	CT-3	$ 0.10	5		$ 0.10	$ 17.59	CT-4	$ 0.04	1		$ 0.04	$ 20.57
21	CT-2		$ 0.49	4	$ 4.12			$ 0.49	$ 21.80	CT-3	$ 0.10	4		$ 0.10	$ 17.69	CT-4	$ 0.04	4	$ 4.12	$ 4.16	$ 24.73
22	CT-2		$ 0.49	3	$ 4.12			$ 0.49	$ 22.29	CT-3	$ 0.10	3		$ 0.10	$ 17.79	CT-4	$ 0.04	3		$ 0.04	$ 24.77
23	CT-2		$ 0.49	2	$ 4.12			$ 0.49	$ 22.78	CT-3	$ 0.10	2		$ 0.10	$ 17.88	CT-4	$ 0.04	2		$ 0.04	$ 24.81
24	CT-2		$ 0.49	1	$ 4.12			$ 0.49	$ 23.27	CT-3	$ 0.10	1		$ 0.10	$ 17.98	CT-4	$ 0.04	1		$ 0.04	$ 24.85
25	CT-2		$ 0.49	8	$ 4.12	$ 4.12		$ 4.61	$ 27.88	CT-3	$ 0.10	6	$ 4.12	$ 4.22	$ 22.20	CT-4	$ 0.04	4	$ 4.12	$ 4.16	$ 29.01
26	CT-2		$ 0.49	7	$ 4.12			$ 0.49	$ 28.37	CT-3	$ 0.10	5		$ 0.10	$ 22.30	CT-4	$ 0.04	3		$ 0.04	$ 29.05
27	CT-2		$ 0.49	6	$ 4.12			$ 0.49	$ 28.86	CT-3	$ 0.10	4		$ 0.10	$ 22.40	CT-4	$ 0.04	2		$ 0.04	$ 29.09
28	CT-2		$ 0.49	5	$ 4.12			$ 0.49	$ 29.35	CT-3	$ 0.10	3		$ 0.10	$ 22.49	CT-4	$ 0.04	1		$ 0.04	$ 29.13
29	CT-2		$ 0.49	4	$ 4.12			$ 0.49	$ 29.84	CT-3	$ 0.10	2		$ 0.10	$ 22.59	CT-4	$ 0.04	4	$ 4.12	$ 4.16	$ 33.29
30	CT-2		$ 0.49	3	$ 4.12			$ 0.49	$ 30.33	CT-3	$ 0.10	1		$ 0.10	$ 22.69	CT-4	$ 0.04	3		$ 0.04	$ 33.34
31	CT-2		$ 0.49	2	$ 4.12			$ 0.49	$ 30.82	CT-3	$ 0.10	6	$ 4.12	$ 4.22	$ 26.91	CT-4	$ 0.04	2		$ 0.04	$ 33.38
32	CT-2		$ 0.49	1	$ 4.12			$ 0.49	$ 31.31	CT-3	$ 0.10	5		$ 0.10	$ 27.01	CT-4	$ 0.04	1		$ 0.04	$ 33.42
33	CT-2		$ 0.49	8	$ 4.12	$ 4.12		$ 4.61	$ 35.92	CT-3	$ 0.10	4		$ 0.10	$ 27.10	CT-4	$ 0.04	4	$ 4.12	$ 4.16	$ 37.58
34	CT-2		$ 0.49	7	$ 4.12			$ 0.49	$ 36.41	CT-3	$ 0.10	3		$ 0.10	$ 27.20	CT-4	$ 0.04	3		$ 0.04	$ 37.62
35	CT-2		$ 0.49	6	$ 4.12			$ 0.49	$ 36.90	CT-3	$ 0.10	2		$ 0.10	$ 27.30	CT-4	$ 0.04	2		$ 0.04	$ 37.66
36	CT-2		$ 0.49	5	$ 4.12			$ 0.49	$ 37.39	CT-3	$ 0.10	1		$ 0.10	$ 27.40	CT-4	$ 0.04	1		$ 0.04	$ 37.70
37	CT-2		$ 0.49	4	$ 4.12			$ 0.49	$ 37.88	CT-3	$ 0.10	6	$ 4.12	$ 4.22	$ 31.62	CT-4	$ 0.04	4	$ 4.12	$ 4.16	$ 41.86
38	CT-2		$ 0.49	3	$ 4.12			$ 0.49	$ 38.37	CT-3	$ 0.10	5		$ 0.10	$ 31.71	CT-4	$ 0.04	3		$ 0.04	$ 41.90
39	CT-2		$ 0.49	2	$ 4.12			$ 0.49	$ 38.86	CT-3	$ 0.10	4		$ 0.10	$ 31.81	CT-4	$ 0.04	2		$ 0.04	$ 41.94
40	CT-2		$ 0.49	1	$ 4.12			$ 0.49	$ 39.35	CT-3	$ 0.10	3		$ 0.10	$ 31.91	CT-4	$ 0.04	1		$ 0.04	$ 41.98
41	CT-2		$ 0.49	8	$ 4.12	$ 4.12		$ 4.61	$ 43.96	CT-3	$ 0.10	2		$ 0.10	$ 32.01	CT-4	$ 0.04	4	$ 4.12	$ 4.16	$ 46.14
42	CT-2		$ 0.49	7	$ 4.12			$ 0.49	$ 44.45	CT-3	$ 0.10	1		$ 0.10	$ 32.11	CT-4	$ 0.04	3		$ 0.04	$ 46.19
43	CT-2		$ 0.49	6	$ 4.12			$ 0.49	$ 44.94	CT-3	$ 0.10	6	$ 4.12	$ 4.22	$ 36.32	CT-4	$ 0.04	2		$ 0.04	$ 46.23
44	CT-2		$ 0.49	5	$ 4.12			$ 0.49	$ 45.43	CT-3	$ 0.10	5		$ 0.10	$ 36.42	CT-4	$ 0.04	1		$ 0.04	$ 46.27
45	CT-2		$ 0.49	4	$ 4.12			$ 0.49	$ 45.92	CT-3	$ 0.10	4		$ 0.10	$ 36.52	CT-4	$ 0.04	4	$ 4.12	$ 4.16	$ 50.43
46	CT-2		$ 0.49	3	$ 4.12			$ 0.49	$ 46.41	CT-3	$ 0.10	3		$ 0.10	$ 36.62	CT-4	$ 0.04	3		$ 0.04	$ 50.47
47	CT-2		$ 0.49	2	$ 4.12			$ 0.49	$ 46.90	CT-3	$ 0.10	2		$ 0.10	$ 36.72	CT-4	$ 0.04	2		$ 0.04	$ 50.51
48	CT-2		$ 0.49	1	$ 4.12			$ 0.49	$ 47.39	CT-3	$ 0.10	1		$ 0.10	$ 36.81	CT-4	$ 0.04	1		$ 0.04	$ 50.55
49	CT-2		$ 0.49	8	$ 4.12	$ 4.12		$ 4.61	$ 52.00	CT-3	$ 0.10	6	$ 4.12	$ 4.22	$ 41.03	CT-4	$ 0.04	4	$ 4.12	$ 4.16	$ 54.71
50	CT-2		$ 0.49	7	$ 4.12		$ 0.55	$ 1.04	$ 53.04	CT-3	$ 0.10	5		$ 0.65	$ 41.68	CT-4	$ 0.04	3		$ 0.59	$ 55.30
	TCO	3.27	$ 24.50			$ 24.72	$ 0.55		**$ 53.04**		$ 4.90		$ 32.96		**$ 41.68**		$ 2.04		$ 49.44		**$ 55.30**

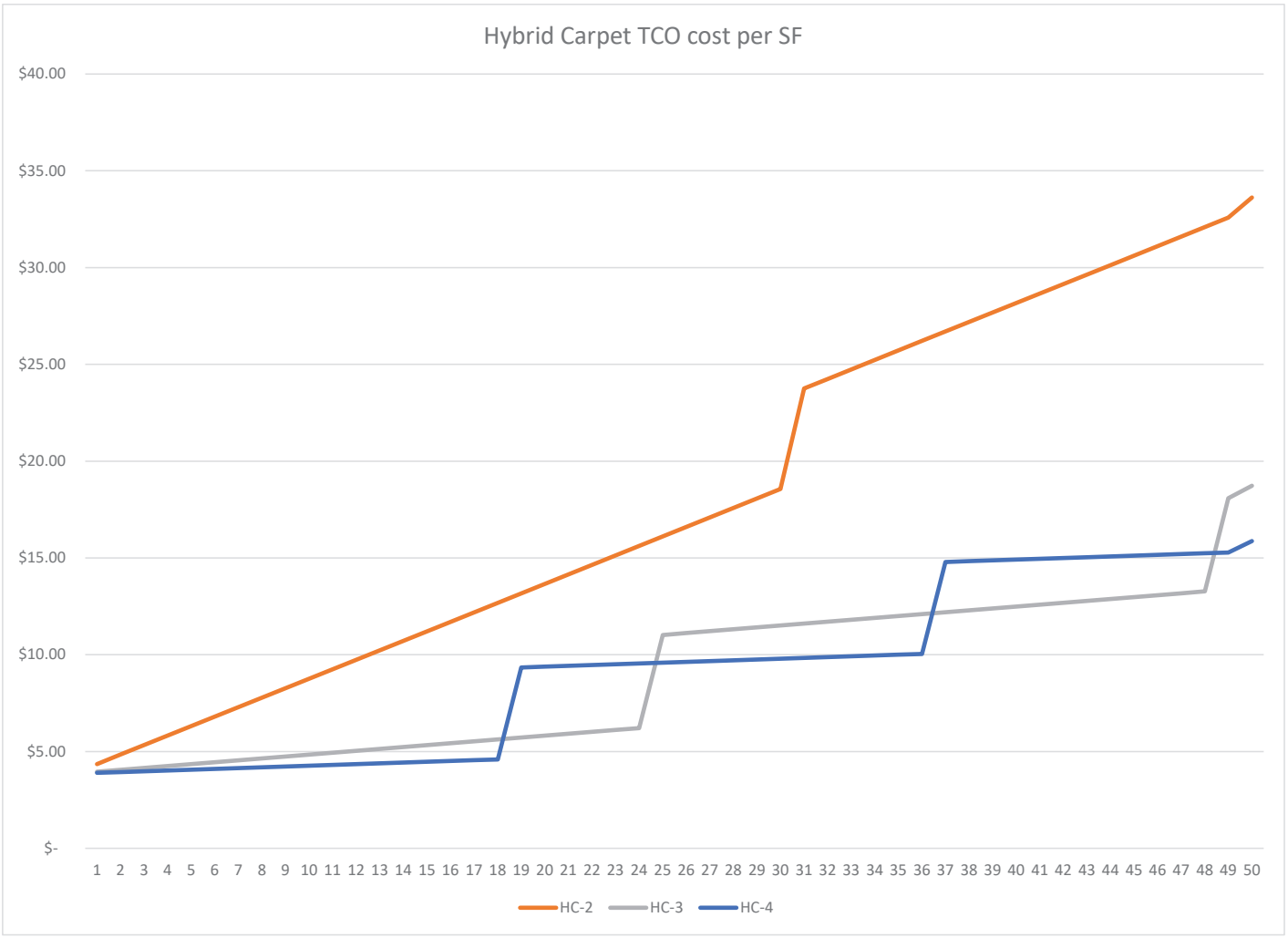

CT Cumulative TCO cost per SF
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
CT-2
CT-3
CT-4

CFaR036-17

Hybrid Carpet TCO Scenario Analysis

Year	Scenario	First Cost	Annual Maintenance	Remaining Life	Renewal Cost	Renewal	EOL	Expense	Cumm. TCO	Scenario	Annual Maintenance	Remaining Life	Renewal	Expense	Cumm. TCO	Scenario	Annual Maintenance	Remaining Life	Renewal	Expense	Cumm. TCO
1	HC-2	$ 3.86	$ 0.49	30	$ 4.71			$ 4.35	$ 4.35	HC-3	$ 0.10	24		$ 3.96	$ 3.96	HC-4	$ 0.04	18		$ 3.90	$ 3.90
2	HC-2		$ 0.49	29	$ 4.71			$ 0.49	$ 4.84	HC-3	$ 0.10	23		$ 0.10	$ 4.06	HC-4	$ 0.04	17		$ 0.04	$ 3.94
3	HC-2		$ 0.49	28	$ 4.71			$ 0.49	$ 5.33	HC-3	$ 0.10	22		$ 0.10	$ 4.15	HC-4	$ 0.04	16		$ 0.04	$ 3.98
4	HC-2		$ 0.49	27	$ 4.71			$ 0.49	$ 5.82	HC-3	$ 0.10	21		$ 0.10	$ 4.25	HC-4	$ 0.04	15		$ 0.04	$ 4.02
5	HC-2		$ 0.49	26	$ 4.71			$ 0.49	$ 6.31	HC-3	$ 0.10	20		$ 0.10	$ 4.35	HC-4	$ 0.04	14		$ 0.04	$ 4.06
6	HC-2		$ 0.49	25	$ 4.71			$ 0.49	$ 6.80	HC-3	$ 0.10	19		$ 0.10	$ 4.45	HC-4	$ 0.04	13		$ 0.04	$ 4.11
7	HC-2		$ 0.49	24	$ 4.71			$ 0.49	$ 7.29	HC-3	$ 0.10	18		$ 0.10	$ 4.55	HC-4	$ 0.04	12		$ 0.04	$ 4.15
8	HC-2		$ 0.49	23	$ 4.71			$ 0.49	$ 7.78	HC-3	$ 0.10	17		$ 0.10	$ 4.64	HC-4	$ 0.04	11		$ 0.04	$ 4.19
9	HC-2		$ 0.49	22	$ 4.71			$ 0.49	$ 8.27	HC-3	$ 0.10	16		$ 0.10	$ 4.74	HC-4	$ 0.04	10		$ 0.04	$ 4.23
10	HC-2		$ 0.49	21	$ 4.71			$ 0.49	$ 8.76	HC-3	$ 0.10	15		$ 0.10	$ 4.84	HC-4	$ 0.04	9		$ 0.04	$ 4.27
11	HC-2		$ 0.49	20	$ 4.71			$ 0.49	$ 9.25	HC-3	$ 0.10	14		$ 0.10	$ 4.94	HC-4	$ 0.04	8		$ 0.04	$ 4.31
12	HC-2		$ 0.49	19	$ 4.71			$ 0.49	$ 9.74	HC-3	$ 0.10	13		$ 0.10	$ 5.04	HC-4	$ 0.04	7		$ 0.04	$ 4.35
13	HC-2		$ 0.49	18	$ 4.71			$ 0.49	$ 10.23	HC-3	$ 0.10	12		$ 0.10	$ 5.13	HC-4	$ 0.04	6		$ 0.04	$ 4.39
14	HC-2		$ 0.49	17	$ 4.71			$ 0.49	$ 10.72	HC-3	$ 0.10	11		$ 0.10	$ 5.23	HC-4	$ 0.04	5		$ 0.04	$ 4.43
15	HC-2		$ 0.49	16	$ 4.71			$ 0.49	$ 11.21	HC-3	$ 0.10	10		$ 0.10	$ 5.33	HC-4	$ 0.04	4		$ 0.04	$ 4.47
16	HC-2		$ 0.49	15	$ 4.71			$ 0.49	$ 11.70	HC-3	$ 0.10	9		$ 0.10	$ 5.43	HC-4	$ 0.04	3		$ 0.04	$ 4.51
17	HC-2		$ 0.49	14	$ 4.71			$ 0.49	$ 12.19	HC-3	$ 0.10	8		$ 0.10	$ 5.53	HC-4	$ 0.04	2		$ 0.04	$ 4.55
18	HC-2		$ 0.49	13	$ 4.71			$ 0.49	$ 12.68	HC-3	$ 0.10	7		$ 0.10	$ 5.62	HC-4	$ 0.04	1		$ 0.04	$ 4.60
19	HC-2		$ 0.49	12	$ 4.71			$ 0.49	$ 13.17	HC-3	$ 0.10	6		$ 0.10	$ 5.72	HC-4	$ 0.04	18	$ 4.71	$ 4.75	$ 9.35
20	HC-2		$ 0.49	11	$ 4.71			$ 0.49	$ 13.66	HC-3	$ 0.10	5		$ 0.10	$ 5.82	HC-4	$ 0.04	17		$ 0.04	$ 9.39
21	HC-2		$ 0.49	10	$ 4.71			$ 0.49	$ 14.15	HC-3	$ 0.10	4		$ 0.10	$ 5.92	HC-4	$ 0.04	16		$ 0.04	$ 9.43
22	HC-2		$ 0.49	9	$ 4.71			$ 0.49	$ 14.64	HC-3	$ 0.10	3		$ 0.10	$ 6.02	HC-4	$ 0.04	15		$ 0.04	$ 9.47
23	HC-2		$ 0.49	8	$ 4.71			$ 0.49	$ 15.13	HC-3	$ 0.10	2		$ 0.10	$ 6.11	HC-4	$ 0.04	14		$ 0.04	$ 9.51
24	HC-2		$ 0.49	7	$ 4.71			$ 0.49	$ 15.62	HC-3	$ 0.10	1		$ 0.10	$ 6.21	HC-4	$ 0.04	13		$ 0.04	$ 9.55
25	HC-2		$ 0.49	6	$ 4.71			$ 0.49	$ 16.11	HC-3	$ 0.10	24	$ 4.71	$ 4.81	$ 11.02	HC-4	$ 0.04	12		$ 0.04	$ 9.59
26	HC-2		$ 0.49	5	$ 4.71			$ 0.49	$ 16.60	HC-3	$ 0.10	23		$ 0.10	$ 11.12	HC-4	$ 0.04	11		$ 0.04	$ 9.63
27	HC-2		$ 0.49	4	$ 4.71			$ 0.49	$ 17.09	HC-3	$ 0.10	22		$ 0.10	$ 11.22	HC-4	$ 0.04	10		$ 0.04	$ 9.67
28	HC-2		$ 0.49	3	$ 4.71			$ 0.49	$ 17.58	HC-3	$ 0.10	21		$ 0.10	$ 11.31	HC-4	$ 0.04	9		$ 0.04	$ 9.71
29	HC-2		$ 0.49	2	$ 4.71			$ 0.49	$ 18.07	HC-3	$ 0.10	20		$ 0.10	$ 11.41	HC-4	$ 0.04	8		$ 0.04	$ 9.75
30	HC-2		$ 0.49	1	$ 4.71			$ 0.49	$ 18.56	HC-3	$ 0.10	19		$ 0.10	$ 11.51	HC-4	$ 0.04	7		$ 0.04	$ 9.80
31	HC-2		$ 0.49	30	$ 4.71	$ 4.71		$ 5.20	$ 23.76	HC-3	$ 0.10	18		$ 0.10	$ 11.61	HC-4	$ 0.04	6		$ 0.04	$ 9.84
32	HC-2		$ 0.49	29	$ 4.71			$ 0.49	$ 24.25	HC-3	$ 0.10	17		$ 0.10	$ 11.71	HC-4	$ 0.04	5		$ 0.04	$ 9.88
33	HC-2		$ 0.49	28	$ 4.71			$ 0.49	$ 24.74	HC-3	$ 0.10	16		$ 0.10	$ 11.80	HC-4	$ 0.04	4		$ 0.04	$ 9.92
34	HC-2		$ 0.49	27	$ 4.71			$ 0.49	$ 25.23	HC-3	$ 0.10	15		$ 0.10	$ 11.90	HC-4	$ 0.04	3		$ 0.04	$ 9.96
35	HC-2		$ 0.49	26	$ 4.71			$ 0.49	$ 25.72	HC-3	$ 0.10	14		$ 0.10	$ 12.00	HC-4	$ 0.04	2		$ 0.04	$ 10.00
36	HC-2		$ 0.49	25	$ 4.71			$ 0.49	$ 26.21	HC-3	$ 0.10	13		$ 0.10	$ 12.10	HC-4	$ 0.04	1		$ 0.04	$ 10.04
37	HC-2		$ 0.49	24	$ 4.71			$ 0.49	$ 26.70	HC-3	$ 0.10	12		$ 0.10	$ 12.20	HC-4	$ 0.04	18	$ 4.71	$ 4.75	$ 14.79
38	HC-2		$ 0.49	23	$ 4.71			$ 0.49	$ 27.19	HC-3	$ 0.10	11		$ 0.10	$ 12.29	HC-4	$ 0.04	17		$ 0.04	$ 14.83
39	HC-2		$ 0.49	22	$ 4.71			$ 0.49	$ 27.68	HC-3	$ 0.10	10		$ 0.10	$ 12.39	HC-4	$ 0.04	16		$ 0.04	$ 14.87
40	HC-2		$ 0.49	21	$ 4.71			$ 0.49	$ 28.17	HC-3	$ 0.10	9		$ 0.10	$ 12.49	HC-4	$ 0.04	15		$ 0.04	$ 14.91
41	HC-2		$ 0.49	20	$ 4.71			$ 0.49	$ 28.66	HC-3	$ 0.10	8		$ 0.10	$ 12.59	HC-4	$ 0.04	14		$ 0.04	$ 14.95
42	HC-2		$ 0.49	19	$ 4.71			$ 0.49	$ 29.15	HC-3	$ 0.10	7		$ 0.10	$ 12.69	HC-4	$ 0.04	13		$ 0.04	$ 15.00
43	HC-2		$ 0.49	18	$ 4.71			$ 0.49	$ 29.64	HC-3	$ 0.10	6		$ 0.10	$ 12.78	HC-4	$ 0.04	12		$ 0.04	$ 15.04
44	HC-2		$ 0.49	17	$ 4.71			$ 0.49	$ 30.13	HC-3	$ 0.10	5		$ 0.10	$ 12.88	HC-4	$ 0.04	11		$ 0.04	$ 15.08
45	HC-2		$ 0.49	16	$ 4.71			$ 0.49	$ 30.62	HC-3	$ 0.10	4		$ 0.10	$ 12.98	HC-4	$ 0.04	10		$ 0.04	$ 15.12
46	HC-2		$ 0.49	15	$ 4.71			$ 0.49	$ 31.11	HC-3	$ 0.10	3		$ 0.10	$ 13.08	HC-4	$ 0.04	9		$ 0.04	$ 15.16
47	HC-2		$ 0.49	14	$ 4.71			$ 0.49	$ 31.60	HC-3	$ 0.10	2		$ 0.10	$ 13.18	HC-4	$ 0.04	8		$ 0.04	$ 15.20
48	HC-2		$ 0.49	13	$ 4.71			$ 0.49	$ 32.09	HC-3	$ 0.10	1		$ 0.10	$ 13.27	HC-4	$ 0.04	7		$ 0.04	$ 15.24
49	HC-2		$ 0.49	12	$ 4.71			$ 0.49	$ 32.58	HC-3	$ 0.10	24	$ 4.71	$ 4.81	$ 18.08	HC-4	$ 0.04	6		$ 0.04	$ 15.28
50	HC-2		$ 0.49	11	$ 4.71		$ 0.55	$ 1.04	$ 33.62	HC-3	$ 0.10	23		$ 0.65	$ 18.73	HC-4	$ 0.04	5		$ 0.59	$ 15.87
	TCO	3.86	$ 24.50			$ 4.71	$ 0.55		**$ 33.62**		$ 4.90		$ 9.42		**$ 18.73**		$ 2.04		$ 9.42		**$ 15.87**

CFaR036-17


Hybrid Carpet TCO cost per SF
$40.00
$35.00
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
HC-2
HC-3
HC-4

CFaR036-17

Polished Concrete TCO Scenario Analyssis

Year	Scenario	First Cost	Annual Maintenance	Remaining Life	Renewal Cost	Renewal	EOL	Expense	Cumm. TCO	Scenario	Annual Maintenance	Remaining Life	Renewal	Expense	Cumm. TCO	Scenario	Annual Maintenance	Remaining Life	Renewal	Expense	Cumm. TCO
1	PC-2	$ 5.57	$ 0.68	25	$ 12.96			$ 6.25	$ 6.25	PC-3	$ 0.14	20		$ 5.71	$ 5.71	PC-4	$ 0.06	15		$ 5.63	$ 5.63
2	PC-2		$ 0.68	24	$ 12.96			$ 0.68	$ 6.93	PC-3	$ 0.14	19		$ 0.14	$ 5.84	PC-4	$ 0.06	14		$ 0.06	$ 5.68
3	PC-2		$ 0.68	23	$ 12.96			$ 0.68	$ 7.61	PC-3	$ 0.14	18		$ 0.14	$ 5.98	PC-4	$ 0.06	13		$ 0.06	$ 5.74
4	PC-2		$ 0.68	22	$ 12.96			$ 0.68	$ 8.29	PC-3	$ 0.14	17		$ 0.14	$ 6.11	PC-4	$ 0.06	12		$ 0.06	$ 5.80
5	PC-2		$ 0.68	21	$ 12.96			$ 0.68	$ 8.97	PC-3	$ 0.14	16		$ 0.14	$ 6.25	PC-4	$ 0.06	11		$ 0.06	$ 5.85
6	PC-2		$ 0.68	20	$ 12.96			$ 0.68	$ 9.65	PC-3	$ 0.14	15		$ 0.14	$ 6.39	PC-4	$ 0.06	10		$ 0.06	$ 5.91
7	PC-2		$ 0.68	19	$ 12.96			$ 0.68	$ 10.33	PC-3	$ 0.14	14		$ 0.14	$ 6.52	PC-4	$ 0.06	9		$ 0.06	$ 5.97
8	PC-2		$ 0.68	18	$ 12.96			$ 0.68	$ 11.01	PC-3	$ 0.14	13		$ 0.14	$ 6.66	PC-4	$ 0.06	8		$ 0.06	$ 6.02
9	PC-2		$ 0.68	17	$ 12.96			$ 0.68	$ 11.69	PC-3	$ 0.14	12		$ 0.14	$ 6.79	PC-4	$ 0.06	7		$ 0.06	$ 6.08
10	PC-2		$ 0.68	16	$ 12.96			$ 0.68	$ 12.37	PC-3	$ 0.14	11		$ 0.14	$ 6.93	PC-4	$ 0.06	6		$ 0.06	$ 6.14
11	PC-2		$ 0.68	15	$ 12.96			$ 0.68	$ 13.05	PC-3	$ 0.14	10		$ 0.14	$ 7.07	PC-4	$ 0.06	5		$ 0.06	$ 6.19
12	PC-2		$ 0.68	14	$ 12.96			$ 0.68	$ 13.73	PC-3	$ 0.14	9		$ 0.14	$ 7.20	PC-4	$ 0.06	4		$ 0.06	$ 6.25
13	PC-2		$ 0.68	13	$ 12.96			$ 0.68	$ 14.41	PC-3	$ 0.14	8		$ 0.14	$ 7.34	PC-4	$ 0.06	3		$ 0.06	$ 6.31
14	PC-2		$ 0.68	12	$ 12.96			$ 0.68	$ 15.09	PC-3	$ 0.14	7		$ 0.14	$ 7.47	PC-4	$ 0.06	2		$ 0.06	$ 6.36
15	PC-2		$ 0.68	11	$ 12.96			$ 0.68	$ 15.77	PC-3	$ 0.14	6		$ 0.14	$ 7.61	PC-4	$ 0.06	1		$ 0.06	$ 6.42
16	PC-2		$ 0.68	10	$ 12.96			$ 0.68	$ 16.45	PC-3	$ 0.14	5		$ 0.14	$ 7.75	PC-4	$ 0.06	15	$ 12.96	$ 13.02	$ 19.44
17	PC-2		$ 0.68	9	$ 12.96			$ 0.68	$ 17.13	PC-3	$ 0.14	4		$ 0.14	$ 7.88	PC-4	$ 0.06	14		$ 0.06	$ 19.49
18	PC-2		$ 0.68	8	$ 12.96			$ 0.68	$ 17.81	PC-3	$ 0.14	3		$ 0.14	$ 8.02	PC-4	$ 0.06	13		$ 0.06	$ 19.55
19	PC-2		$ 0.68	7	$ 12.96			$ 0.68	$ 18.49	PC-3	$ 0.14	2		$ 0.14	$ 8.15	PC-4	$ 0.06	12		$ 0.06	$ 19.61
20	PC-2		$ 0.68	6	$ 12.96			$ 0.68	$ 19.17	PC-3	$ 0.14	1		$ 0.14	$ 8.29	PC-4	$ 0.06	11		$ 0.06	$ 19.66
21	PC-2		$ 0.68	5	$ 12.96			$ 0.68	$ 19.85	PC-3	$ 0.14	20	$ 12.96	$ 13.10	$ 21.39	PC-4	$ 0.06	10		$ 0.06	$ 19.72
22	PC-2		$ 0.68	4	$ 12.96			$ 0.68	$ 20.53	PC-3	$ 0.14	19		$ 0.14	$ 21.52	PC-4	$ 0.06	9		$ 0.06	$ 19.78
23	PC-2		$ 0.68	3	$ 12.96			$ 0.68	$ 21.21	PC-3	$ 0.14	18		$ 0.14	$ 21.66	PC-4	$ 0.06	8		$ 0.06	$ 19.83
24	PC-2		$ 0.68	2	$ 12.96			$ 0.68	$ 21.89	PC-3	$ 0.14	17		$ 0.14	$ 21.79	PC-4	$ 0.06	7		$ 0.06	$ 19.89
25	PC-2		$ 0.68	1	$ 12.96			$ 0.68	$ 22.57	PC-3	$ 0.14	16		$ 0.14	$ 21.93	PC-4	$ 0.06	6		$ 0.06	$ 19.95
26	PC-2		$ 0.68	25	$ 12.96	$ 12.96		$ 13.64	$ 36.21	PC-3	$ 0.14	15		$ 0.14	$ 22.07	PC-4	$ 0.06	5		$ 0.06	$ 20.00
27	PC-2		$ 0.68	24	$ 12.96			$ 0.68	$ 36.89	PC-3	$ 0.14	14		$ 0.14	$ 22.20	PC-4	$ 0.06	4		$ 0.06	$ 20.06
28	PC-2		$ 0.68	23	$ 12.96			$ 0.68	$ 37.57	PC-3	$ 0.14	13		$ 0.14	$ 22.34	PC-4	$ 0.06	3		$ 0.06	$ 20.12
29	PC-2		$ 0.68	22	$ 12.96			$ 0.68	$ 38.25	PC-3	$ 0.14	12		$ 0.14	$ 22.47	PC-4	$ 0.06	2		$ 0.06	$ 20.17
30	PC-2		$ 0.68	21	$ 12.96			$ 0.68	$ 38.93	PC-3	$ 0.14	11		$ 0.14	$ 22.61	PC-4	$ 0.06	1		$ 0.06	$ 20.23
31	PC-2		$ 0.68	20	$ 12.96			$ 0.68	$ 39.61	PC-3	$ 0.14	10		$ 0.14	$ 22.75	PC-4	$ 0.06	15	$ 12.96	$ 13.02	$ 33.25
32	PC-2		$ 0.68	19	$ 12.96			$ 0.68	$ 40.29	PC-3	$ 0.14	9		$ 0.14	$ 22.88	PC-4	$ 0.06	14		$ 0.06	$ 33.30
33	PC-2		$ 0.68	18	$ 12.96			$ 0.68	$ 40.97	PC-3	$ 0.14	8		$ 0.14	$ 23.02	PC-4	$ 0.06	13		$ 0.06	$ 33.36
34	PC-2		$ 0.68	17	$ 12.96			$ 0.68	$ 41.65	PC-3	$ 0.14	7		$ 0.14	$ 23.15	PC-4	$ 0.06	12		$ 0.06	$ 33.42
35	PC-2		$ 0.68	16	$ 12.96			$ 0.68	$ 42.33	PC-3	$ 0.14	6		$ 0.14	$ 23.29	PC-4	$ 0.06	11		$ 0.06	$ 33.47
36	PC-2		$ 0.68	15	$ 12.96			$ 0.68	$ 43.01	PC-3	$ 0.14	5		$ 0.14	$ 23.43	PC-4	$ 0.06	10		$ 0.06	$ 33.53
37	PC-2		$ 0.68	14	$ 12.96			$ 0.68	$ 43.69	PC-3	$ 0.14	4		$ 0.14	$ 23.56	PC-4	$ 0.06	9		$ 0.06	$ 33.59
38	PC-2		$ 0.68	13	$ 12.96			$ 0.68	$ 44.37	PC-3	$ 0.14	3		$ 0.14	$ 23.70	PC-4	$ 0.06	8		$ 0.06	$ 33.64
39	PC-2		$ 0.68	12	$ 12.96			$ 0.68	$ 45.05	PC-3	$ 0.14	2		$ 0.14	$ 23.83	PC-4	$ 0.06	7		$ 0.06	$ 33.70
40	PC-2		$ 0.68	11	$ 12.96			$ 0.68	$ 45.73	PC-3	$ 0.14	1		$ 0.14	$ 23.97	PC-4	$ 0.06	6		$ 0.06	$ 33.76
41	PC-2		$ 0.68	10	$ 12.96			$ 0.68	$ 46.41	PC-3	$ 0.14	20	$ 12.96	$ 13.10	$ 37.07	PC-4	$ 0.06	5		$ 0.06	$ 33.81
42	PC-2		$ 0.68	9	$ 12.96			$ 0.68	$ 47.09	PC-3	$ 0.14	19		$ 0.14	$ 37.20	PC-4	$ 0.06	4		$ 0.06	$ 33.87
43	PC-2		$ 0.68	8	$ 12.96			$ 0.68	$ 47.77	PC-3	$ 0.14	18		$ 0.14	$ 37.34	PC-4	$ 0.06	3		$ 0.06	$ 33.93
44	PC-2		$ 0.68	7	$ 12.96			$ 0.68	$ 48.45	PC-3	$ 0.14	17		$ 0.14	$ 37.47	PC-4	$ 0.06	2		$ 0.06	$ 33.98
45	PC-2		$ 0.68	6	$ 12.96			$ 0.68	$ 49.13	PC-3	$ 0.14	16		$ 0.14	$ 37.61	PC-4	$ 0.06	1		$ 0.06	$ 34.04
46	PC-2		$ 0.68	5	$ 12.96			$ 0.68	$ 49.81	PC-3	$ 0.14	15		$ 0.14	$ 37.75	PC-4	$ 0.06	15	$ 12.96	$ 13.02	$ 47.06
47	PC-2		$ 0.68	4	$ 12.96			$ 0.68	$ 50.49	PC-3	$ 0.14	14		$ 0.14	$ 37.88	PC-4	$ 0.06	14		$ 0.06	$ 47.11
48	PC-2		$ 0.68	3	$ 12.96			$ 0.68	$ 51.17	PC-3	$ 0.14	13		$ 0.14	$ 38.02	PC-4	$ 0.06	13		$ 0.06	$ 47.17
49	PC-2		$ 0.68	2	$ 12.96			$ 0.68	$ 51.85	PC-3	$ 0.14	12		$ 0.14	$ 38.15	PC-4	$ 0.06	12		$ 0.06	$ 47.23
50	PC-2		$ 0.68	1	$ 12.96		$ 3.00	$ 3.68	$ 55.53	PC-3	$ 0.14	11		$ 3.14	$ 41.29	PC-4	$ 0.06	11		$ 3.06	$ 50.28
	TCO	5.57	$ 34.00			$ 12.96	$ 3.00		**$ 55.53**		$ 6.80		$ 25.92		**$ 41.29**		$ 2.83		$ 38.88		**$ 50.28**

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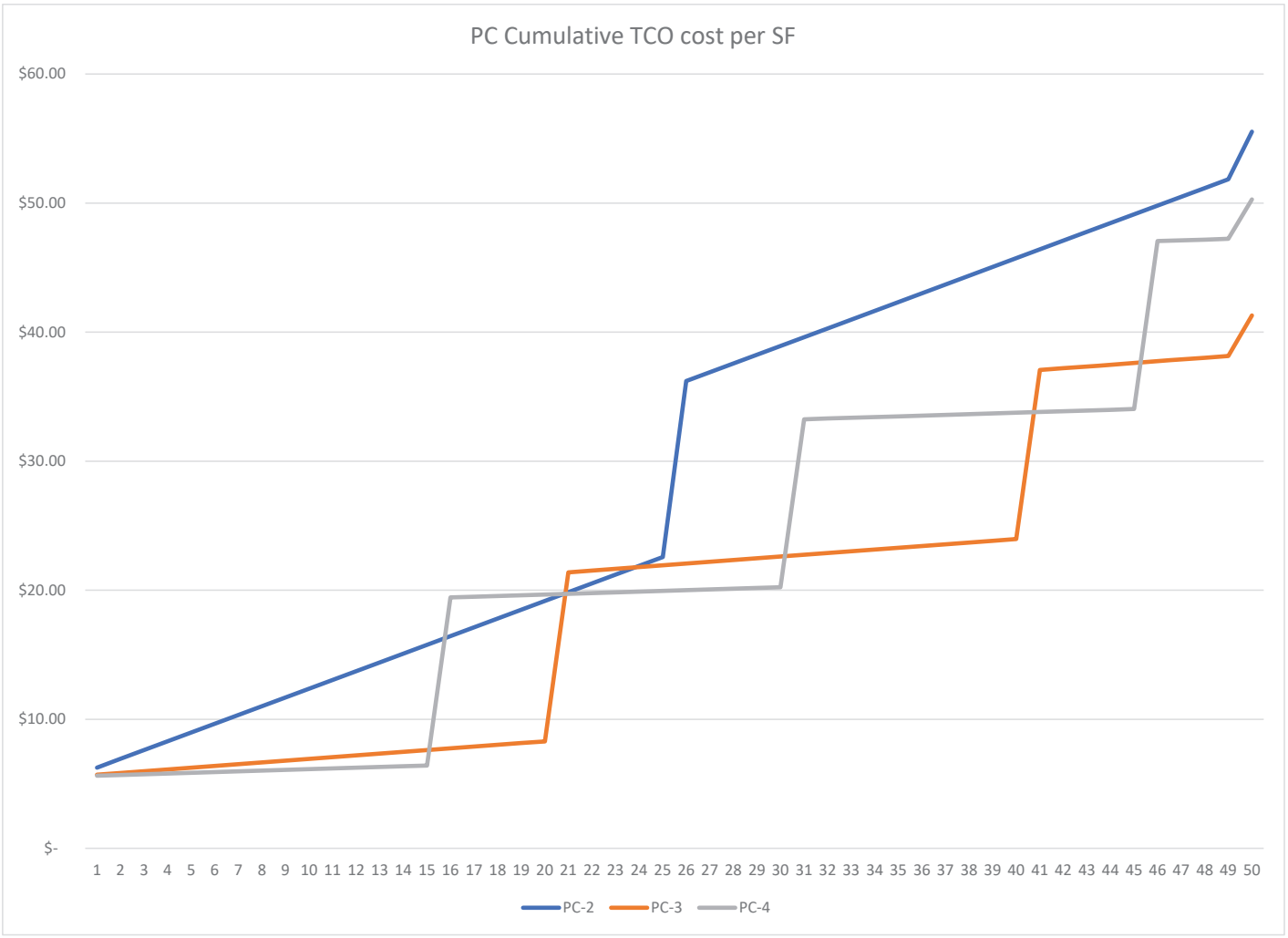
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$30.00
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$-
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PC-2
PC-3
PC-4

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Luxury Vinyl Tile TCO Scenario Analysis

Year	Scenario	First Cost	Annual Maintenance	Remaining Life	Renewal Cost	Renewal	EOL	Expense	Cumm. TCO	Scenario	Annual Maintenance	Remaining Life	Renewal	Expense	Cumm. TCO	Scenario	Annual Maintenance	Remaining Life	Renewal	Expense	Cumm. TCO
1	LVT-2	$ 4.36	$ 1.10	20	$ 8.68			$ 5.46	$ 5.46	LVT-3	$ 0.22	16		$ 4.58	$ 4.58	LVT-4	$ 0.09	12		$ 4.45	$ 4.45
2	LVT-2		$ 1.10	19	$ 8.68			$ 1.10	$ 6.56	LVT-3	$ 0.22	15		$ 0.22	$ 4.80	LVT-4	$ 0.09	11		$ 0.09	$ 4.54
3	LVT-2		$ 1.10	18	$ 8.68			$ 1.10	$ 7.66	LVT-3	$ 0.22	14		$ 0.22	$ 5.02	LVT-4	$ 0.09	10		$ 0.09	$ 4.64
4	LVT-2		$ 1.10	17	$ 8.68			$ 1.10	$ 8.76	LVT-3	$ 0.22	13		$ 0.22	$ 5.24	LVT-4	$ 0.09	9		$ 0.09	$ 4.73
5	LVT-2		$ 1.10	16	$ 8.68			$ 1.10	$ 9.86	LVT-3	$ 0.22	12		$ 0.22	$ 5.46	LVT-4	$ 0.09	8		$ 0.09	$ 4.82
6	LVT-2		$ 1.10	15	$ 8.68			$ 1.10	$ 10.96	LVT-3	$ 0.22	11		$ 0.22	$ 5.68	LVT-4	$ 0.09	7		$ 0.09	$ 4.91
7	LVT-2		$ 1.10	14	$ 8.68			$ 1.10	$ 12.06	LVT-3	$ 0.22	10		$ 0.22	$ 5.90	LVT-4	$ 0.09	6		$ 0.09	$ 5.00
8	LVT-2		$ 1.10	13	$ 8.68			$ 1.10	$ 13.16	LVT-3	$ 0.22	9		$ 0.22	$ 6.12	LVT-4	$ 0.09	5		$ 0.09	$ 5.09
9	LVT-2		$ 1.10	12	$ 8.68			$ 1.10	$ 14.26	LVT-3	$ 0.22	8		$ 0.22	$ 6.34	LVT-4	$ 0.09	4		$ 0.09	$ 5.19
10	LVT-2		$ 1.10	11	$ 8.68			$ 1.10	$ 15.36	LVT-3	$ 0.22	7		$ 0.22	$ 6.56	LVT-4	$ 0.09	3		$ 0.09	$ 5.28
11	LVT-2		$ 1.10	10	$ 8.68			$ 1.10	$ 16.46	LVT-3	$ 0.22	6		$ 0.22	$ 6.78	LVT-4	$ 0.09	2		$ 0.09	$ 5.37
12	LVT-2		$ 1.10	9	$ 8.68			$ 1.10	$ 17.56	LVT-3	$ 0.22	5		$ 0.22	$ 7.00	LVT-4	$ 0.09	1		$ 0.09	$ 5.46
13	LVT-2		$ 1.10	8	$ 8.68			$ 1.10	$ 18.66	LVT-3	$ 0.22	4		$ 0.22	$ 7.22	LVT-4	$ 0.09	12	$ 8.68	$ 8.77	$ 14.23
14	LVT-2		$ 1.10	7	$ 8.68			$ 1.10	$ 19.76	LVT-3	$ 0.22	3		$ 0.22	$ 7.44	LVT-4	$ 0.09	11		$ 0.09	$ 14.32
15	LVT-2		$ 1.10	6	$ 8.68			$ 1.10	$ 20.86	LVT-3	$ 0.22	2		$ 0.22	$ 7.66	LVT-4	$ 0.09	10		$ 0.09	$ 14.42
16	LVT-2		$ 1.10	5	$ 8.68			$ 1.10	$ 21.96	LVT-3	$ 0.22	1		$ 0.22	$ 7.88	LVT-4	$ 0.09	9		$ 0.09	$ 14.51
17	LVT-2		$ 1.10	4	$ 8.68			$ 1.10	$ 23.06	LVT-3	$ 0.22	16	$ 7.88	$ 8.10	$ 15.98	LVT-4	$ 0.09	8		$ 0.09	$ 14.60
18	LVT-2		$ 1.10	3	$ 8.68			$ 1.10	$ 24.16	LVT-3	$ 0.22	15		$ 0.22	$ 16.20	LVT-4	$ 0.09	7		$ 0.09	$ 14.69
19	LVT-2		$ 1.10	2	$ 8.68			$ 1.10	$ 25.26	LVT-3	$ 0.22	14		$ 0.22	$ 16.42	LVT-4	$ 0.09	6		$ 0.09	$ 14.78
20	LVT-2		$ 1.10	1	$ 8.68			$ 1.10	$ 26.36	LVT-3	$ 0.22	13		$ 0.22	$ 16.64	LVT-4	$ 0.09	5		$ 0.09	$ 14.87
21	LVT-2		$ 1.10	20	$ 8.68	$ 8.68		$ 9.78	$ 36.14	LVT-3	$ 0.22	12		$ 0.22	$ 16.86	LVT-4	$ 0.09	4		$ 0.09	$ 14.97
22	LVT-2		$ 1.10	19	$ 8.68			$ 1.10	$ 37.24	LVT-3	$ 0.22	11		$ 0.22	$ 17.08	LVT-4	$ 0.09	3		$ 0.09	$ 15.06
23	LVT-2		$ 1.10	18	$ 8.68			$ 1.10	$ 38.34	LVT-3	$ 0.22	10		$ 0.22	$ 17.30	LVT-4	$ 0.09	2		$ 0.09	$ 15.15
24	LVT-2		$ 1.10	17	$ 8.68			$ 1.10	$ 39.44	LVT-3	$ 0.22	9		$ 0.22	$ 17.52	LVT-4	$ 0.09	1		$ 0.09	$ 15.24
25	LVT-2		$ 1.10	16	$ 8.68			$ 1.10	$ 40.54	LVT-3	$ 0.22	8		$ 0.22	$ 17.74	LVT-4	$ 0.09	12	$ 8.68	$ 8.77	$ 24.01
26	LVT-2		$ 1.10	15	$ 8.68			$ 1.10	$ 41.64	LVT-3	$ 0.22	7		$ 0.22	$ 17.96	LVT-4	$ 0.09	11		$ 0.09	$ 24.10
27	LVT-2		$ 1.10	14	$ 8.68			$ 1.10	$ 42.74	LVT-3	$ 0.22	6		$ 0.22	$ 18.18	LVT-4	$ 0.09	10		$ 0.09	$ 24.20
28	LVT-2		$ 1.10	13	$ 8.68			$ 1.10	$ 43.84	LVT-3	$ 0.22	5		$ 0.22	$ 18.40	LVT-4	$ 0.09	9		$ 0.09	$ 24.29
29	LVT-2		$ 1.10	12	$ 8.68			$ 1.10	$ 44.94	LVT-3	$ 0.22	4		$ 0.22	$ 18.62	LVT-4	$ 0.09	8		$ 0.09	$ 24.38
30	LVT-2		$ 1.10	11	$ 8.68			$ 1.10	$ 46.04	LVT-3	$ 0.22	3		$ 0.22	$ 18.84	LVT-4	$ 0.09	7		$ 0.09	$ 24.47
31	LVT-2		$ 1.10	10	$ 8.68			$ 1.10	$ 47.14	LVT-3	$ 0.22	2		$ 0.22	$ 19.06	LVT-4	$ 0.09	6		$ 0.09	$ 24.56
32	LVT-2		$ 1.10	9	$ 8.68			$ 1.10	$ 48.24	LVT-3	$ 0.22	1		$ 0.22	$ 19.28	LVT-4	$ 0.09	5		$ 0.09	$ 24.65
33	LVT-2		$ 1.10	8	$ 8.68			$ 1.10	$ 49.34	LVT-3	$ 0.22	16	$ 7.88	$ 8.10	$ 27.38	LVT-4	$ 0.09	4		$ 0.09	$ 24.75
34	LVT-2		$ 1.10	7	$ 8.68			$ 1.10	$ 50.44	LVT-3	$ 0.22	15		$ 0.22	$ 27.60	LVT-4	$ 0.09	3		$ 0.09	$ 24.84
35	LVT-2		$ 1.10	6	$ 8.68			$ 1.10	$ 51.54	LVT-3	$ 0.22	14		$ 0.22	$ 27.82	LVT-4	$ 0.09	2		$ 0.09	$ 24.93
36	LVT-2		$ 1.10	5	$ 8.68			$ 1.10	$ 52.64	LVT-3	$ 0.22	13		$ 0.22	$ 28.04	LVT-4	$ 0.09	1		$ 0.09	$ 25.02
37	LVT-2		$ 1.10	4	$ 8.68			$ 1.10	$ 53.74	LVT-3	$ 0.22	12		$ 0.22	$ 28.26	LVT-4	$ 0.09	12	$ 8.68	$ 8.77	$ 33.79
38	LVT-2		$ 1.10	3	$ 8.68			$ 1.10	$ 54.84	LVT-3	$ 0.22	11		$ 0.22	$ 28.48	LVT-4	$ 0.09	11		$ 0.09	$ 33.88
39	LVT-2		$ 1.10	2	$ 8.68			$ 1.10	$ 55.94	LVT-3	$ 0.22	10		$ 0.22	$ 28.70	LVT-4	$ 0.09	10		$ 0.09	$ 33.98
40	LVT-2		$ 1.10	1	$ 8.68			$ 1.10	$ 57.04	LVT-3	$ 0.22	9		$ 0.22	$ 28.92	LVT-4	$ 0.09	9		$ 0.09	$ 34.07
41	LVT-2		$ 1.10	20	$ 8.68	$ 8.68		$ 9.78	$ 66.82	LVT-3	$ 0.22	8		$ 0.22	$ 29.14	LVT-4	$ 0.09	8		$ 0.09	$ 34.16
42	LVT-2		$ 1.10	19	$ 8.68			$ 1.10	$ 67.92	LVT-3	$ 0.22	7		$ 0.22	$ 29.36	LVT-4	$ 0.09	7		$ 0.09	$ 34.25
43	LVT-2		$ 1.10	18	$ 8.68			$ 1.10	$ 69.02	LVT-3	$ 0.22	6		$ 0.22	$ 29.58	LVT-4	$ 0.09	6		$ 0.09	$ 34.34
44	LVT-2		$ 1.10	17	$ 8.68			$ 1.10	$ 70.12	LVT-3	$ 0.22	5		$ 0.22	$ 29.80	LVT-4	$ 0.09	5		$ 0.09	$ 34.43
45	LVT-2		$ 1.10	16	$ 8.68			$ 1.10	$ 71.22	LVT-3	$ 0.22	4		$ 0.22	$ 30.02	LVT-4	$ 0.09	4		$ 0.09	$ 34.53
46	LVT-2		$ 1.10	15	$ 8.68			$ 1.10	$ 72.32	LVT-3	$ 0.22	3		$ 0.22	$ 30.24	LVT-4	$ 0.09	3		$ 0.09	$ 34.62
47	LVT-2		$ 1.10	14	$ 8.68			$ 1.10	$ 73.42	LVT-3	$ 0.22	2		$ 0.22	$ 30.46	LVT-4	$ 0.09	2		$ 0.09	$ 34.71
48	LVT-2		$ 1.10	13	$ 8.68			$ 1.10	$ 74.52	LVT-3	$ 0.22	1		$ 0.22	$ 30.68	LVT-4	$ 0.09	1		$ 0.09	$ 34.80
49	LVT-2		$ 1.10	12	$ 8.68			$ 1.10	$ 75.62	LVT-3	$ 0.22	16	$ 7.88	$ 8.10	$ 38.78	LVT-4	$ 0.09	12	$ 8.68	$ 8.77	$ 43.57
50	LVT-2		$ 1.10	11	$ 8.68		$ 1.35	$ 2.45	$ 78.07	LVT-3	$ 0.22	15		$ 1.57	$ 40.35	LVT-4	$ 0.09	11		$ 1.44	$ 45.01
	TCO	**4.36**	**$ 55.00**			**$ 17.36**	**$ 1.35**		**$ 78.07**		**$ 11.00**		**$ 23.64**		**$ 40.35**		**$ 4.58**		**$ 34.72**		**$ 45.01**

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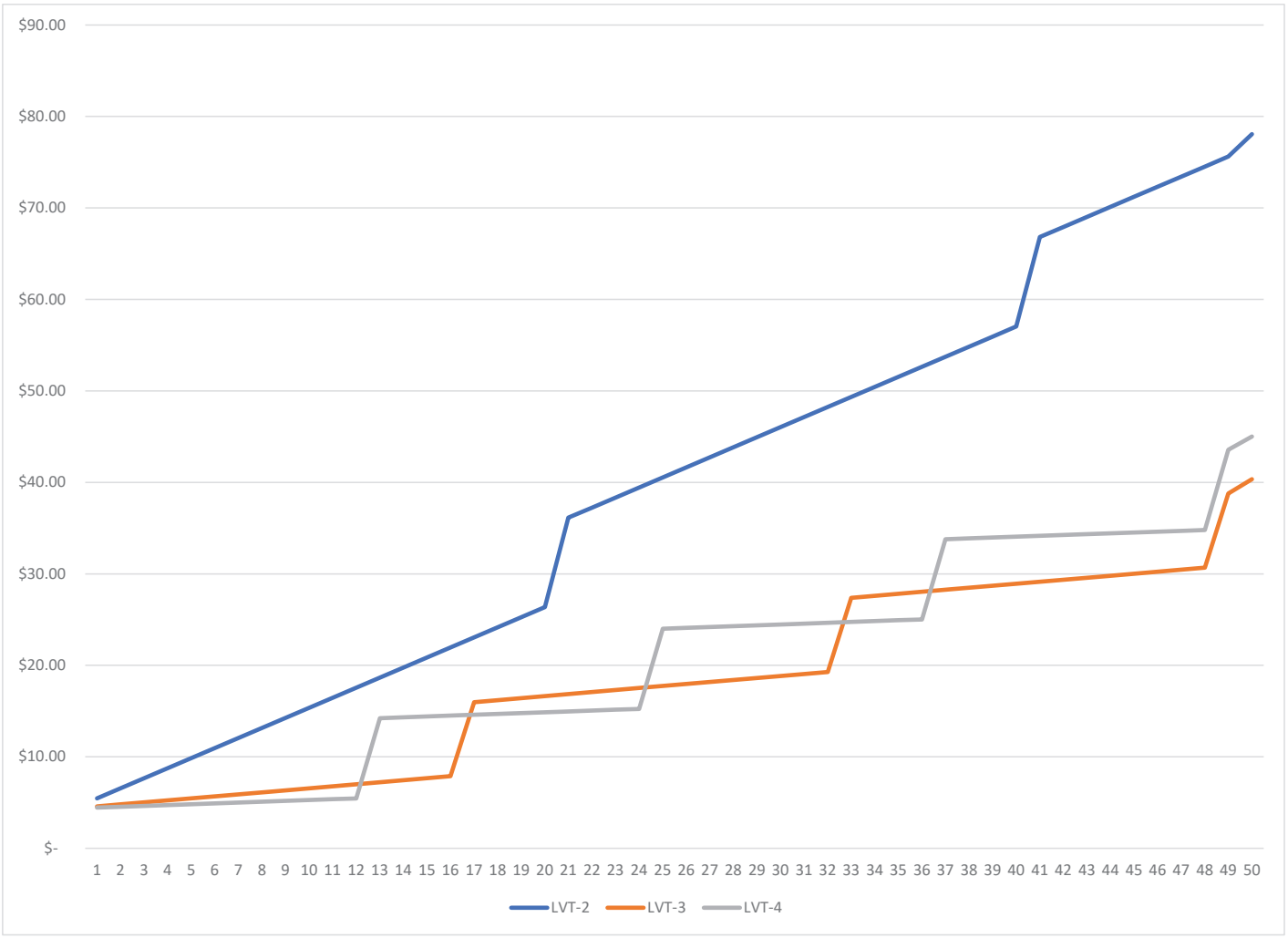
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LVT-3
LVT-4

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