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MEDIA AND ENTERTAINMENT SUSTAINABILITY ON THE CLOUD

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ABSTRACT

Media and Entertainment (M&E) companies are committing to become more sustainable for their employees, customers, and communities. At the same time, M&E companies are also seeking to enhance and re-invent their businesses using cloud computing (the on-demand delivery of compute power, database, storage, applications, and other IT resources via the Internet with pay-as-you-go pricing). Fortunately, the goals of improving sustainability and cloud adoption can be synergistic, as enhanced business efficiency via cloud can also drive sustainability in terms of lower carbon emissions and better water stewardship. Cloud providers, through scale and focus on innovation, can achieve higher resource utilization and greater energy efficiency than is possible for typical on-premises or collocated data centers. This paper will examine why M&E companies are seeking sustainability, basic sustainability terminology, M&E sustainability organizations, published sustainability goals of M&E companies, and how M&E companies have actually enhanced their sustainability on the cloud.

INTRODUCTION

Businesses and organizations can have negative environmental impacts such as direct or indirect carbon emissions, unrecyclable waste, and damage to shared resources like clean water. The need for sustainability in these areas touches everyone, and multiple sectors of society have expressed interest in sustainability. Many are now using sustainability as a measure for what companies they will work with, invest in, and buy from. Responding to demands from customers, employees, impact investment guidelines, and government regulations, companies are increasingly taking sustainability seriously. Media & Entertainment (M&E) companies are now making pledges, developing plans and strategies for sustainability, and are acting on these plans to achieve measurable sustainability goals.

At the same time, M&E companies are also seeking to enhance and re-invent their businesses using cloud computing, defined as the on-demand delivery of compute power, database, storage, applications, and other IT resources via the Internet with pay-as-you-go pricing. Fortunately, the goals of improving sustainability and cloud adoption can be synergistic, as enhanced business efficiency via cloud can also drive sustainability.

M&E SUSTAINABILITY GOALS AND ORGANIZATIONS

Examples of Sustainability Goals

As organizations plan their sustainability strategies, they can identify specific milestone

goals to motivate and guide solutions. These include:

- "100% Zero Carbon Energy", when all energy purchases are obtained from zero net greenhouse has (GHG) emissions sources (such as solar, wind, geothermal, biomass, hydroelectric, and nuclear).

- "100% Renewable Energy", when all energy purchases are from a naturally replenishing resource that produces zero net GHG emissions (nuclear and large hydroelectric sources are generally not considered "renewable"),

- "Carbon Neutral", when a company is in balance between emitting carbon and absorbing carbon emissions. Achieving this may include purchase of offsetting carbon credits.

- "Net Zero Carbon", is carbon neutrality when all technologically possible emissions have been eliminated.

Table 1 lists examples of M&E companies have publicly announced sustainability goals.

M&E Company	**Zero Carbon & Renewable Energy**	**Carbon Neutral & Net Zero Carbon**
Amazon [1]	"powering our operations with 100% renewable energy by **2025**"	"net-zero carbon emissions across our operations by **2040**"
BBC [2]		"Net Zero by **2030**"
BT Group PLC [3]	"networks and buildings are all [**currently**] powered by renewable electricity"	"become a net zero business by the end of **March 2031**"
Comcast [4]		"carbon neutral by **2035"**
Disney [5]	"100% zero carbon electricity by **2030**"	"Net zero emissions for direct operations by **2030**"
ITV [6]	"Power business with 100% renewable energy by **2025**"	"Net Zero Carbon Emissions by **2030**"
Netflix [7]		"By the close of **2022**, Netflix will achieve net zero greenhouse gas emissions."
Sony [8]	"100% renewable energy in its own operations…by…**2030**"	"carbon neutrality throughout the entire value chain…by…**2040**"

TABLE 1: Examples of M&E Company Public Sustainability Goals

For example, in 2019, Amazon (the parent company of Prime Video and Amazon Web Services) co-founded The Climate Pledge, a commitment to be net-zero carbon across the business by 2040. Over 400 businesses have now committed to The Climate Pledge, including M&E companies ITV, STV Group PLC, and BT Group PLC (the parent company of BT Consumer & BT Sport) [9]. Amazon has also launched The Climate Pledge Fund [10] to support the development of sustainable and decarbonizing technologies and services with an initial $2 billion in funding, and the Right Now Climate Fund [11], a $100 million fund to restore and conserve forests, wetlands, and grasslands around the world.

M&E Sustainability Organizations

Several organizations provide support, guidance, and certification for M&E sustainability:

- **ALBERT** is an environmental organization to encourage the TV and film production industry to reduce waste and its carbon footprint. Additionally, Albert offers guidance on how to promote and discuss environmental issues in editorial content [12].
- The **Digital Production Partnership (DPP)** has established the "DPP Committed to Sustainability" program, which provides a practical tool to assess an organization's progress against key environmental measures, and a common framework for procurement teams to assess the environmental impact of their suppliers [13].
- **DIMPACT** is a collaborative initiative between leading media, entertainment and technology companies and world-class researchers. DIMPACT's web application can estimate carbon emissions associated with video streaming, online banner advertising, digital publishing, and audio streaming [14].
- **Entertainment and Culture for Climate Action (ECCA)** is a global collaborative initiative to unite the cultural sector on shared climate goals and solutions. ECCA has brought together stakeholders in the film and television sector and will be gradually expanding to include all entertainment and culture including theater, music, performing arts and visual arts. ECCA is supported by the UN Framework Convention on Climate Change (UNFCCC) secretariat and the UN Education, Science and Culture Organization (UNESCO) [15].
- The **Environmental Media Association (EMA)** is a diverse subsection of entertainment industry influencers, entrepreneurs in business, and green icons dedicated to the mission of promoting environmental progress. The EMA Green Seal is a recognition program honoring progress in sustainable production for movies, television shows, and filmed commercials [16].
- **Greening of Streaming** is an organization created to address growing concerns about the energy impact of the Internet streaming sector. It provides a forum for the streaming industry to develop better engineering and to foster collaboration through the supply chain to provide a great experience for the consumer without wasting energy [17].
- The **Sustainable Production Alliance (SPA)** is a consortium of the world's leading film, television and streaming companies dedicated to accelerating the transformation of the entertainment business into a more sustainable industry. In partnership with the Producers Guild of America Foundation's PGA Green Committee, SPA established the Green Production Guide to provide tools and resources to help implement sustainable plans for production and reduce the industry's overall environmental impact [18].

CLOUD SUSTAINABILITY

Sustainability Shared Responsibility Model

A sustainability shared responsibility model is a framework that outlines the sustainability responsibilities of cloud service providers (CSPs) and customers. Defining the division of labor between a CSP and its customers can help all parties concentrate on the areas where they can bring value to improving sustainability. For example, Figure 1 diagrams the Amazon Web Services (AWS) sustainability shared responsibility model, which can be described as:

- AWS is responsible for optimizing the sustainability of the cloud – delivering efficient, shared infrastructure, water stewardship, and sourcing renewable power.
- Customers are responsible for sustainability in the cloud – optimizing workloads and resource utilization, and minimizing the total resources required to be deployed for workloads.

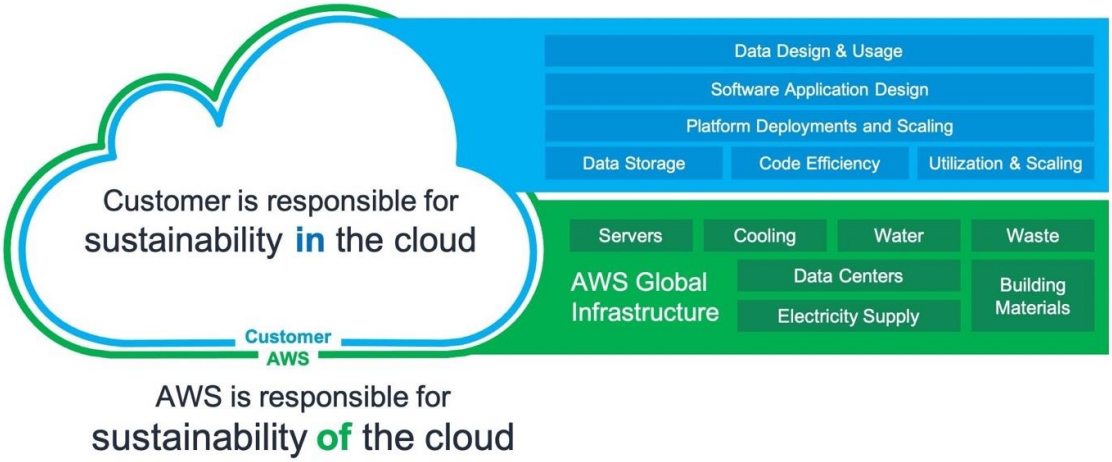

FIGURE 1: AWS Shared Responsibility Model of Cloud Sustainability

Sustainability of the cloud

Energy Efficiency

Cloud providers have a lower carbon footprint and are more energy efficient than typical on-premises alternatives because of scalable investments in efficient power and cooling technology, more energy efficient server populations, and higher server utilization rates. Cloud workloads reduce impact by taking advantage of shared resources, such as networking, power, cooling, and physical facilities.

For example, the results of a study by 451 Research show that AWS infrastructure is 3.6 times more energy efficient than the median of surveyed enterprise data centers in the U.S. [19] and up to five times more energy efficient than typical EU enterprise infrastructure [20]. More than two-thirds of this advantage is attributable to the combination of a more energy efficient server population and much higher server utilization. Average enterprise server utilization rate is only about 18%, leaving a significant amount of capacity completely unused. When carbon intensity of consumed electricity and renewable energy purchases are factored in, AWS executes the same workloads as enterprise data centers with an 88% lower carbon footprint.

Cloud providers also gain efficiency via innovative technologies. For instance, AWS has improved power efficiency and availability by removing the central Uninterruptible Power Supply (UPS) from its data center design, and instead integrates small battery packs and custom power supplies into racks. These changes combined reduce energy conversion loss by about 35%.

Renewable Energy

Amazon is the largest corporate buyer of renewable energy (20 GW), including over 400 wind farms, solar farms, and rooftop solar installations at company buildings in 22 countries [21]. Amazon has reached 85% renewable energy across the business in 2021, and is on

a path to powering operations with 100% renewable energy by 2025 [22]. In 2021, 13 AWS Regions were powered with over 95% renewable energy, as shown in Figure 2 [23].

Figure 2: AWS Regions Powered by Over 95% Renewable Energy in 2021

Water Stewardship

Water is an important element of data center cooling, and the proper stewardship of water is important for cloud water sustainability. For example, AWS has committed to being "water positive" by 2030, meaning returning more water to communities than it uses in its direct operations [24]. Water positivity is driven by four areas of effort: water efficiency, sustainable sources, community water reuse, and water replenishment.

Water efficiency: AWS is constantly innovating across its infrastructure to reduce water consumption. Its 2021 global water use efficiency (WUE) metric was 0.25 liters of water per kilowatt-hour. This was achieved by using advanced cloud services, such as Internet of Things (IoT) technologies, to analyze real-time water use and identify and fix leaks. AWS further improves operational efficiency by eliminating cooling water use in many of its facilities for most of the year, instead relying on outside air. For example, in Ireland and Sweden, AWS uses no water to cool its data centers for 95% of the year. AWS also invests in on-site water-treatment systems that allow it to reuse water multiple times, minimizing water consumed for cooling.

Sustainable sources: AWS uses sustainable water sources, such as recycled water and rainwater harvesting, wherever possible. Using recycled water, which is only suitable for a limited set of applications such as irrigation and industrial use, preserves valuable drinking water for communities. In Northern Virginia, AWS worked with Loudoun Water to become the first data center operator in the state approved to use recycled water in direct evaporative cooling systems. AWS already uses recycled water for cooling in 20 data centers around the world and has plans to expand recycled water use in more facilities as it works toward becoming water positive.

Community water reuse: After maximizing the use of water in its data centers, the spent liquid is still safe for many other uses. In Oregon, AWS provides up to 96% of the cooling water from its data centers to local farmers at no charge for use in irrigating crops like corn, soybeans, and wheat.

Water replenishment: To meet its water positive commitment, AWS is investing in water replenishment projects in the communities where it operates. Replenishment projects expand water access, availability, and quality by restoring watersheds and bringing clean water, sanitation, and hygiene services to water-stressed communities. To date, AWS has

completed replenishment projects in Brazil, India, Indonesia, and South Africa, providing 1.6 billion liters of freshwater each year to people in those communities. AWS also has several new projects, which, once completed, will provide more than 823 million liters of water to communities each year, including in India, UK, and the US.

Embodied Carbon

Embodied carbon is the emissions associated with materials and construction processes throughout the whole lifecycle of a building or infrastructure. Steel is one of the largest contributors of embodied carbon in the structure of data centers. AWS is working to lower these emissions by working with mills using electric arc furnace production processes. AWS suppliers are using up to 100% recycled content and are powered by electricity only, reducing embodied carbon up to 70%. AWS delivered six projects constructed with recycled steel in 2021, and will expand this to all future U.S. and European data centers moving forward. Concrete also contributes a large share of embodied carbon in data center construction due to emissions from calcination during production. AWS design standards now require concrete with a 20% reduction in embodied carbon versus standard concrete for new U.S. data centers, and this requirement will be expanded globally [25].

Sustainability in the cloud

Sustainability in the cloud is a continuous effort focused on energy reduction and efficiency across all components of a workload by achieving the maximum benefit from the resources provisioned and minimizing the total resources required. This effort can range from the initial selection of an efficient programming language, adoption of modern algorithms, use of efficient data storage techniques, deploying to correctly sized and efficient compute infrastructure, and minimizing requirements for high-powered end-user hardware.

Sustainability Pillar of the AWS Well-Architected Framework

The AWS Well-Architected Framework helps cloud architects understand the advantages and disadvantages of decisions made while building workloads on AWS. The Framework provides a way to consistently measure cloud architectures against best practices and to identify areas for improvement. The Framework is based on six pillars: operational excellence, security, reliability, performance efficiency, cost optimization, and in December, 2021, the sustainability pillar was added [26].

The sustainability pillar provides design principles, operational guidance, best-practices, potential trade-offs, and improvement plans to meet sustainability targets for cloud workloads. Design principles for architecting cloud workloads to maximize sustainability and minimize impact include:

- **Understand your impact:** Measure the impact of your cloud workload and model the future impact of your workload. Include all sources of impact, including impacts resulting from customer use of your products, and impacts resulting from their eventual decommissioning and retirement. Compare the productive output with the total impact of your cloud workloads by reviewing the resources and emissions required per unit of work. Use this data to establish key performance indicators (KPIs), evaluate ways to improve productivity while reducing impact, and estimate the impact of proposed changes over time. In particular, the AWS Customer Carbon Footprint Tool [27] provides customers with an overview of the carbon emissions associated with their usage of cloud services, an estimation of the emissions reduction resulting from use of cloud vs. an on-premises equivalent, and a forecast of emissions reductions as AWS progresses towards powering operations with 100% renewable energy.

- **Establish sustainability goals:** For each cloud workload, establish long-term sustainability goals such as reducing the compute and storage resources required per transaction. Model the return on investment of sustainability improvements for existing workloads, and give owners the resources they need to invest in sustainability goals. Plan for growth, and architect workloads so that growth results in reduced impact intensity measured against an appropriate unit, such as per user or per transaction. Goals help to support the wider sustainability goals of your business or organization, identify regressions, and prioritize areas of potential improvement.

- **Maximize utilization:** Right-size workloads and implement efficient design to ensure high utilization and maximize the energy efficiency of the underlying hardware. Two hosts running at 30% utilization are less efficient than one host running at 60% due to baseline power consumption per host. At the same time, eliminate or minimize idle resources, processing, and storage to reduce the total energy required to power your workload.

- **Maximize utilization:** Anticipate and adopt new, more efficient hardware and software offerings: Support the upstream improvements your partners and suppliers make to help you reduce the impact of your cloud workloads. Continually monitor and evaluate new, more efficient hardware and software offerings. Design for flexibility to allow for the rapid adoption of new efficient technologies. For example, AWS Arm64-based Graviton3 processors use up to 60% less energy for the same performance than non-Graviton Amazon Elastic Compute Cloud (EC2) instances [28].

- **Use managed services:** Sharing services across a broad customer base helps maximize resource utilization, which reduces the amount of infrastructure needed to support cloud workloads. For example, customers can share the impact of common data center components like power and networking by migrating workloads to the cloud and adopting managed services, such as AWS Fargate for serverless containers, or AWS Lambda serverless compute. Use managed services that can help minimize your impact, such as automatically moving infrequently accessed data to cold storage with Amazon S3 Lifecycle configurations or use Amazon EC2 Auto Scaling to adjust capacity to meet demand.

- **Reduce the downstream impact of your cloud workloads:** Reduce the amount of energy or resources required to use your services. Reduce or eliminate the need for customers to upgrade their devices to use your services. Test using mechanisms such as AWS Device Farm to understand expected impact and test with customers to understand the actual impact from using your services.

SUSTAINABILITY IN SPECIFIC M&E APPLICATIONS

Live Cloud Production

One particular application where cloud can enhance sustainability is in live production. Traditionally, outside broadcast (OB) trucks heavily laden with production gear are driven to sports and entertainment venues. Production staff are typically flown in for a day or two for the event. According to the ALBERT Annual Review of 2021, “Travel remains the biggest part of a production’s carbon footprint, regardless of genre…the data shows us that road and air travel are the most prevalent transport types used by production.” [29] Live cloud production minimizes the needed on-site production staff to those only needed for camera and mic set-up and their operators. Live feeds from all cameras and mics are sent to the cloud, where software-based systems are used to produce the event. Directors, engineers, and operators of switchers, graphics, edit, and replay systems can produce the event from any location with adequate Internet connectivity. This reduces the need to transport those systems as hardware in trucks, and reduces the need to fly staff to the venue city.

Remote film and television production will commonly chose to utilize portable generators to reliably provide the large amounts of electricity needed. According to Albert, “Most [film and TV] productions will hire a minimum of two high power diesel generators, which each consume an average of 80 litres of diesel per 12 hour period of use, emitting half a tonne of CO2 emissions.” [30]. In the 2006 “Sustainability Report in the Motion Picture Industry” from UCLA, diesel fuel is described as “commonly used, despite their environmental drawbacks and the immediate noise and smell; a key advantage of generators powered by diesel rather than natural gas is the fact that they can be refueled while running” [31].

As media production hardware becomes virtualized into software, more workloads migrate from diesel-powered on-premises workloads to renewable-powered workloads in the cloud. Digital-first marketing, advertising, and technology services company Media.Monks developed a cloud-based broadcasting workflow for remote live event production that “virtualizes racks of hardware that would have been transported on production trucks and keeps air travel to a minimum…Instead of flying in a 20-person crew from around the world to an event venue with haul gear, we can send a lean team on-site with a portable flypack; we turn on the servers, connect, and we’re working with virtually no limitations to innovation” [32]. Figure 3 compares the cloud-based workflow compared to a traditional OB workflow. Media.Monks leverages Amazon EC2 instances as virtual desktops to mix the video, audio, and graphics for their virtual reality broadcast [33]. This workflow allows Media.Monks to reduce the number of production staff required to travel to site, and is helping them to achieve their commitment to achieve carbon neutrality by 2024.

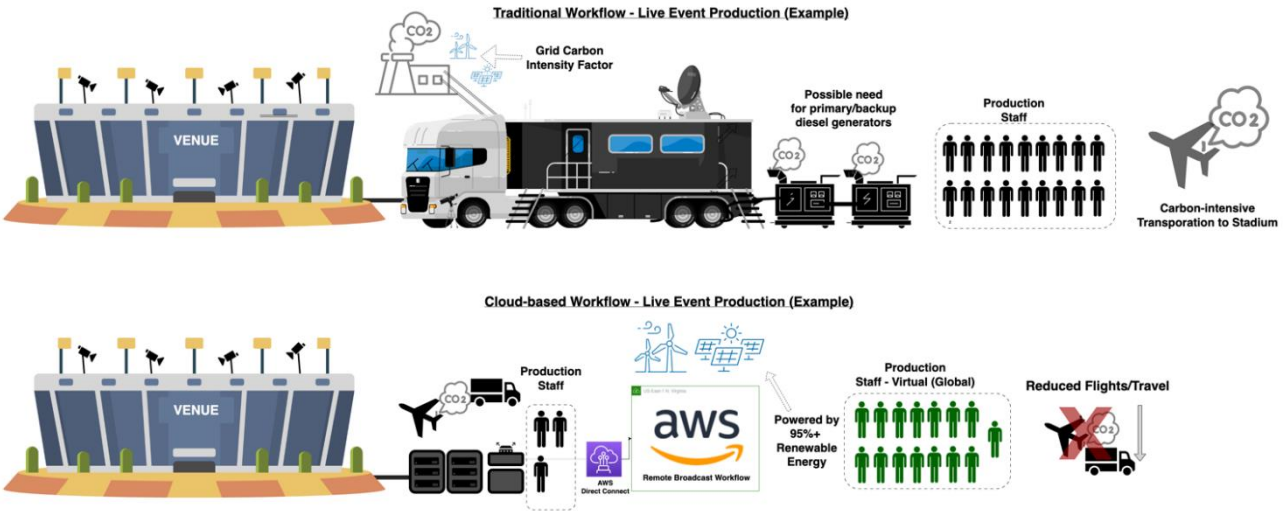

FIGURE 3: Media.Monks Cloud-Based Workflow Compared to Traditional OB Workflow

As part of IBC’s Accelerator Media Innovation Programme in 2021 [34], a team of sports broadcasters, rights-owners and technology vendors carried out a workflow trial to produce an English Premier League game on the cloud to support the goal of a net zero carbon future for live productions. The trial included cloud-based video switching, graphics, replay, standards conversion, and editing of a closer for the end of the show.

The project team consisted of BBC Sport, BT Sport, Sky Sports and international rights-holders NBCUniversal and SuperSport, working together with the English Premier League, IMG/Premier League Productions and ALBERT. Technology was provided by Amazon Web Services, Blackbird, Hitomi, Microsoft, M2A Media, Singular.live and Zixi.

The Accelerator project highlighted potential fuel reduction that remote/cloud workflows allow. During the trial, the team found that the amount of fuel required on-site was reduced

by over 50%. It was learned that the on-site infrastructure could be significantly reduced, which would allow in the future for smaller trucks with less power draw and less carbon impact from resulting from transportation of the equipment. Cloud production reduced the technical infrastructure required for the gallery production. For some broadcasters, this was by up to 70%. Cloud production further reduced the requirements for significant on-site technical facilities by allowing signals to be sent quickly and easily to multiple locations.

In addition to sports, live news events can also be remotely produced. For the 26th Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) in Glasgow, also known as COP26, Sky News set up a dedicated news channel produced from London entirely in the cloud [35]. Sky estimated that it reduced its emission footprint by 90%, generating 10kgs of CO2e per 9 hours of programming versus what would have been 119kg by traditional means. By transporting fewer production staff and using cloud-based production tools, staff can be more efficiently utilized (with less down time from travel) while improving work-life balance. Lead-time on production equipment is removed if it is virtualized using software on the cloud. Productions can be rapidly scaled up or down as needed. Producers can gain easier access to a diverse global talent pool, and engineering teams can more freely choose to host workloads in regions adjacent to clean energy sources. And training becomes less burdensome as staff can be trained at home with immediate access to all necessary production systems on-demand, instead of waiting for a production to be over before being able to access a physical switcher, mixer, replay device, etc.

Cloud Based Media Supply Chain

The content storage, processing, and distribution operations of digital media files and their associated metadata is known as “media supply chain”. This is one of the most mature M&E workloads in the cloud. SDVI Rally is an example of a media supply chain platform that enables media companies to optimize the infrastructure deployment and resource utilization associated with running dynamic, responsive media supply chains in the cloud. Since it ensures that cloud infrastructure is always properly sized for the workload requirements, Rally-managed supply chains consume only the resources needed and eliminate the waste associated with underutilized infrastructure. Rally resource management has also been designed so that the platform itself makes utilization more efficient: in 2021, Rally and the supply chains it manages consumed 39% less compute resources per content hour than the previous year of operation. This equates to SDVI’s customers using 12,940 fewer dual-quadcore CPU servers running in customer data centers [36]. Furthermore, the company launched its Net-Zero Supply Chains initiative in January 2022, which offsets all GHG emissions associated with the Rally platform, including emissions from operating all third-party application services under Rally management. These offsets take the form of Gold Standard Verified Emission Reductions (VERs) [37].

Cloud-based digital asset management (DAM) tools can allow a globally distributed workforce to share metadata and content over the Internet without requiring emissions from personnel travel or media courier services. Content can be shared directly between production and distribution partner companies using cloud storage “in place” without the need for an explicit Internet transfer. For example, Imagen, a media management platform vendor, works with cloud providers that are committed to renewable energy and elect to use resources in regions which are already running 100% renewable energy [38]. With this approach, despite a 4x growth in the use of cloud services in the past 5 years, Imagen’s CO2 consumption is declining, and remaining emissions are offset with carbon credits.

In another example, UKTV, a subsidiary of the BBC, migrated their media asset library to the cloud, which contributed toward their broader sustainability goals to be Net Zero by 2030. This migration used an event driven solution, so that the vast majority of cloud compute resources were consumed only during active tasks. When the tasks have been completed, the asset management solution only required a minimal amount of constant compute resources when idle, reducing compute waste and excess carbon attributable to this workload [39].

Edit in the Cloud

To assess carbon emissions from video editing, environmental consultancy Green Element compared the impact of three different workflows: “on-premises”, “cloud based” and “cloud native” [40]. The “on-premises” edit workflow required all edit staff to travel to the event, and to use typical editing software there. The “cloud based” workflow was a lift-and-shift migration of typical editing software to cloud virtual instances accessed using remote desktop, and requiring upload, download, and storage of full 50 Mbit/s high resolution files. The “cloud native” workflow (using Blackbird software) transcoded video from live camera feeds or files on-premises into a 2 Mbit/s lightweight proxy version that goes directly into the cloud in real time, and can then be frame accurately edited in a web browser. The workflows were modeled using a two-week event with 4,000 hours of TV and 50 editors. If on-premises, the editors would need to fly 2,000km on economy class plane travel to the event.

The on-premises model emitted 174t of CO2e (with 15t due to personnel travel), the cloud-based model emitted 96t, and the cloud native model emitted 15t. Just moving editing to the cloud showed a 44% reduction in emissions, but going further and optimizing use on the cloud showed a 91% reduction.

CONCLUSION

M&E companies today are simultaneously planning for sustainability as well as migrating workloads to and re-inventing their businesses on the cloud. Fortunately, these two business strategies can work together. The scale and focus on innovation of cloud providers can achieve higher resource utilization and energy efficiency than on-premises computing. The more flexible use of cloud services only when needed by the business reduces wasted energy use. Virtualizing operations in the cloud accessed over the Internet makes operations easier and location-independent, while also reducing the need for transportation-related GHG emissions. Sustainability and cloud enablement work together well for M&E companies.

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