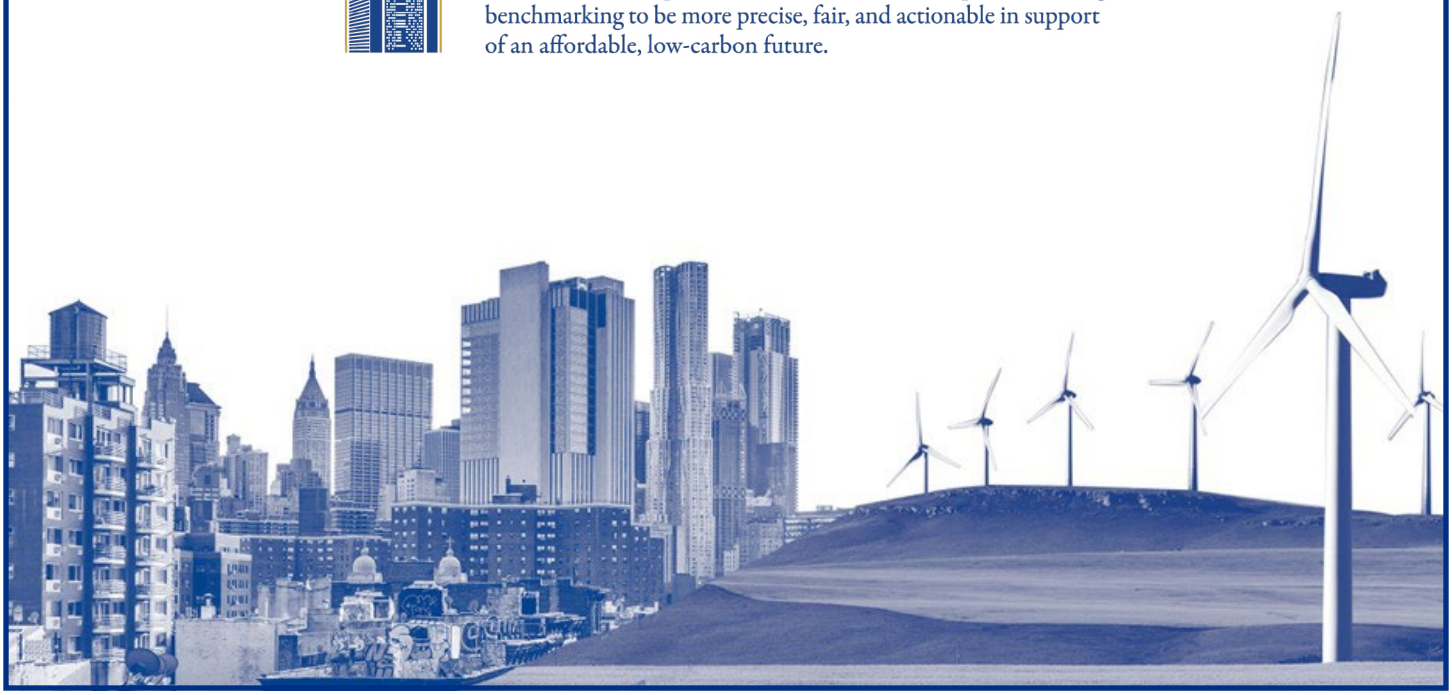
People Counting and Energy Metering Solutions in the Commercial Building Market:

Market Trends, Available Technologies, and Deployment Strategies to Support Hourly Building Benchmarking

BENCHMARK 8760

An initiative to explore how **hourly data** can improve building benchmarking to be more precise, fair, and actionable in support of an affordable, low-carbon future.



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EXECUTIVE SUMMARY

BACKGROUND

Benchmark 8760 is an initiative to explore how hourly data can improve building benchmarking to be more precise, fair, and actionable in support of an affordable, low-carbon future.

The initiative's first project is to develop a proof-of-concept benchmarking platform that ingests **hourly energy, occupancy, local grid intensity and weather** data from a sample set of ten (10) New York City buildings. The intent of this project is to explore whether hourly data can be securely extracted from properties and shared with a building benchmarking platform in an affordable, scalable, and privacy-protecting manner.

The Benchmark 8760 project team conducted market research and a detailed review of available technologies on two (2) data collection functions that are critical for hourly benchmarking: counting and electricity metering.

This report reviews the findings of our market research, and based upon this work, identifies ideal people counting and energy metering deployments to support hourly benchmarking.

MARKET RESEARCH

PEOPLE COUNTING

Prior to 2019, people counting solutions in commercial buildings were uncommon. The onset of the Covid-19 global pandemic was the catalyst for a substantial increase in people counting solution deployments. Vendors and connected building professional estimate that deployments of people counting technologies have increased 200% - 500% in response to the pandemic.

Within the commercial building market, approximately 80% market share has been captured by camera or computer vision solutions and time-of-flight solutions. These solutions are high accuracy and low cost.

Industry standards for hardware deployment, data storage, and privacy are not well defined within the commercial building space. Additionally, accuracy of people counting solutions can vary widely based on the product and application.

ENERGY METERING

Master utility metering is the most common metering configuration in commercial buildings. Prior to the New York Public Service Commission's Advanced Metering Rollout Order, Con Edison used accumulation meters, which measured total electricity usage per billing cycle without tracking time of use. Con Edison's smart meter rollout program began in 2017, and as of June 2021, more than 4 million smart utility meters have been deployed. Smart meters capture 15-minute interval data, which can be shared with customers via the Green Button Connect data-sharing standard.

Non-utility-provided electric meters have also become smarter and easier to integrate into buildings over time. A major distinction within non-utility metering technology is between revenue-grade and non-revenue-grade meters. Accuracy requirements for revenue-grade meters are defined in the American National Standards Institute (ANSI) Standard C12.20-2015. Revenue-grade meters can be used for billing purposes, while non-revenue-grade meters cannot.

AVAILABLE TECHNOLOGIES AND RECOMMENDED DEPLOYMENTS TO SUPPORT HOURLY BENCHMARKING

PEOPLE COUNTING

All available technologies discussed throughout this report can capture hourly people counts and can support an hourly benchmarking approach.

Computer vision security cameras and **turnstiles with ACM API integration** are the best-fit solutions for buildings with sophisticated access control systems. These solutions are high-accuracy and leverage existing hardware, thereby reducing deployment costs.

Time-of-flight sensors, **stereoscopic cameras**, and **thermal imaging** are the best-fit solutions for buildings that do not have sophisticated access control systems. These stand-alone devices are high accuracy and easy to deploy. Ceiling heights and the ability to run CAT6 cabling to covered spaces will determine which of these solutions is appropriate for a specific building.

ENERGY METERING

Utility-provided smart meters in combination with the Green Button data reporting standard is a high-accuracy and low-cost approach to capturing hourly energy data and reporting it in a common format to support hourly benchmarking.

In cases where a building does not have a utility-provided smart meter, a non-utility revenue-grade total power meter connected with a software product that captures interval data and provides connectivity to a cloud-based platform is the best-fit solution.

1. INTRODUCTION

Benchmark 8760 is an initiative to explore how hourly data can improve building benchmarking to be more precise, fair, and actionable in support of an affordable, low-carbon future.

The initiative represents a diverse group of stakeholders from real estate, government, academia, and industry, who are interested in seeding the evolution of benchmarking methodologies and building performance standards to better recognize building behaviors that positively contribute to the clean and affordable energy transition.

The goal of this document is to provide a base-level understanding of two (2) data collection functions that are critical for hourly benchmarking: people counting and electricity metering. We begin with a review of market research conducted by the Benchmark 8760 project team. We then discuss available technologies and their application in the commercial building market. Lastly, we discuss considerations for the deployment of people counting and energy metering technologies in tall commercial buildings and recommend solutions that support an hourly benchmarking approach.

2. MARKET RESEARCH

2.1 PEOPLE COUNTING

HISTORY AND RECENT TRENDS

Prior to 2019, people counting solutions in commercial buildings were uncommon. Vendors and connected building professionals estimate that less than 1% of commercial buildings in New York City had a people counting system before the onset of Covid-19 in early 2020. Before the pandemic, most people counting applications focused on retail, where tracking customer entrance/exits directly connected to revenue. Museums and transportation hubs also deployed people counters to track overall foot traffic. Deployment of "break-beam" sensors was the first widespread use of people counters within these building typologies.[1,2]

Covid-19 was a definitive turning point for people counting solutions in the commercial building market. During the pandemic, commercial building Owners responded to the increased need for analytics on social distancing and contact tracing by deploying people counting technologies and services on a larger scale. Vendors and connected building professional estimate that deployments of people counting technologies have increased 200% - 500% in response to the pandemic.

As occupants return to the office, the relevance of people counting technology continues to grow. Real-time people counts are enabling new flexible work approaches such as hot desking and as-used cleaning schedules for workspaces and communal areas.

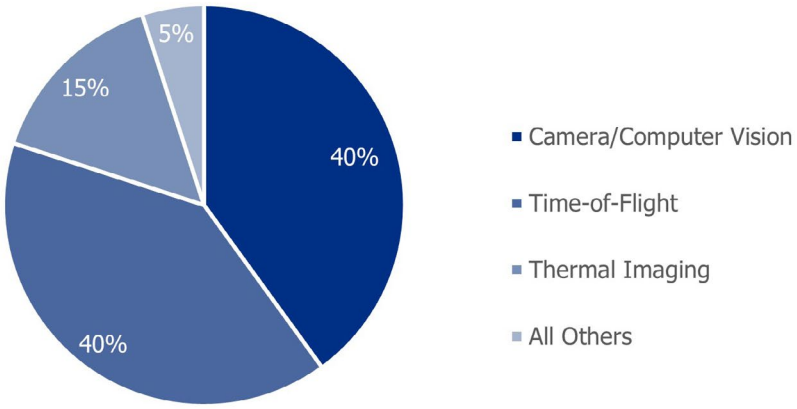
While the percentage of commercial buildings with people counting solutions in New York City remains small in an absolute sense, the trend in deployments indicates that market demand for people counting solutions is growing and available technologies have strong product-market fit.

1 Break-beams have accuracy below 75%, particularly when multiple people enter a space simultaneously.
2 Break beam sensors are pairs of infrared beams set up across entry/exit points.

MARKET LEADERS

Approximately 80% of the commercial building market has been captured by camera and computer vision solutions, such as Facit and Nexus, and time-of-flight solutions, such as Density Entry and Irisys Vector 4D.

Figure 1: Market Share by Solution Type



Due to the increase in occupancy counting deployments during the last three years, the commercial building market is heavily skewed toward newer technologies, whereas other sectors such as retail or transportation tend to use older, legacy solutions.

STANDARDS FOR DEPLOYMENT

Industry-wide standards for deployment of people counters in commercial spaces are not available. Each vendor typically offers an installation guide that a Consulting Engineer or the Installing Contractor can reference.

DATA STANDARDS AND PRIVACY

In the U.S., standards for collecting and storing people counting data are not well defined.

In the European Union, the General Data Protection Regulation[3] (GDPR) defines standards for occupancy counting. The GDPR specifically regulates how to collect, store, and retrieve personally identifiable information (PII).[4]

ACCURACY OF SOLUTIONS

Accuracy of people counting solutions can vary widely based on the product and application. A Building Manager, commissioning professional or vendor measures accuracy by comparing the system count to a manual count of entrances and exits. The table below shows a sample accuracy verification exercise. In the sample, the solution vendor captured manual counts and compared this data to the product count for three (3) consecutive hours on November 10, 2021.

Table 1: Accuracy Verification of a People Counting Solution

11/10/2021	11.00 - 12:00	12:00 - 13:00	13:00 - 14:00
VENDOR PRODUCT COUNT	192	309	352
ACTUAL	195	312	358
ACCURACY	98.46%	99.04%	98.32%

3 Intersoft. General Data Protection Regulation. (Intersoft, 2022)

4 People counting solution vendors who work in the European Union typically limit the collection of personal data as much as possible to avoid being subject to these regulations. For example, Facit, a computer vision camera solution, pre-processes the camera feed to obscure personal data such as facial features. Only the obscured feed without PII is retained and used for analytics.

The building's people count is reset to zero at midnight every day to avoid cumulative error. Typically, vendors report lower accuracies in promotional material than they see in the field because installation specific factors have the potential to reduce accuracy.[5]

The question of how accurate a people counting solution needs to be depends on the application. Uses such as demand control ventilation and optimized startup can operate successfully with 85 - 90% data accuracy. Market leading solutions can produce 95%+ accuracy in a variety of field settings.

2.2 ENERGY METERING

HISTORY AND RECENT TRENDS

Before the advent of electrical meters, customers and tenants were charged for their energy use by square footage, estimate, or individual lamp. In the 1980s, the desire for more accurate accounting of energy consumption and billing drove New York City's local utility provider, Con Edison, to begin direct-metering customers. First-generation meters were accumulation meters, measuring total electricity usage per billing cycle without tracking time of use. Meter readers were employed by the utility to physically go to the meter location and read the meter for billing purposes.

Figure 2: Examples of Accumulation Meters

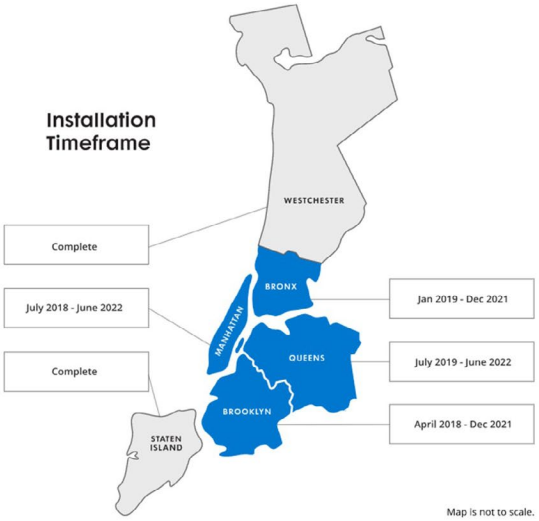
In 2016, the New York Public Service Commission approved an advanced metering rollout for Consolidated Edison in New York City and Westchester County. The PSC's decision directed Con Ed to deploy smart utility meters and to utilize the Green Button Connect data-sharing standard to make interval data accessible to rate payers.[6,7,8,9]

Con Edison's smart utility meter rollout started in 2017, and, as of June 28, 2021, Con Edison has installed more than four million smart utility meters across New York City and Westchester County.

Smart utility meters communicate to Con Edison over a secure wireless communication network using low-frequency radio signals. The meter transmits data to a system of access points on utility poles, which send usage information to Con Edison.[10]

5 Unusual shadows or lighting can reduce the accuracy of camera-based solutions, or temperature fluctuations can reduce thermal imaging technology accuracy.
6 The U.S. Energy Information Administration defines smart metering as "…meters that measure and record electricity usage at a minimum of hourly intervals and that provide the data to both the utility and the utility customer at least once a day." For residential customers, 15 minutes is the standard interval, and for commercial customers 5 minutes is the standard interval.
7 The Green Button Connect data-sharing standard is based on the Energy Services Provider Interface (ESPI) data standard released by the North American Energy Standards Board (NAESB) in the fall of 2011. This standard consists of two (2) components: a common XML format for energy usage information and a data exchange protocol that allows for the automatic transfer of data from a utility to a third party based on customer authorization. By using this data-sharing standard, third parties can access customer usage information from smart utility meters in a standard, recognized format.
8 EIA. How many smart meters are installed in the United States, and who has them?. (EIA, 2021)
9 Con Edison. Green Button Connect Process. (Con Edison, 2018)
10 Con Edison. Smart Meter FAQ. (Con Edison 2022)

Figure 3: Example Smart Meter and Con Ed Smart Meter Rollout Schedule. Source: Con Edison.



Non-utility-provided electric meters have become smarter and easier to integrate into buildings. Vendors offer subscription-based services for meters, including energy management and Tenant billing. Most non-utility-provided meters communicate inside the building over the Modbus protocol to a gateway or directly on an IP network. In either case, smart meters can provide data to cloud-based platforms such as the Energy Star Portfolio Manager or third-party energy management systems.

OVERVIEW OF METERING IN BUILDINGS

Master utility metering is the most common metering configuration in existing commercial buildings. In this configuration, a master utility meter provided by Con Edison measures electricity usage for the entire building and property Owners are responsible for determining how to bill Tenants for their consumption. Many commercial properties have elected to install a total meter behind the utility master meter and submeters on relevant systems to bill Tenants and manage energy more accurately.

Tenant submetering will be mandatory in New York City beginning in 2025 because of Local Law 88.[11] Under this Local Law, each large non-residential Tenant space (> 5,000 sq.ft.) must be submetered and provided with monthly energy statements by the property Owner. Submeters can be installed on electrical mains inside a panel or on individual branch circuits to identify usage of a particular Tenant. In sophisticated buildings, submeters can even be deployed to capture individual energy end uses.

New buildings following ASHRAE Standard 90.1[12] will be required to install a total meter to separately monitor the total electricity energy use. New buildings will have two (2) meters measuring energy input to the building: one (1) from the utility and one (1) from the building.

11 NYC Mayor Office of Sustainability. LL88: Lighting Upgrades and Sub-metering (NYC 2020)
12 ASHRAE. ASHRAE 90-1 Standard. (ASHRAE 2016)

3. DETAILED REVIEW OF AVAILABLE SOLUTIONS

3.1 PEOPLE COUNTING

PEOPLE COUNTING TECHNOLOGIES USING ACCESS CONTROL HARDWARE

Security Cameras + Computer Vision: This solution uses computer vision software, which can run on existing security cameras with views of entry/exit points. An outgrowth of analog camera people counting solutions, this class of solutions replaces proprietary hardware and single-use cameras with computer vision algorithms using video streams from perspective-view CCTV installations. Figure 1 shows a typical view with clear entry/exit. Software can run on a variety of hardware that already exists in the building such as servers or the security cameras. After installation of the software, the vendor performs remote accuracy auditing to train the computer vision system. Figure 2 shows the computer vision software in training. The bespoke nature of camera deployments means that reporting and dashboarding functions must be custom-delivered to the Client.

Figure 4: Typical perspective view of CCTV image. Source: Facit Data Systems.

Table 2: Pros and Cons of Security Cameras + Computer Vision Solutions

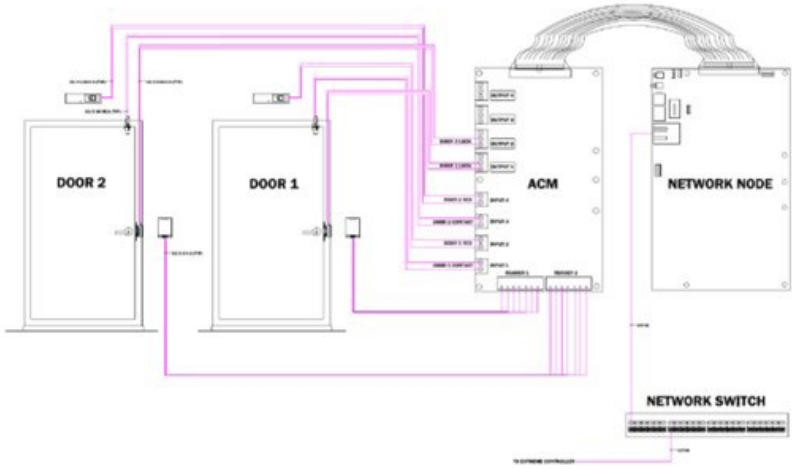
PROS	CONS
• Uses existing security camera hardware, reducing overall cost of the solution. • High-accuracy (95%). • Vendors offering this solution also offer additional services, including queue management and zone-level occupancy counting. • Additional use cases and accuracy are expected to follow computer vision capability growth. • Some vendors offer on-camera computation, eliminating the need to deploy and maintain dedicated servers on premises.	• Integration costs and ongoing service model pricing structure can be expensive. • Bespoke solution that requires custom delivery. • Getting the correct permissions for a computer vision vendor to access and export information from the security system can be difficult. • Building is locked into a particular vendor's ongoing service model. • Requires a clear and unobstructed view of entry/exit points. • May require deployment of dedicated servers if on-camera computation is not available or purchased.

Access Control Systems + Turnstiles: This solution uses the building's existing access control system in combination with existing turnstile hardware. The use of turnstiles for people counting is nascent. This approach is technically feasible and would be ideal for real-time people counting at the building level because it is a high-accuracy and low-cost solution that leverages the building's existing assets.

While this approach shows promise, adjustments to the system to enable net occupancy counting will likely be required. Access control systems do not typically track egress. Some high-security facilities do require and track a "badge out", but these instances are very rare (< 1% of buildings) and are usually high-clearance government facilities or labs.

While the access control system likely will not track occupant egress, the physical door or turnstile hardware can generate a Request to Exit (RTE) when a person passes through the turnstile or pushes a button to open the door. When this occurs, the door or turnstile can provide an analog signal to an access control module (ACM) that can increase or decrease the count appropriately. See Figure 3 for a sample configuration showing analog inputs and connections of the ACM. Doors do not have anti-tailgating technology, meaning that one person can hold the door open for an unknown number of people to enter/exit. Doors therefore do not have a one-to-one relationship between RTE and number of people in the building. Turnstiles, however, have anti-tailgating methods and can connect reported RTE to true exits.

Figure 5: Access control module configuration. Source: Lenel S2.



Turnstiles are already ubiquitous in commercial buildings. However, even turnstiles that can generate an RTE and have appropriate anti-tailgating technology rarely have this output signal wired to an input slot on an ACM. Connecting a turnstile analog signal to an access control module and adjusting the people count to capture net occupancy is possible but requires integration expertise. If security and access control vendors see value in providing whole-building occupancy, they may provide the necessary integrations, further lowering the barrier to adopting this solution.

Table 3: Pros and Cons of Access Control + Turnstile Solutions

PROS	CONS
• Uses existing turnstile and access control module hardware, reducing overall cost of the solution. • Extremely high-accuracy (>99%) • No ongoing fees	• Requires custom integration of RTE to an access control module. • People counting limited to places with existing turnstiles, typically whole building. • People counting is not a focus of existing security system manufacturers, so technical support is limited.

STAND-ALONE PEOPLE COUNTING TECHNOLOGIES

Time of Flight (ToF): These systems use infrared light and phase-shift calculations to compute the distance of objects in the camera's field of view. ToF sensors also use machine learning and computer vision to analyze the resulting data. Like camera and computer vision vendors, ToF vendors typically offer an array of sensing solutions in addition to people counting, such as zone occupancy and queue management.

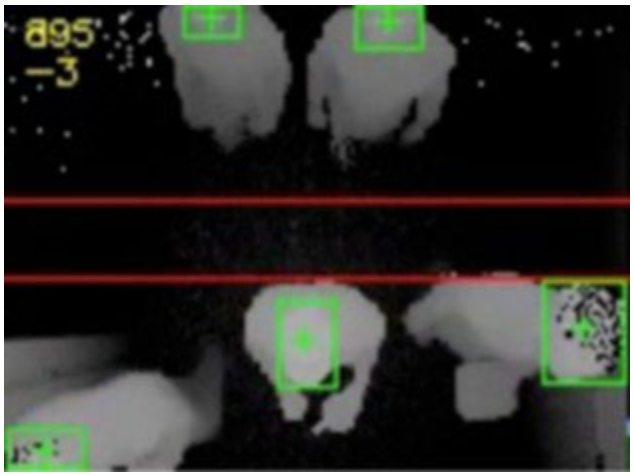
ToF sensors are typically installed above doorways or elevator bays, as seen in Figure 4. One issue observed in deployment is that these sensors must be installed in a limited height band above the floor.[13] When attempting to count people in a space with a high ceiling such as those in many Class A commercial office elevator bays, the system must be mounted on a pole extending from the ceiling to maintain a reasonable signal quality. Some building operators and Tenants find this installation unsightly. These solutions are limited to spaces with ceiling heights between 11 - 14 feet, depending on the vendor.

Figure 6: Time-of-flight sensor mounted. Source: Density.io.

Vendors of ToF sensors use Power over Ethernet (PoE) for both connectivity and power. This necessitates either a switch that can provide PoE in the building nearby, or the installation of a power injector on a switch port. Low-Voltage Contractors are commonly used for installation of these devices. In new construction, people counting is typically carried in the IT Contractor scope of work.

As seen in Figure 5, time-of-flight sensors only generate height measurements of the people walking through its view. By itself, height data is not considered Personally Identifiable Information (PII). Tenant concerns around privacy can be addressed with these systems. ToF sensors are a high-accuracy (≥ 98%) solution.

Figure 7: Depth map from time of flight sensor. Source: Density.io.



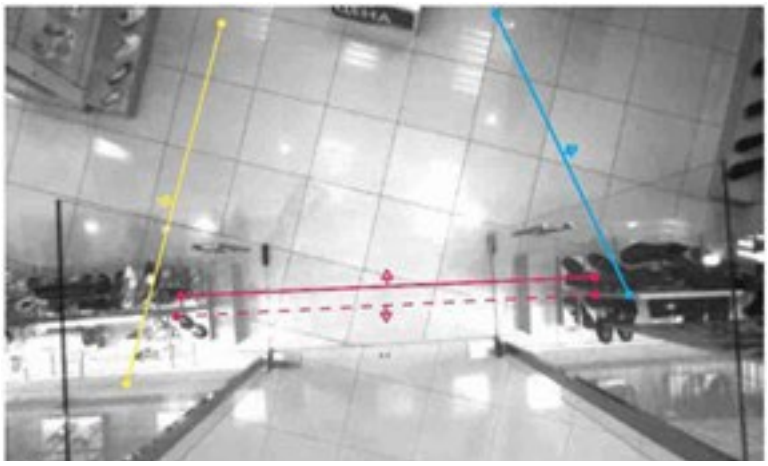
13 ToF sensors signal quality decreases as the distance between the object and the sensor increases.

Table 4: Pros and Cons of Time-of-Flight Solutions.

PROS	CONS
• Ease of integration. • High-accuracy (> 97%). • No Personal Identifiable Information collected beyond height. • Additional accuracy is expected to follow computer vision capability growth.	• Installation costs and ongoing service model pricing structure can be expensive. • Installation ceiling height is limited to 11 - 14 feet without pole extension. • Requires CAT6 cabling from device to building switch. • Switch required to support Power over Ethernet, or power injector required.

Stereoscopic Cameras: This solution uses dedicated cameras for people counting that are mounted above entry/exit points. Stereoscopic cameras offer better accuracy than analog security camera solutions because their location and angle can be adjusted and optimized. They can also be mounted higher than time-of-flight sensors – up to 29.5 ft for high-mount models. Stereoscopic cameras generate a depth map (see Figure 5) from simultaneous side-by-side image feeds.

Figure 8: One of the 2-dimensional feeds from a stereoscopic camera is being used to mark "count lines" during commissioning in retail. Source: IDT Electronics.



Like time-of-flight sensors, they typically connect via PoE. Some innovative use cases include the ability to keep separate people counts grouped by height. A function like this would allow building teams to estimate the percentage of adults or children that enter the space based on specific height criteria. Stereoscopic cameras installed at entry points offer accuracy of approximately 95%.

Table 5: Pros and Cons of Stereoscopic Cameras

PROS	CONS
• Can be mounted on ceilings up to 29.5 ft. • Good accuracy (> 95%). • Innovative use cases such as separate counts for adults and children.	• Installation costs and ongoing service model pricing structure can be expensive. • Collects Personally Identifiable Information. • Requires CAT6 cabling from device to building switch. • Switch required to support Power over Ethernet, or power injector required.

Thermal Imaging: Thermal imaging devices detect a person's body heat, which is easy to discern against the cooler temperature of a lobby floor. Typically, devices are mounted from 8 to 15 feet high. The device contains a sensor, imaging optics, a signal processor, and a networking interface. Multiple devices can be used for wide door openings and can be programmed to avoid double-counting, allowing a network of sensors to act as one device. These devices are relatively low cost and can be easily installed, with the potential to run on battery power and connect to a gateway wirelessly. They do not collect any PII and do not look like security cameras. Their anonymous imaging, lower processing power, and battery power options can reduce installation complexity.

Typically, the accuracy of thermal imaging people counting systems range from 90 - 95%, but accuracy can be degraded by several factors, including sunlight, people walking close together, and a surrounding environment with a temperature close to human skin (approx. 90º - 100ºF). For this reason, thermal sensors work best in conditioned spaces without radiant floors.

Table 6: Pros and Cons of Thermal Imaging Solutions.

PROS	CONS
• Ease of Installation: Options that do not require cabling. Building switch not required to support Power over Ethernet . • No Personally Identifiable Information collected.	• Installation costs and ongoing service model pricing structure can be expensive. • Accuracy lower than other solutions (90 - 95%). • Requires periodic battery replacement by building staff.

3.2 ENERGY METERING

NON-UTILITY METERING TECHNOLOGIES

A major distinction within non-utility metering technology is between revenue-grade and non-revenue-grade meters.

Revenue-grade power meters are defined in the American National Standards Institute (ANSI) Standard C12.20-2015, which establishes the physical aspects and acceptable performance criteria for 0.1, 0.2, and 0.5 accuracy class electricity meters. These classes represent accuracy to within +/-0.1%, +/-0.2%, and +/-0.5% of true value at a full load, respectively. Beyond the designations of these three (3) metering types, the standard covers voltage and frequency ratings, test current values, service connection arrangements, pertinent dimensions, form and display designations, environmental tests, and acceptable performance of the meters and associated equipment.

The ANSI standard is voluntary; however, it and ANSI C12.1, "American National Standard for Electric Meters – Code for Electricity Metering," form the basis for the testing requirements set by most North American utilities and utility commissions for their revenue (i.e., billing) meter requirements. Because these standards form the basis of testing requirements for utility meters, there is a high level of confidence in the accuracy of non-utility revenue-grade meters that meet the requirements of these standards. If revenue-grade meters are to be deployed within a building, decisions about which accuracy class is appropriate for a given application should be made by a qualified Electrical Engineer.

The biggest differentiators for revenue-grade meters in the market are connectivity and data services. Major metering manufacturers such as SATEC and Siemens have API documentation and provide vendor-supported cloud systems. They can provide data to the building management system, but often send data to a separate billing and management system that can provide Tenant-by-Tenant time-of-use energy consumption.

Non-revenue-grade meters cannot be used to determine or bill individual Tenant consumption or to participate in utility-offered demand response programs. Power meters in this category typically have accuracies between 0.5% and 2%. In general, non-revenue-grade meters are used to submeter systems that will not have revenue-based implications but can inform energy efficiency programs or operation. One such example would be for submetering parts of the HVAC system that will not be billed to a Tenant.

4. RECOMMENDED SOLUTIONS TO SUPPORT HOURLY BENCHMARKING

4.1 PEOPLE COUNTING

Property Owners must deploy people counting solutions at scale to support hourly benchmarking and performance standards. The decision tree and recommendations below provide guidance on how building Owners and operators can select an affordable solution given their building's unique conditions.

BEST-FIT OPTIONS FOR BUILDINGS WITH SOPHISTICATED ACCESS CONTROL SYSTEMS

Property Owners can greatly reduce the cost and complexity of installing a people counting solution by taking advantage of existing hardware associated with the building's access control system. Some form of access control (turnstiles, security cameras, security doors) is typical across Class A commercial properties. Depending on the coverage and location of existing hardware, the building IT team's expertise and sophistication, and the building management team's cost consciousness, the best-in-class solutions include Computer Vision Security Cameras and Turnstiles with ACM API Integration.

Table 7: Best-in-Class Options for Buildings with Sophisticated Access Control Systems.

	 COMPUTER VISION SECURITY CAMERA	 TURNSTILES WITH ACM API INTEGRATION
Accuracy	95%	> 99%
PII	Varies by vendor, typically yes in U.S.	Badge-in
Connectivity	Software Install + Remote Access	Wired Proprietary
Cloud Access	Vendor Cloud	ACM API
Initial Hardware/Software Cost for one 10' wide entry point	Approx. $700 per device, one (1), sometimes two (2) devices per entry/exit. Additional $300 hardware cost for analog camera.	N/A; assume exit counting turnstiles already in place
Recurring Cost per year	Approx. $100/camera	$0
Installation Cost	N/A, assumes appropriate existing cameras.	Varies by Integrator, assume wiring of one (1) additional point to ACM and configuration.

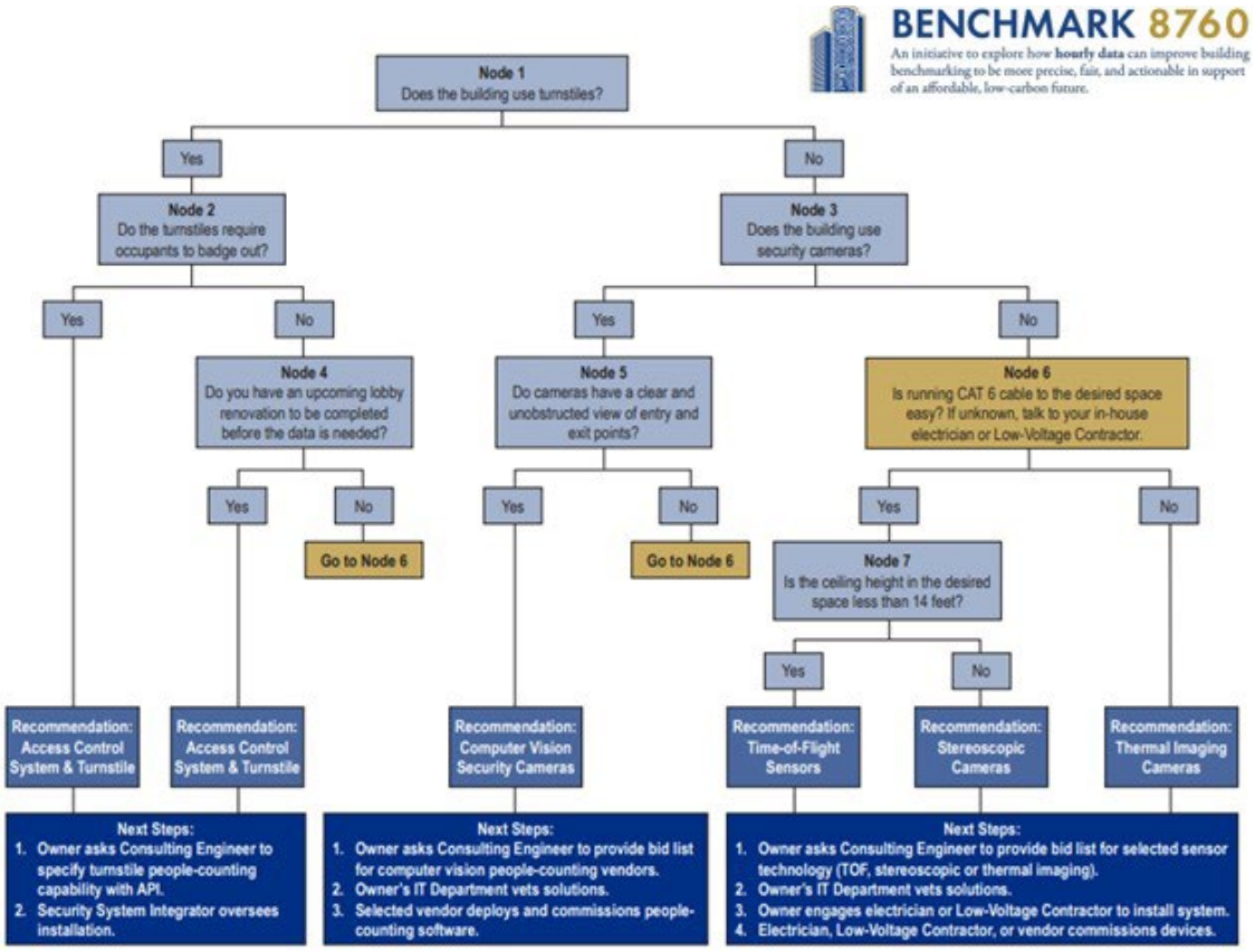
BEST-FIT OPTIONS FOR BUILDINGS WITHOUT SOPHISTICATED ACCESS CONTROL SYSTEMS

In buildings without sophisticated access control hardware capable of supporting people counting, such as cameras that survey entrances or access control modules with API integration, the best-in-class solution is to install a stand-alone people counting solution. Ceiling heights and the ability to run CAT6 cabling to covered spaces will determine if time-of-flight sensors, stereoscopic cameras or thermal imaging is the appropriate solution for the building.

Table 8: Best-in-Class Options for Buildings without Sophisticated Access Control Systems.

	 TIME-OF-FLIGHT (IR)	 STEREOSCOPIC 3D CAMERA	 THERMAL IMAGING
Accuracy	> 97%	> 95%	90 - 95%
PII	Occupant height	Facial features, height	Body temp
Connectivity	PoE/WiFi/LTE	PoE/WiFi	PoE/WiFi/3G
Cloud Access	Optional	Optional	Yes
Initial Hardware/Software Cost for one 10' wide entry point	$900 - $1,800 per device	~$800 per device	$300 - $800 per device
Recurring Cost per year	$0 - $800	$0 - $500	$0 - $500
Installation Cost	$1,000 - $3,000	$1,000 - $3,000	$1,000 - $2,000

BUILDING OWNER DECISION TREE



4.2 ENERGY METERING

WHOLE-BUILDING ELECTRICITY CONSUMPTION DATA IN BUILDINGS WITH UTILITY-PROVIDED SMART METERS

Due to the ubiquity of smart utility meters[14], the best solution to support an hourly benchmarking program is to use existing utility-provided smart meters in combination with the Green Button data-reporting standard. With this method, building Con Edison account holders (building Owner and any direct-metered Tenants) will need to authorize the external benchmarking platform to access their hourly data sets.

14 In New York, Con Edison is scheduled to complete its smart utility meter rollout program by June 2022, at which point hourly energy data will be accessible to all New York building Owners. More broadly, in the United States, 58 investor-owned electric companies have fully deployed smart utility meters in their service regions, representing 107 million smart utility meter deployments. The U.S. Energy Information Administration estimates that nearly half of all current U.S electricity customers have smart utility meters. That number will continue to grow as legacy meters are replaced.

WHOLE-BUILDING CONSUMPTION DATA IN BUILDINGS WITHOUT UTILITY-PROVIDED SMART METERS

In cases where a building does not have a utility-provided smart meter, the property management team should investigate if an upgrade to the existing metering infrastructure is planned by the utility. In New York, property Owners can contact Con Edison and request expedited installation through the Smart Meter rollout program.

If an upgrade by the local utility is not planned, the building management team can deploy a non-utility revenue-grade total power meter downstream of the existing utility meter and connect it with a software product that captures interval data and provides connectivity to a cloud-based platform. This option will require upfront costs for the metering hardware and installation as well as ongoing service and maintenance costs. If the building uses a submetering service provider, using the existing provider for this new work to minimize disruption and start-up time is recommended.

5. CONCLUSION

Capturing hourly people counts and energy data will be central to a benchmarking standard that is more precise, fair and actionable. Understanding the current market landscape for people counting and energy metering technologies is a key step in developing the resources and processes needed for building Owners to integrate these technologies into their buildings in a scalable and affordable manner.

While market penetration of people counting solutions was minimal prior to 2019, Covid-19 has created new market demand. In an absolute sense, deployment of occupancy solutions is still low, but the increasing interest and rise in people counting technology deployments is promising. As this report discusses, there are a variety of strong solutions for people counting that property Owners can be deploy affordably and at scale in buildings with and without sophisticated access control systems. Resources such as the Building Owner Decision Tree can streamline the building Owner decision-making process for selecting an appropriate solution. Additional resources can be developed to continue to support market adoption.

For energy metering, utility-provided smart meters are already ubiquitous in New York and offer the best approach to capturing hourly whole-building electricity data. Smart meter data can be reported in a consistent manner through the Green Button Standard, a reporting standard that is already industry-approved and in use. Outside of New York, where a smart meter rollout program may not exist, other building-initiated revenue-grade metering options exist.

APPENDIX A:
TERMS AND DEFINITIONS

TERMS AND DEFINITIONS

PEOPLE COUNTING

PEOPLE COUNTING TERMINOLOGY	
TERM	**DEFINITION**
People Counters	Devices that measure the number of people entering and exiting a given point such as a doorway or elevator bay.
Occupancy Sensors	Devices that detect the presence of people in a space such as a meeting room, outputting a binary (occupied/unoccupied) or integer signal (3 people).
Computer Vision	A field of machine learning that trains computers to accomplish and automate tasks the human visual system can do, such as counting people as they walk through a door.
Access Control Systems	Electronic systems that control who may enter a location and when. Typically composed of hardware such as a turnstile, keycard readers and access control module.
Time-of-Flight (ToF) Sensors	Sensors that count the number of people entering and exiting a field of view by creating a depth map based on distance between sensor and environment.
Stereoscopic Camera Sensors	Sensors that count the number of people entering and exiting a field of view by creating a depth map using multiple cameras.
Thermal Imaging Sensors	Sensors that count the number of people entering and exiting a field of view by sensing body heat.
Power over Ethernet (PoE)	Systems that pass electric power along with data on twisted-pair ethernet cabling. Multiple versions exist, capable of transmitting 15-watt, 30-watt and up to 100-watt power.

ENERGY METERING

ELECTRIC METERS	
METER NAME	**DEFINITION**
People Counters	Electricity meter provided by the local utility provider for the purposes of billing.
Occupancy Sensors	Electricity meters that measure and record electricity usage at a minimum of hourly intervals and that provide the data to both the utility and the utility customer at least once a day.
Computer Vision	Electricity meter owned by the building for the purpose of measuring whole building electricity consumption.
Access Control Systems	Electricity meter owned by the building for the purpose of measuring some subsection of electricity consumption such as HVAC, lighting, or individual equipment such as a chiller.

ELECTRIC METERS	
METER NAME	**DEFINITION**
Time-of-Flight (ToF) Sensors	Catch-all term for electricity meters that can measure and record electricity usage and provide that data to an end user via connected protocols and/or vendor clouds.
Stereoscopic Camera Sensors	Non-utility meters that meet ANSI C12.20-2015 and can be used for billing. Utility meters use the same standards but are not normally called revenue-grade. Total or submeters can be revenue-grade.
Thermal Imaging Sensors	Non-utility meters that are not certified as having met ANSI C12.20-2015 and cannot be used for billing. Non-revenue-grade meters are commonly used for subsystem metering.
Power over Ethernet (PoE)	Systems that pass electric power along with data on twisted-pair ethernet cabling. Multiple versions exist, capable of transmitting 15-watt, 30-watt and up to 100-watt power.