MARKETING
WHITE PAPER

How IP surveillance systems can reduce energy use

Camera technologies that can lower cost and environmental impact

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AXIS COMMUNICATIONS

Table of contents

1. Introduction

Now more than ever, organizations are considering the impact of energy usage across all business systems. A recently published report reveals that the rising cost of fuel and energy is one of the greatest threats to small- and medium-sized businesses. Making energy efficiencies is not only a corporate social responsibility requirement to reduce a company's carbon footprint but also an important consideration that directly impacts business profitability. A reality of the current energy challenges is that some businesses have been forced to cease trading. We have even seen large corporate organizations close sites due to the rising costs associated with energy usage.

Network cameras are just one of many types of devices that consume energy. However, it is now vital to consider network camera system energy usage, as the rising and unpredictable nature of energy costs has a detrimental impact on ongoing operational expenditure. Traditionally, a business may have solely focused on the capital expenditure of a network camera system. However, a total cost of ownership model, increasingly driven by energy cost, plays a far more significant role in the decision-making process. Therefore, this whitepaper aims to highlight some important considerations that may influence the design of your video surveillance systems to optimize energy efficiency. The whitepaper can also support a business case for potential upgrades that can be offset with energy savings, resulting in a lower total cost of ownership.

While the purpose of this whitepaper isn't to highlight any government initiatives put in place to support investments in energy-efficient technologies, these could be an essential consideration when funding potential projects. Governments around the world have acknowledged the strain that energy prices are having on businesses, as well as the environmental impact that less efficient systems can have. Government incentives can be leveraged to cover system upgrades, so it makes sense to access these available initiatives to improve your systems. At the same time, your organization will be making a positive change in energy usage and carbon reduction commitments.

2. Camera technologies and features

When designing your security systems, the most important consideration should always be the operational performance and how this addresses the associated business risks. But as organizations update their risk register, the unpredictable nature of rising energy costs is a new challenge that needs to be considered. If organizations look to evaluate their operational technologies, they will see their video surveillance system's impact and how changes can be made to reduce power consumption.

Two essential factors will support a business in lowering its energy requirements. Firstly, we have seen discussions around business intelligence (BI) and digital transformation gain momentum in recent years. This has focused attention on what data is being collected, how it can be utilized by a wider number of stakeholders within an organization, and how it can make the business operate more efficiently. To help a company realize its ambition and become more efficient, network video surveillance systems are being used creatively and interacting with other building systems, creating a smarter, more efficient environment. At the same time, with the continued investment in innovation, we have seen the capabilities of traditional video surveillance systems change. Technological advances have directly impacted the way these systems are designed, specified, and operated today. So much more can be achieved and delivered while using significantly less hardware. Without compromising on the performance of the operational systems, businesses are seeing improved operation efficiencies and reduced power requirements.

Let's explore some of these important innovations supporting businesses in reducing energy usage. For the purposes of making a comparison between different technologies, we have selected both current and EOL technologies based on the resolution of the camera models. Whilst some of the models identified are EOL, these will still be deployed and operational enabling us to identify possible cost saving that may help with an argument for future upgrades.

2.1 Camera resolution

Camera resolution is a good starting place to compare technology development and energy efficiency. Through increased processing power built into the camera, there has been a significant advancement in camera capabilities that have evolved with the adoption of IP technologies. Focusing purely on the pixel density values and associated distances gives us a good energy use comparison without compromising on the quality of the captured image. So, considering how the system will be operated and its requirements, this can show how higher-resolution cameras will impact energy usage.

			Identification	Recognition	Detection	
SVGA	800x600	AXIS P1353	2m	4m	19m	Identification @ 250pix/m
1Mpxl	1280x720 (720P HD)	AXIS P1354	3m	6m	31m	Recognition @ 125pix/m
2Mpxl	1920x1080 (1080p HD)	AXIS P1375	5m	9m	46m	Detection @ 25pix/m
3Mpxl	2048x1536	AXIS P3346	5m	10m	45m	
5Mpxl	2592x1944	AXIS P1377	6m	12m	62m	
8Mpxl	3840x2160 (4K UHD)	AXIS P1468	9m	18m	91m	

All distances calculated at 80° FoV
All distances rounded to nearest meter

Pixel density distances

The distances shown are not absolute maximum distances possible for each pixel density value
To enable a fair comparison between all of the different image resolutions all values were calculated at the same horizontal field of view (80 degrees) for each camera. By increasing the focal length of the lens on the camera and reducing the FoV these distance would increase. The table should be used as a very general overview guide and the values shown are not absolute.

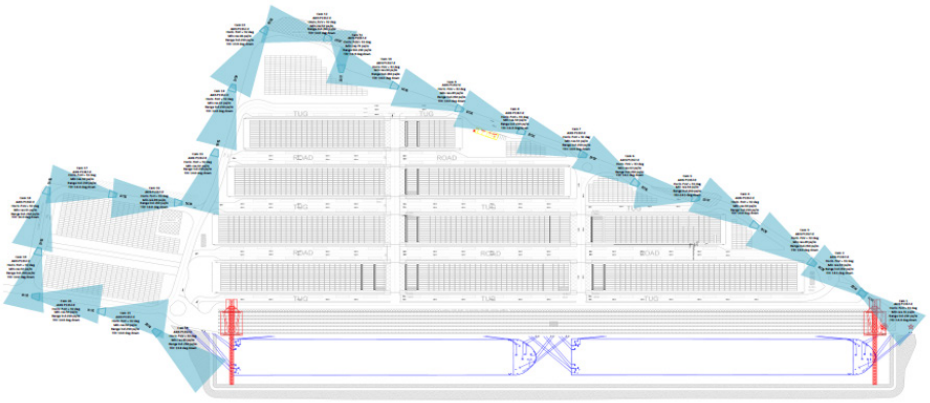
The table below compares the percentage increase and decrease against each of the resolutions highlighted at a defined pixel density. For the purposes of the comparison, the settings are in accordance with the parameters displayed in the table below.

		Detection	SVG % +/-	1Mpxl % +/-	2Mpxl % +/-	3Mpxl % +/-	5Mpxl % +/-	8Mpxl % +/-
SVGA	AXIS P1353	19m		-63%	-142%	-142%	-226%	-374%
1Mpxl	AXIS P1354	31m	63%		-49%	-48%	-100%	-190%
2Mpxl	AXIS P1375	46m	142%	49%		0	-35%	-98%
3Mpxl	AXIS P3346	45m	142%	48%	0		-35%	-98%
5Mpxl	AXIS P1377	62m	226%	100%	35%	35%		-47%
8Mpxl	AXIS P1468	91m	374%	190%	98%	98%	47%	

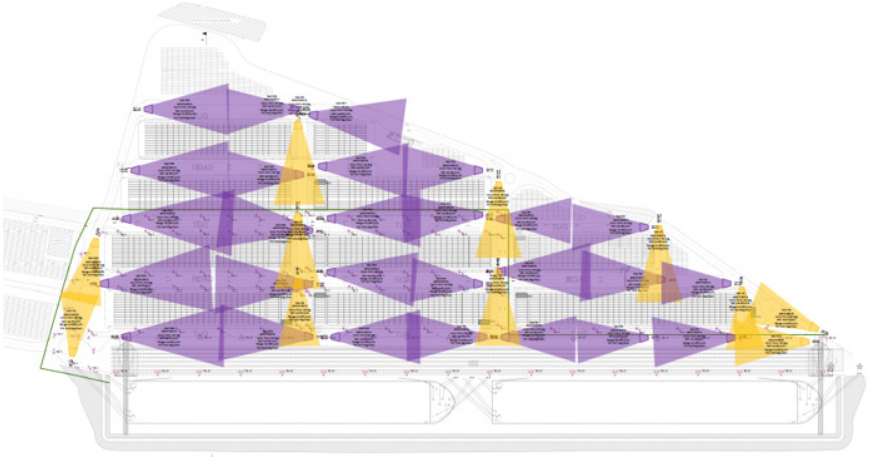
Detection @ 25pix/m
Figures rounded to the nearest full %

To give a direct comparison between the resolutions, a generic customer site plan has been developed to highlight a potential camera layout using an 8Mpxl camera as chosen by the client. The brief was to give detection levels of coverage to the perimeter of the site boundaries and also detection level coverage to the roadways between the container areas. The perimeter boundaries measured 2,000m, and the roadways measured 3,870m. While thermal cameras had been discussed for the perimeter, visual camera technology was ultimately selected for evaluation.

Example showing perimeter cameras



Example showing internal roadways



When comparing the number of cameras required to generate the same level of coverage across the site, it presented significant differences. The table below shows the comparison in the number of cameras required, assuming cameras could be located in the optimum positions with the same levels of spacing between each device to ensure the use of the minimum quantity of cameras. Though in reality, a site design will rarely have this luxury, for comparison purposes, this best reflects the quantities of cameras required.

		Detection	Perimeter	Roadways	Total
SVGA	AXIS P1353	19m	106	204	310
1Mpxl	AXIS P1354	31m	65	125	190
2Mpxl	AXIS P1375	46m	44	84	128
3Mpxl	AXIS P3346	45m	44	85	129
5Mpxl	AXIS P1377	62m	33	63	96
8Mpxl	AXIS P1468	91m	22	42	64

Detection @ 25pix/m
Perimeter @ 2000m
Roadways @ 3870m

The table above shows the reduced camera count achievable while still providing the same level of coverage across the site. As a result, this provides cost savings from the reduced number of cameras required, as well as a reduction in the associated items and work needed for installation, including cabling, commissioning, storage, infrastructure, and civil engineering. Crucially, the following table also shows the impact on power consumption in comparison between the different solutions.

Based on fixed IP cameras (24x7 operation, 25fps) to cover 5870m	Camera No.	Annual power consumption	Annual power cost	5 year power cost
SVGA	310	19840 kWh	€5,952.00	€29,760.00
1Mpxl	190	12160 kWh	€3,648.00	€18,240.00
2Mpxl	128	8192 kWh	€2,457.60	€12,288.00
3Mpxl	129	8256 kWh	€2,476.80	€12,384.00
5Mpxl	96	6144 kWh	€1,843.20	€9,216.00
8Mpxl	64	4096 kWh	€1,228.80	€6,144.00

Power calculations based on €0.30 per kWh. This figure will vary depending on local tariffs, but assumed as an average. 5 year power cost is assuming no rate changes.

As you can see from the table above, additional cost savings can be achieved related to the specific power consumption of the camera resolution used. When looking at an upgrade of the whole surveillance system, starting with consideration of a function such as resolution can go a long way to demonstrating the potential of a quick return on investment.

2.2 Multi-view streaming

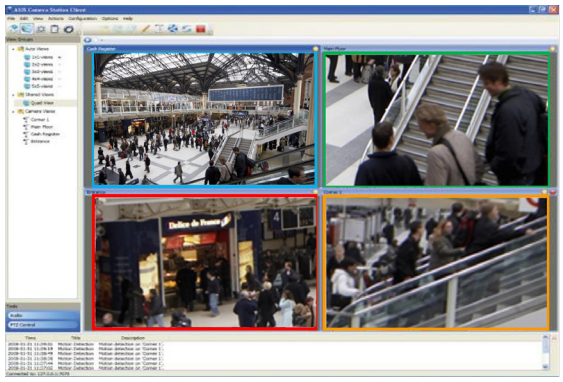
With the increase in resolution and camera processor, the power came the ability to take multiple streams from an individual camera. This in turn, offered the potential to stream multiple views from a single camera, giving the operator the perception that they are looking at several different fixed camera positions.

This feature is very useful if you want to zoom into multiple areas simultaneously for monitoring purposes. A scenario example could be the entrance to a building where you would like to simultaneously focus on the entrance door, reception area, and barriers. Each specific view can be segregated into a viewing window shown individually within the monitoring workstation. If positioned correctly, this has the potential to reduce the number of cameras needed. If a high-megapixel camera is used, even when the specific view is split, each subsequent viewing window can match the same resolution as the single view from a smaller-resolution camera. As a result, multi-view streaming capabilities doesn't mean a compromise in the resolution of the displayed image.

With multi-streaming capabilities running up to eight views from a single camera, the potential reductions in camera count and energy use can be seen immediately. As camera processing power and pixel count increase in line with further technology development, the number of available streams is also likely to increase, multiplying the potential to further reduce the camera count.

Megapixel camera being used for overview

Megapixel camera with multi-view streaming



The example here shows how a single camera, positioned correctly, can achieve the desired coverage at the same resolution as a higher number of smaller-resolution cameras. Aside from the clear benefits of only having to procure and install a single camera, run one cable, and maintain just one device, there are also ongoing savings related to the annual energy costs.

Based on 8 fixed camera view	8 1Mpxl cameras	1 5Mpxl camera with multi-view streaming option enabled
Annual power consumption	504 kWh	64 kWh
Annual power cost	€151.20 server power and camera power	€19.20 camera power with 1% increase to load

Power calculations based on €0.30 per kWh. This figure will vary depending on local tariffs, but assumed as an average.

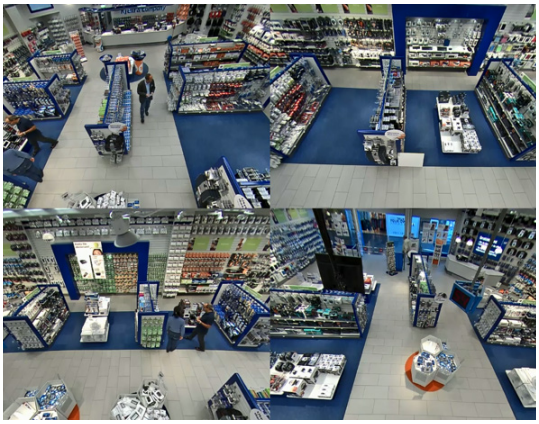
The table above shows a direct correlation between cost savings on offer from using different camera technologies to achieve the same level of coverage without compromising on the system's image quality or operational performance. This example demonstrates a potential energy cost saving of more than 85% based on the camera quantities used. As the results assume a best-case scenario of utilizing a single, high-megapixel camera to replace eight lower-resolution cameras, results will vary depending on alternative camera requirements.

2.3 360° overview surveillance cameras / Multi-sensor cameras

The introduction of 360/180° overview surveillance cameras, also known as fisheye cameras and more recently, multi-sensor cameras, has added further scope to the capability of reducing camera count and, subsequently, saving on energy costs. With the ability to de-warp images, seamlessly insert different sensors into the same display, and still run multi-view streaming, users can install centrally located cameras that can look and record in all directions simultaneously.

The introduction of this technology has significantly reduced the camera quantities needed on a number of large systems while improving coverage and reducing potential blind spots. By introducing a single 360° overview surveillance camera, a client could expect to see a potential 75% reduction in the camera count as a minimum. This is assuming 100% visibility of an area of 650m^2/7000ft^2 compared to using four individual cameras pointing in different directions. Compared to using multi-sensor cameras, using individual cameras would also leave a blind spot directly below each installed device.

Based on the number of cameras it would take to cover a large area, it would be unlikely that a client would wish to have 100% coverage using traditional cameras. Instead, utilizing the 360° overview camera will increase coverage of the site while reducing the total number of cameras required. Naturally, fewer cameras mean lower power consumption and decreased installation, operation, and maintenance costs.



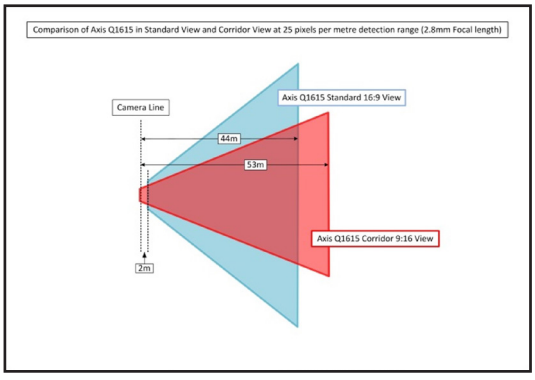
2.4 Axis Corridor Format

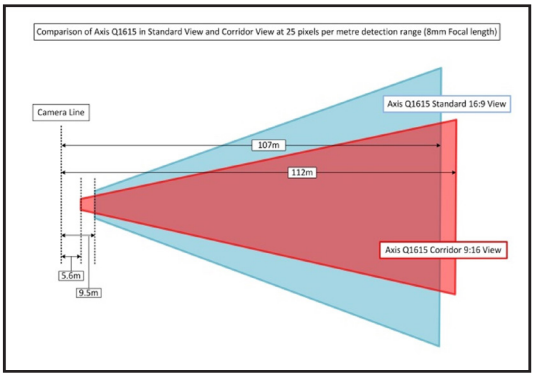
In many surveillance situations, some areas are more vertical than horizontal in shape. This includes applications such as staircases, hallways, aisles, roads, runways, and tunnels. In these situations, the traditional 'landscape' format is not the optimal solution since it creates video streams where a large part of the field of view – specifically the sides of the image – is redundant. In turn, this means that the image quality is not maximized because the total area and resolution of the camera's image sensor aren't fully utilized. In the process, bandwidth and storage are also wasted.

Axis provides a unique solution to this problem thanks to Corridor Format. This well-established format allows you to achieve a vertically oriented,' portrait-shaped video stream from the camera. The video is adapted perfectly to the monitored area, maximizing image quality while eliminating bandwidth and storage waste.

Axis Corridor Format is even more useful for modern HDTV network cameras that deliver a 16:9 aspect ratio since the resulting image will have a 9:16 aspect ratio – just the right scale for narrow corridors, hallways, or aisles. Due to this change in aspect ratio, which can provide a more extended detection range across a vertical field of view from the same camera, there is the potential to reduce the camera count, providing the system is correctly designed.

As Axis Corridor Format is well aligned to applications in segments such as retail, data centers and transportation, potential savings in camera count and subsequent energy costs over multiple sites make a compelling argument for this technology.





Corridor format images
By using Axis Corridor Format, the customer can fully maximize the horizontal field of view. This has the potential to reduce a camera's blind spot and increase the available detection zone. If an elongated horizontal view is not required, Axis Corridor format, in conjunction with a varifocal lens, can be used to increase the pixel density within the scene. The benefit is no extra hardware cost or increases to camera bandwidth as the same image is transmitted.

As demonstrated in the above diagrams, through a direct comparison of AXIS Q1615 camera with the varifocal lens set at 2.8mm, you can see the level of coverage increase when changed from a 16:9 format to a 9:16 format. With the traditional 16:9 view, AXIS Q1615 can provide coverage of 25 pixels per meter up to 42m to achieve detection levels of evidence. When the same camera is rotated to 9:16, it is able to provide the same level of 25 pixels per meter, but the detection level can now be extended up to 53 meters. This change in aspect ratio increases the coverage distance from the same camera by 27%.

As the varifocal lens can also be zoomed into the full capability of 8mm, Axis Corridor Format can also be utilized across other segments, such as critical infrastructure, to benefit from extended detection ranges. The above-right diagram shows both coverage areas achieving 25 pixels per meter at the furthest point.
The 16:9 aspect ratio provides a coverage area of 107m from the camera position with a blind spot of 9.5m, meaning the coverage is 97.5m. However, when we change the camera's aspect ratio to 9:16, we achieve coverage across 112m with a reduced blind spot of 5.6m, meaning the total coverage area is 106.4m. This shows an increased coverage distance of 9.5% by changing the aspect ratio from the traditional format to corridor format.

If we use a similar scenario to that used for the resolution example, we can make a direct comparison to show detection coverage and the number of cameras required for an environment that involves perimeter detection and coverage across the roadways.

		Detection	Perimeter	Roadways	Total
2Mpxl	AXIS Q1615 16:9 - 2.8mm	42	48	93	141
2Mpxl	AXIS Q1615 9:16 - 2.8mm	53	38	73	111
2Mpxl	AXIS Q1615 16:9 - 8mm	97.5	21	40	61
2Mpxl	AXIS Q1615 9:16 - 8mm	106.4	19	36	55

Detection @ 25pix/m
Perimeter @ 2000m
Roadways @ 3870m

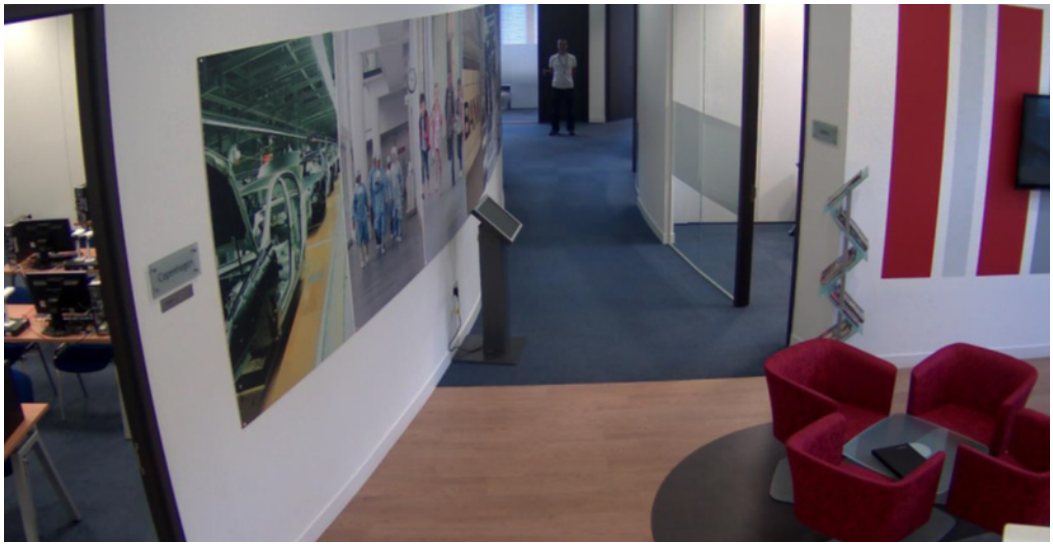
The table above shows the benefit of using an Axis camera in Corridor Format, which given the right situation enables increased detection with a reduced total number of cameras. In table row 1, AXIS Q1615 with a focal length of 2.8mm shows an increased camera count requirement of approximately 27% if the 16:9 aspect ratio is retained, compared to using the 9:16 Corridor Format. The potential of detection distance increasing and coinciding with the total camera number decreasing when the aspect ratio is changed to Corridor Format is also seen when the focal length is changed to 8mm, as depicted in rows 3 and 4.

Based on fixed IP cameras (24x7 operation, 25fps) to cover 5870m	Camera No.	Annual power consumption	Annual power cost	5 year power cost
2Mpxl - 16:9, 2.8mm	141	9024 kWh	€2,707.20	€13,536.00
2Mpxl - 9:16, 2.8mm	111	7104 kWh	€2,131.20	€10,656.00
2Mpxl - 16:9, 8mm	61	3904 kWh	€1,171.20	€5,856.00
2Mpxl - 9:16, 8mm	55	3520 kWh	€1,056.00	€5,280.00

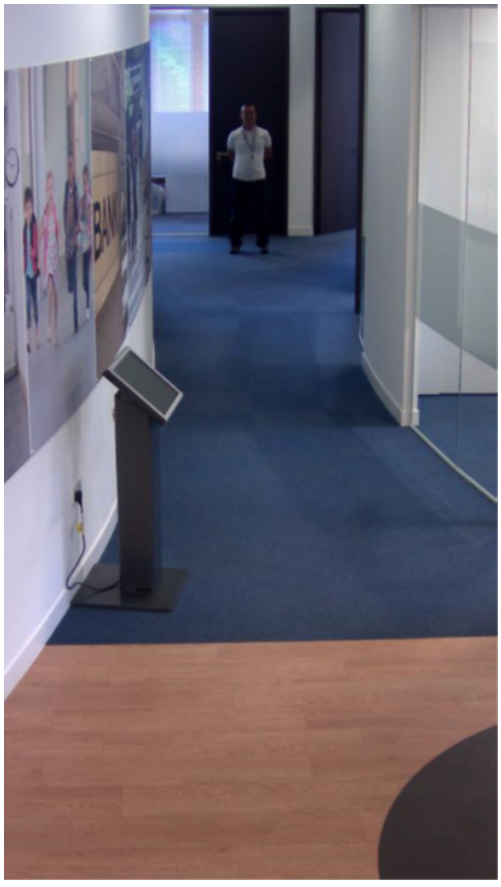
Power calculations based on €0.30 per kWh. This figure will vary depending on local tariffs, but assumed as an average.
5 year power cost is assuming no rate changes.

Considering the reduced hardware requirement, the table above shows how the deployment of the same camera model in Corridor Format will enable a reduction in power consumption. As already mentioned, these cameras lend themselves to vertically orientated scenes in environments such as retail centers, shops, railway stations, and data centers. Organizations involved in these sectors are likely to be multi-site, very cost sensitive, and with well-documented corporate social responsibility guidelines. As a result, a small change to their video surveillance system design by introducing Corridor Format could present significant energy and cost savings across their entire estate.

Another benefit that Corridor Format offers is the ability to consolidate pixels into a defined area, giving the appearance of an improvement in resolution. The image below was captured using an AXIS P3346 camera in 1080p resolution. In 16:9 mode, a significant proportion of the captured image – namely the corridor walls - is of no interest. This essentially means there's a reduction in the usable pixels across the actual area of interest.



Instead, the following image is presented with Axis Corridor Format. The camera sensor is physically rotated by 90°, and the image is electronically counter-rotated to ensure the correct orientation for viewing. This image is refocused to match the top and bottom view of the original 16:9 image, resulting in a higher pixel density in the area of interest.



The comparison below shows the improved image quality available with Axis Corridor Format when digitally zooming in on the image: recognition is now possible where it wasn't before. This has been achieved using the same camera, meaning no increase in cost to generate an improved and more usable image.

Combining these new IP camera technologies can reduce the physical number of devices required to achieve the same, if not better, results, with reduced requirements on system power. More than this, less camera hardware also means a reduced requirement on network infrastructure. If designed correctly, this also means a significantly reduced demand on bandwidth and storage, which is where we can see significant savings.

2.5 AXIS Camera Application Platform

AXIS Camera Application Platform (ACAP) is an open platform that allows application developers to market and sell Axis-compatible applications. The platform supports video analytics applications that provide products with a whole host of new intelligent capabilities to improve systems' operation performance or provide business intelligence. At the same time, the ACAP and edge-based analytics strategy is only possible due to the significant performance benefits driven by the processing capabilities seen in Axis cameras.

With analytics now being deployed at the edge (directly in the camera), a new serverless architecture can be achieved, reducing the need for server hardware and its associated costs. And with a reduction in hardware, this also reduces energy demands, which are typically high with energy-intensive server technology.

The ACAP open application platform has attracted significant interest among Axis development partners. With the constantly changing landscape, third-party Axis partners have continued to innovate new and improved analytics that sit directly in the cameras and run independently of the VMS provider. With several thousand partners providing analytics, the ongoing cost savings achieved are significant.

To demonstrate the energy-saving potential, one such project comparison involved AXIS Perimeter Defender (APD) and Digital Barriers' SafeZone analytics. Both are CPNI-approved and formerly iLIDS primary approved, so they offer the same technical functionality. However, AXIS Perimeter Defender is fully edge-based and supported by ACAP, while Digital Barriers' offering is server-based.

To enable a side-by-side energy use evaluation, Digital Barriers compared a four-camera server-based solution with a four-camera serverless ACAP solution.

Based on 4x IP cameras (outdoor) with video analytics on 4 channels (24x7 operaton)	Server-based video analysis (e.g., original SafeZone server product)	AXIS Perimeter Defender (APD)
Annual power consumption	857 kWh (381 kg)	252 kWh (112 kg)
Annual power cost	€257.10 server power and camera power	€75.60

Power calculations based on €0.30 per kWh. This figure will vary depending on local tariffs, but assumed as an average.
Server specificaton, power and support costs based on Dell PowerEdge R210 II (source: Dell.co.uk)

The table above directly compares two solutions, each offering the same technical performance. Even though the most significant cost saving is achieved through reducing server hardware, the percentage saving in energy between the two solutions is significant, especially if sites scale up in size and camera count increases.

2.6 Axis Lightfinder technology

A day and night camera is designed to be used in outdoor installations or indoor environments with poor lighting. While delivering colour images during the day, the camera can automatically switch to night mode as light diminishes and use near-infrared (IR) light to provide black and white images. However, maintaining image sharpness and low noise, particularly in varying outdoor lighting conditions, can be a challenge for many camera manufacturers.

Research and development at Axis has led to the introduction of the revolutionary Lightfinder feature. This technology is the result of a meticulous choice of the right sensor and lens, combined with in-house chip development and the elaboration of image processing.

As a result, a camera with Lightfinder technology can operate in significantly lower lux levels compared to traditional surveillance cameras available on the market. Aside from the improvement in image quality during demanding low light environments, Lightfinder also enables energy saving. This is thanks to the reduction in additional lighting sources typically needed within close proximity to a traditional camera during nighttime operation.

Camera image during the day

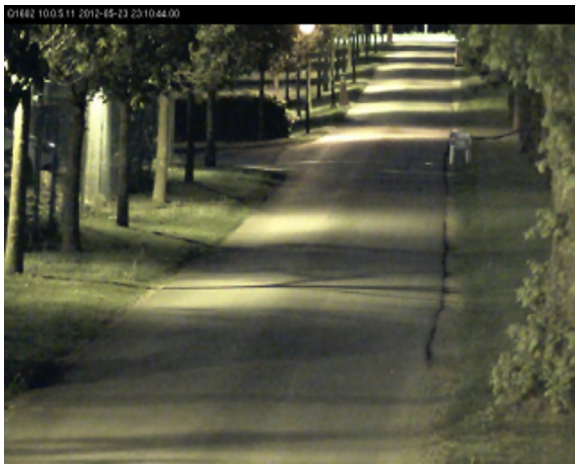
Camera image during the night without Lightfinder technology

Based on fixed IP cameras (24x7 operation, 25fps)	Power usage/ kWh	Number	Annual power consumption	Annual power cost	5 year power cost
AXIS P3346-V Fixed Camera (No Lightfinder)	0.0065	12	683.28 kWh	€204,98	€1,024.90
Lighting source	0.4	6	21,024 kWh	€5,328.00	€31,536.00
				€6,512.18	€32,560.90

Power calculations based on €0.30 per kWh. This figure will vary depending on local tariffs, but assumed as an average.
5 year power cost is assuming no rate changes.

The above table demonstrates the relatively high energy requirements to operate a camera without Lightfinder technology due to the dependence on an additional lighting source. For the purposes of the comparison, a fixed camera has been positioned every 25m to cover a perimeter measuring 300m. Lighting has been mounted every 50m to increase the lux levels in the environment.

A nighttime image from a camera with Lightfinder



Based on fixed IP cameras (24x7 operation, 25fps)	Power usage/ kWh	Number	Annual power consumption	Annual power cost	5 year power cost
AXIS P3265-LVE Fixed Camera	0.00972	12	1,018.97 kWh	€305,69	€1,528.45

Power calculations based on €0.30 per kWh. This figure will vary depending on local tariffs, but assumed as an average. 5 year power cost is assuming no rate changes.

A camera with Lightfinder has the capability to utilize any ambient lighting in the area. This removes the need for additional lighting sources, saving hardware and installation, with energy costs also reduced, as demonstrated in the table above. Using Lightfinder technology, up to 96% of additional lighting can be removed. Comparing standard cameras with Lightfinder-enabled solutions, the potential cost savings can be highly significant, especially when scaling this technology over a larger site.

It is worth noting that Lightfinder still needs lighting for the cameras to operate efficiently, though the technology can still provide high image quality with very low light levels. In the event that there is insufficient light in the environment, additional lighting will always be required. As a result, lux levels should always be considered before designing the system.

2.7 OptimizedIR

Alternatively, to provide video in complete darkness, Axis offers OptimizedIR technology – combining camera intelligence with extremely power-efficient LEDs. Due to the minimal heat dissipation, Power over Ethernet (PoE) is sufficient to power them, with no additional cabling required.

The LEDs are high quality and durable, and their lifetime is further prolonged because of their low heat generation. With a lower operating temperature, the LEDs also last longer. Optimized IR is also power-efficient because it illuminates the scene evenly and minimizes the amount of light outside the view, achieved by using a minimal LED concentration.

Could Lightfinder or Optimizer IR technologies offering the savings needed to justify upgrading and replacing older technologies?

3. IP recording and storage solutions

With the advent of new technologies, the reliability, cost, and performance of surveillance system recording and storage methods have improved significantly. While the size and technical complexities of the system will dictate the type of storage required, selecting the right storage type will offer significant cost savings, depending on the technology and build of the servers.

3.1 Solid-state SD card storage

IP cameras can now compress images to a much smaller file size than previously possible, allowing the use of SD cards inside the cameras as the main storage for smaller applications. As this is solid-state technology with no moving parts, there are minimal energy use requirements for recording purposes.

While the main benefits of SD cards are to enable failover recording or offer localized storage, their use also reduces the need for additional networked attached storage (NAS) and the extra hardware and energy requirements associated. Naturally, the recommendation is not to use SD cards as the only form of storage unless considering a low-risk application such as a residential or small retail environment. Nevertheless, the carefully considered replacement of a proportion of NAS and server storage with SD card technology can significantly reduce energy requirements.

3.2 Compression techniques with Axis Zipstream

The compression technique selected will have a significant impact on bandwidth and storage requirements, but not all compression technologies are the same. Even if you compare H.264 or H.265 implementations across multiple vendors, you will almost certainly get a different figure, as there are so many components that influence the outcome.

Axis Zipstream technology makes it possible to use higher resolution to increase forensic usability while reducing storage costs. The intelligent compression method ensures that important image details get enough attention in the video stream while unnecessary data is removed.

Most networked video surveillance systems today are limited by bandwidth and storage for recorded video. Zipstream is a radically improved, standard-compatible video encoder implementation that lowers bandwidth and storage requirements by an average of 50% or more when compared to standard compression. At the same time, important details and motion are preserved at high video quality.

3.3 AXIS Companion / Edge storage

AXIS Companion is the market's easiest-to-use video management system for video surveillance small systems. With AXIS Companion, all video is recorded on SD cards in the cameras without needing a DVR or server-based recording platform, making each camera a smart, independent video recording device. The system consists of standard Axis cameras, SD cards, software clients for PC and smartphones, and standard network equipment.

This system has several operational and technical benefits, and the platform is also free to download and use. As AXIS Companion is a DVR or serverless solution, it removes the risk of a single point of failure. The software will need to be installed on a PC or laptop in order to commission the system. For the purposes of monitoring and viewing images, this can be achieved from an alternative device such as a smartphone or tablet.

Based on 10x Fixed IP cameras (24x7 operation at 30fps)	DVR solution	AXIS Companion
Annual power consumption	2926 kWh	394 kWh)
Annual power cost	€877,80 server power and camera power	€118,20 camera power with 1% increase to load

Power calculations based on €0.30 per kWh. This figure will vary depending on local tariffs, but assumed as an average. Server specificaton, power and support costs based on DVR with RAID5 storage.

As the table above shows, there is a compelling argument to use a serverless or hosted service, and AXIS Companion can save as much as 85% in annual power costs. It is worth noting that for the purposes of the exercise, both systems used the same cameras performing in the same operational environment.

3.4 Server-based recording solutions

Multiple high definition video streams are highly data-intensive, so your choice of server solution can significantly impact energy use. In recent years, server technology has evolved, allowing more powerful servers with higher-density onboard storage solutions. As High Definition becomes the de facto standard in professional security installations, AXIS TIP Partner Secure Logiq manufactures a range of hardware appliances specifically designed and optimized to efficiently store, transmit and display multiple streams of HD video data. By utilizing this specialist technology, as well as significant cost savings, there is a significantly reduced energy and environmental impact.

Requirements

Here we will look at three of the options available on the market today and compare the overall power consumption. We will look at a 600x camera system to define a comparison between server solutions. We will assume a constant recording bit rate of 2Mbps at 25IPS recording, stored for a duration of 31 days with a peak bit rate of 3Mbps to allow for processing calculations. All calculations are based on the following table.

Camera	Average bit rate (Mbps)	Peak bit rate (Mbps)	Days recording	RAW storage (TB)	Total bit rate (Peak) Mbps
600	2	3	31	401.76	1800

IT-centric storage solution

Due to their multipurpose design and generic, non-optimized nature, most IT-centric servers have a processing cap of 256 Mbps, which can often be a more limiting factor than the onboard storage, which typically spans up to 21TB in RAID5. Electricity costs have been calculated at 0,30€ per kWh, while cooling costs, and power are linear and are generally similar to the total server power requirements.

IT-centric								
Product	Quantity	Power (peak)	Power (Avg)	Total power (Avg)	BTU per hour	Cost (hour)	Cost (year)	5 year cost
Servers (20TB)	7	270	270	1,890	6,448.68			
Storage arrays (20TB)	14	200	200	2,800	9,553.60			
			Total power (W)	**4,690**		1,407	**€12,325.32**	
			Total Heat (BTU/h)		**16,002.28**	1,407	**€12,325.32**	
							€24,650.64	**€123,253.20**

Linear storage solution

Linear storage is still relatively new to the IP video surveillance market and requires integration into specific VMS platforms for optimum efficiency. A sequential storage method offers significant power savings compared to conventional server technology. Because the drives that are not being recorded on remain static, they use less power and become more energy efficient.

The disadvantage of this method is that the throughput is limited to a single disk's read/write speed, so for large camera counts, more machines have to be used to achieve the same result. Linear storage also relies on server technology to process the IP video, which must be accounted for when calculating power.

Linear array								
Product	**Quantity**	**Power (peak)**	**Power (Avg)**	**Total power (Avg)**	**BTU per hour**	**Cost (hour)**	**Cost (year)**	**5 year cost**
NVR unit	12	140	100	1,200	4,094.40			
Linear storage	12	100	65	780	2,661.36			
			Total power (W)	**1,980**		0.594	**€5,203.44**	
			Total Heat (BTU/h)		**6,755.76**	0.594	**€5,203.44**	
							€10,406.88	**€52,034.40**

Optimized server technology for IP surveillance

By utilizing best-in-class components, tested together and optimized for IP surveillance applications, AXIS TIP Partner Secure Logic has created a range of servers which can handle 4000Mbps throughput with 480TB useable data onboard a single 4U unit. Because they often run well under peak processing power and feature advanced RAID arrays to spread the load average, power use is usually significantly lower than the peak power requirements. Additionally, each 4U unit can replace multiple, which will also provide significant power savings. The units in the calculations below feature 750Mbps throughput (duplex) and 140TB useable onboard storage.

Secure Logiq								
Product	**Quantity**	**Power (peak)**	**Power (Avg)**	**Total power (Avg)**	**BTU per hour**	**Cost (hour)**	**Cost (year)**	**5 year cost**
Secure Logiq server	3	550	350	1,050	3,582.60			
			Total power (W)	**1,050**		0.315	**€2,759.40**	
			Total Heat (BTU/h)		**3,582.60**	0.315	**€2,759.40**	
							€5,518.808	**€27,594.00**

Selecting the right storage application clearly offers the most signification power and energy savings. But it should not be forgotten that all the different camera technologies and features impact the design and size of the server application, so should be designed together.

4. Other important considerations

4.1 Government initiatives

There are many government initiatives, incentives, and funding options that are designed to support businesses in reducing their carbon footprint and making energy savings. Some examples include:

> Energy efficiency grants and loans: Many governments offer grants and loans to help businesses invest in energy-efficient technologies and practices.
> Tax credits and deductions: Some governments offer tax credits or deductions for businesses that invest in energy-efficient equipment or make other efforts to reduce their carbon footprint.
> Renewable energy incentives: Governments may offer incentives for businesses that generate their own renewable energy, such as through solar panels or wind turbines.
> Carbon pricing: Some governments have implemented carbon pricing systems, such as a carbon tax or cap-and-trade program, which create a financial incentive for businesses to reduce their greenhouse gas emissions.
> Energy benchmarking and disclosure: Some governments require businesses to disclose their energy use and/or participate in energy benchmarking programs, which can help identify opportunities for energy savings.
> Technical assistance: Many governments offer technical assistance to help businesses identify and implement energy-saving measures.
> Public procurement: Governments may prioritize procuring goods and services from companies that have demonstrated a commitment to sustainability and reducing their carbon footprint.

This is just a sampling of the types of initiatives that may be available. It's worth checking with your local government or relevant regulatory agency to see what specific programs or incentives are available in your area.

5. Conclusion

As presented through the data provided in this document, the advancements in new IP surveillance technologies can provide cost savings directly related to reducing energy consumption. Not only does this show the benefits of upgrading from an existing analogue or older IP video surveillance system, but it also shows the importance of selecting the right camera technology and storage vendor. Not all technologies are designed the same. We encourage our partners and end users to evaluate all areas of the video surveillance system, especially when carrying out a total cost of ownership comparison.

Selecting the right technology will play its part in minimizing the escalating and unpredictable costs associated with increasing energy bills. At the same time, upgrading old systems and working with vendors that consider their technology's impact on the environment will support businesses in meeting their own carbon reduction initiatives.

5.1 Comments and clarifications

The purpose of this whitepaper has been to build awareness around the impact of energy costs associated with video surveillance systems and the broader sustainability benefits that can be achieved. However, as a priority, Axis recommendations will always focus on the design and specification of security systems to meet operational needs. Once this is achieved, we can then look at the broader business impact, such as energy savings.

It is also worth noting that the test criteria for each of the applications may differ depending on the environmental conditions of each site. It is always recommended that each surveillance system is designed specifically for the application for which it is intended. All technologies and features have been developed to improve systems capabilities, but they may not be suitable for each individual application.

About Axis Communications

Axis enables a smarter and safer world by creating solutions for improving security and business performance. As a network technology company and industry leader, Axis offers solutions in video surveillance, access control, intercom, and audio systems. They are enhanced by intelligent analytics applications and supported by high-quality training.

Axis has around 4,000 dedicated employees in over 50 countries and collaborates with technology and system integration partners worldwide to deliver customer solutions. Axis was founded in 1984, and the headquarters are in Lund, Sweden.