a screen new deal

a route map to sustainable film production

ALBERT THE NATIONAL LOTTERY® BFI ARUP

This report has been produced as a collaboration between albert, the BFI and Arup between November 2019 and July 2020. The project was funded by the BFI Research and Statistics Fund, which is supported by National Lottery funding, and Arup.

A series of stakeholder engagement activities and production data analysis identified relevant opportunities for the film production industry to operate more sustainably. These opportunities have then been distilled into a vision and set of recommendations to support the industry in taking steps towards a more sustainable future.

We would like to thank all contributors for their insight and advice.

To find more insights around sustainable film production, visit inspire.driversofchange.com

For more information, please email foresight@arup.com

contents

ALBERT   THE NATIONAL LOTTERY®   BFI   ARUP

forewords

Aaron Matthews
Head of Industry Sustainability, albert

In 2019 the Climate Change Act was amended to legislate for net zero emissions in the UK by 2050. It means that every sector, including the Film Industry will be required to make significant changes to meet this statutory target.

At albert we have long understood the significant contribution that studio and location filming has on the environmental impact of the film and television industry. This study shines a light on the systemic changes required to alter that trajectory. The innovation needed will be made possible if the industry can unite in collaboration and openness with a shared vision for the future.

As we emerge from a worldwide lockdown and try to restart our industry, the idea of introducing complex changes might feel overwhelming, but this is exactly the right time to rethink our processes. By engaging with the challenge now, we can take advantage of the long amortisation and lead times involved in infrastructure change. But the most exciting opportunity is for the film community to lead by example with a positive, impactful transformation that breeds innovation and hope for the future.

The film industry inspires, influences, motivates and entertains millions of people worldwide, but there's an environmental cost to this; every feature film we make produces thousands of tonnes of carbon. It's an impact we can no longer ignore, we have to act now. We need to build an industry that works more efficiently, creatively and collaboratively. We need to take that positive, transformational story that we so easily create in fiction and make it our reality. Will you join us? ▫

Tim Snelson
Associate Director, Arup

Many people don't think twice about the environmental impact of what we consume on our televisions, mobile devices or cinema screens. The connection between what we watch and the enormous effort that goes into its creation is too complex and well-hidden for most audiences to realise. This must change urgently, and Arup is proud to support albert, The National Lottery and BFI in their ongoing efforts to do so.

Our study highlights the complexity, urgency and importance of more sustainable and resource-efficient approaches to film production. When we think about the future of studios and film production we face a dilemma. What trends and innovations really matter to us? And how can we achieve change across an industry that is complex and highly-dependent on a set of trusted routines and practices? We argue this complexity is an opportunity, a chance to look at radical new ideas and to learn from innovation in other industries. Solving the sustainability challenge will be a competitive advantage that the UK production industry should pursue collectively and with a clear vision.

Innovation today is not just about making individual things faster and better. Climate change, globalisation, digital transformation, and environmental degradation are all systemic challenges. It is also the transformation of man-made systems where the answers to these challenges lie. Studios and film production are one of these complex systems, where the potential for change is huge. Yet to transform it will require all of us to work together as one. From the people providing the energy that runs sets, to those consuming content all over the world. Let's try and transform together. ▫

Harriet Finney
Director of External Affairs, BFI

This study arrives at what is an unparalleled moment for film and television production around the world. It was commissioned prior to the COVID-19 pandemic and the impact that is having on our industry and our lives, and is being published as we start to develop new ways of working on set and on location, at every step of production. We are grappling with an undeniable period of change in our industry but the impacts of climate emergency are right before all of us.

Our evidence review *Green matters - Environmental sustainability and film production: an overview of current practice* provided a snapshot of UK film production activity and the kinds of levers that could help change behaviour in production – if you haven't looked at this yet, may I encourage you to do so. *A screen new deal: a route map to sustainable film production*, produced by built environment specialists Arup, takes that work further, providing a blueprint for the film ecosystem, mapping out design and operational recommendations, providing information about the new services, materials and knowledge required to achieve more sustainable production. Case studies reveal bold ideas, showing how change is happening.

Sharing innovation and knowledge to kick-start a more sustainable ecosystem is vital for all of our futures. ▫

executive summary

The film production industry requires systemic change to become sustainable. This report sets out a route map to achieve this goal.

Data analysis shows that one average tentpole film production – a film with a budget of over US$70m – generates 2,840 tonnes of CO_2e, the equivalent amount absorbed by 3,709 acres of forest in a year. Within this, transport accounts for approximately 51% of carbon emissions, mains electricity and gas use accounts for around 34%, and diesel generators for the remaining 15%. Unnecessary material waste is also produced at every scale of production, from studio buildings to props. Climate science outlines that we need not just to reduce our negative impact, but exchange it for positive impact. While hard to imagine, this bold reality exposes the profound change required.

Taking a holistic look across the industry, this research highlights five key areas of opportunity for transformation, with three corresponding interventions:

▷ **production materials:** reuse of materials, buying virgin materials responsibly and resource-efficient set construction

▷ **energy and water:** energy demand reduction, sustainable energy sources and water demand reduction

▷ **studio buildings and facilities:** repurposing buildings, buying products as a service and smart building management

▷ **studio sites and locations:** consolidated movement, wayfinding and communication, and health and wellbeing services

▷ **production planning:** collaboration tools, virtual planning and shared infrastructure

The report examines each opportunity area in turn, setting out its current status before exploring the suggested interventions, their potential benefits, and the critical requirements for their implementation. If realised as an integrated system, these interventions could result in a significant step change for the industry, both in reducing negative impacts and having a positive influence on people and the environment.

It should be noted that there are certain recommendations in this report that cannot be ignored should any meaningful progress on environmental sustainability be desired. These include material reuse networks, ending reliance on electricity created by fossil fuels and a new approach to transport systems.

No single filming stakeholder is capable or responsible for bringing about such changes in isolation, so radical co-operation and co-ordination must be considered the most vital recommendations of all. Changes need to be made across the whole ecosystem. These range from everyday practices and choices that are relatively simple to adopt, to structural industry-wide shifts. Actionable recommendations are provided for each set of stakeholders in order to facilitate prioritisation and decision-making.

The report concludes with 'the screen new deal' – six principles on which a sustainable future depends, starting with the need to measure the industry's true environmental impact. Digital collaboration and planning for reuse will also be fundamental, along with the right infrastructure at studio sites to support sustainable production. Ultimately none of this will be achieved without leadership or a shared sense of responsibility. Implementing these changes should not be seen as a duty but as chance to improve production delivery, gain financial efficiencies, and increase the viability and desirability of sustainable filming destinations.

"This transition is neither a story of sacrifice nor of duty. This is simply about building an industry that works more efficiently, creatively and collaboratively"

albert production handbook

methodology

This report is informed by a research approach that combines depth and breadth of insight by integrating industry-focused qualitative and quantitative data with global trends and best practices.

More than 50 interviews were conducted with a diverse range of stakeholders from studios, productions, industry bodies, service providers, and buildings and infrastructure designers from across the UK and the USA. Specific roles included set designers, costume designers, location managers, line producers, studio managers, lighting specialists, energy experts and sustainability consultants. Five film studio sites were visited across England, Wales and California. One unit base and the corresponding film location was also visited in England. The interviews and visits helped understand the shape of the film industry, the way it operates, and the drivers behind current practices and behaviours. In parallel, a review of 44 papers including industry reports and academic research allowed the project team to identify emerging trends and ascertain the landscape of existing sustainability initiatives, their impact, and key challenges and opportunities.

The analysis of data contained in sustainability reports from 19 productions filmed in both the UK and the USA in the last five years provided evidence of resource consumption patterns and associated carbon emissions. Tentpole productions (with a budget of US$70m or over) were chosen as a subject of analysis, as productions with large budgets are also those that have the largest carbon footprint. The analysis was also instrumental to evaluate consistency and accuracy of sustainability reporting from film productions.

The stakeholder and data insights highlighted the key sustainability challenges the industry is facing and informed a list of 15 opportunity areas across the following five themes: production materials, energy and water, studio buildings and facilities, studio sites and locations, and production planning. The interviewees and other key stakeholders from industry were invited to a workshop at Arup's offices to review and prioritise these opportunities. The session identified barriers and enablers to the adoption of selected opportunities and evaluated the scale of their impact if implemented.

Following this, further interviews were held with global experts in building design and energy solutions as well as representatives from the industry including a production accountant and an actor. The aim of these interviews was to test the prioritised opportunities and identify critical changes that would need to be made by the industry to make them work in practice.

All of these components informed the project team's understanding of the film industry and helped to identify where the greatest opportunities for systemic change lie. This underpins an aspirational, yet actionable, vision for sustainable film production. □
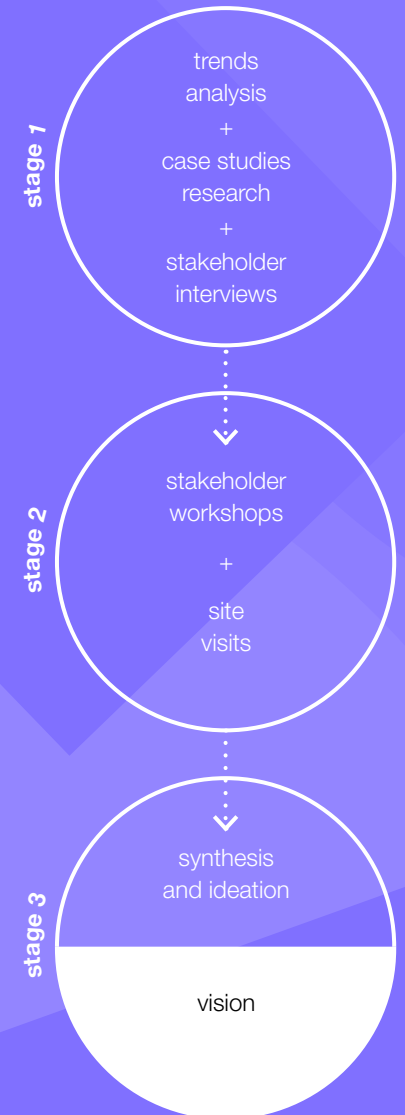
44
papers reviewed

19
data sets

15
technical experts

50
industry interviews

37
workshop attendees

06
site visits

stage 1
trends
analysis
+
case studies
research
+
stakeholder
interviews

stage 2
stakeholder
workshops
+
site
visits

stage 3
synthesis
and ideation

vision

introduction

setting the scene

The climate emergency is advancing at a relentless pace and surpassing all predictions. Our planet has become indisputably hotter in the past 35 years[1], with 2019 one of the warmest years on record.[2] Evidence from the past two decades links the exacerbation of climate change to human activity,[3] and particularly to emissions of carbon dioxide and other greenhouse gases, which have risen exponentially since the 1950s.[4]

For its size, the film production industry produces significant emissions. A 2006 study from UCLA shows that, relative to its economic activity in Los Angeles, film production makes a larger contribution to greenhouse gas emissions than the manufacturing, clothing or hotel industries.[5] The lack of availability of more recent comparative studies also indicates how little attention this issue receives across the industry and society in general.

Within the industry, the perception of sustainability focuses on issues that seem within reach and resonate with public interest. For example, a lot of effort is put in to curbing plastic water bottle use. Yet there is little awareness of the overall impact of the industry and what the key contributing factors are.

This research shows that transport has the largest impact in terms of carbon emissions, accounting for just over 50% of total emissions for tentpole productions. Of this, 70% is associated with land transport, and 30% with air travel. Behind these figures is a tendency for those who work in the industry to prioritise preparedness for unpredictable circumstances in the tight schedules that are typical of film production, as illustrated in this quote from a Danish director: "It was so nice to have all the lenses in a truck outside, so that when I needed a lens I could just ask for it, rather than the night before having to make plans and check that the specific lens was ordered and delivered."[6]

Energy in the form of mains electricity and gas consumption is the second largest contributor to carbon emissions, accounting for approximately 34% of total emissions. Of this, 30% is due to production activities and 4% to temporary accommodation in hotels and rented apartments. The wide use of diesel generators accounts for 15% of total carbon emissions. The convenience and flexibility of diesel generators have caused their unquestioned popularity in the industry. While the environmental impact of using fossil fuels is recognised, there is still a reluctance to adopt innovative battery-based solutions that are already available in the market. While battery generators require more planning, they could facilitate the transition towards a more substantial use of local renewables. ▷
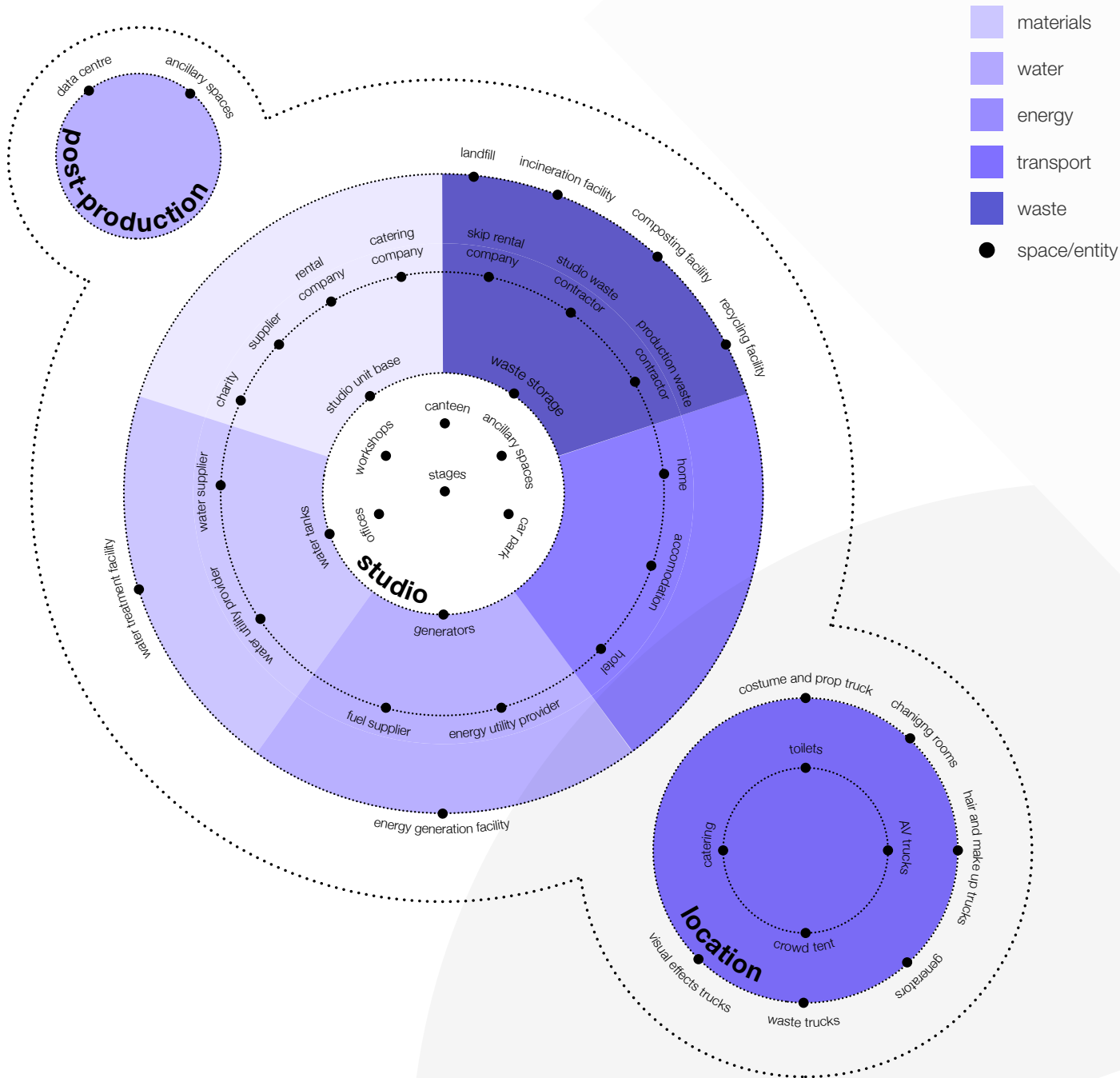
an average **day** filming

equates to more than one person's annual carbon footprint

an average **hour** filming

equates to the carbon footprint of a return flight from London to New York

Image by Mitch Hodge on Unsplash

Diagram labels:

Legend:
- materials
- water
- energy
- transport
- waste
- ● space/entity

post-production
- data centre
- ancillary spaces

studio
- canteen
- ancillary spaces
- workshops
- stages
- offices
- car park
- studio unit base
- water tanks
- generators

materials ring:
- catering company
- rental company
- supplier
- charity
- water supplier
- water utility provider
- water treatment facility
- fuel supplier
- energy utility provider
- energy generation facility

waste ring:
- landfill
- incineration facility
- composting facility
- recycling facility
- skip rental company
- studio waste contractor
- production waste contractor
- waste storage

transport:
- home
- accomodation
- hotel

location
- costume and prop truck
- changing rooms
- hair and make up trucks
- toilets
- AV trucks
- catering
- crowd tent
- generators
- visual effects trucks
- waste trucks

◁ **film production spaces**

This diagram shows a conceptual map of key spaces and functions involved in the film production life cycle across studios, locations and post-production facilities. Each component is mapped according to its main area of impact: materials, water, energy, transport and waste.

▷ The likely growth of the film industry globally emphasises the urgency of a shift towards more sustainable practices. While the COVID-19 pandemic and its associated impact on the industry has caused an unavoidable temporary drop in activity, the high demand for content seen in projections published before 2020 is likely to mean growth trends will resume as the global economy recovers.

In the past decade the global film industry has seen a year-on-year growth in revenue, with global box office revenues increasing from about US$38bn in 2016 to nearly US$43bn in 2019.[7]

Within North American and European markets, video streaming platforms play an increasingly prominent role in distribution. Looking at both markets together, the average annual growth rate is predicted at 7.5% between 2020 and 2025, resulting in revenues of US$50.2bn by 2025.[8] In 2018, Netflix and Amazon almost doubled the amount spent on UK-made television shows, reaching £280m. This helped drive the streaming video on demand sector to more than £3bn in annual revenues.[9] As a result, the demand for content and high-quality studio space equipped with emerging technologies is rising. Some production companies are seeking long-term contracts with studios to secure filming space. ▷

▷ While Western markets are leaders in terms of revenue, film production volumes are significantly larger in China, India and Nigeria, surpassing those of the USA.[10][11][12] Yet these regions follow different growth patterns, focusing on high volumes and relatively low budgets.

Sustainability is an emerging driver for USA, UK and European film productions. Key initiatives aiming to improve reporting and increase the adoption of sustainable practices include the US Green Production Guide,[13] Interreg Europe's Green Screen initiative[14] and its partnership projects such as Film London's The Grid Project[15], the UK's albert carbon calculator[16] and Green Rider initiative[17] and Film Flanders' Sustainable Filmmaking.[18]

Where measures to cut carbon emissions and reduce resource consumption are pursued, cultural, behavioural and organisational aspects often limit their success. The lack of sustainability related investor requirements in film production also has a large role to play. Sustainable behaviours are often perceived as limiting factors to creativity, which drives decision-making in the industry. Adopting new technologies or production methods that could improve environmental performance is also seen as a risk, one that could undermine the agility and responsiveness of productions that operate under heavy time pressures. The absence of an established industry-wide infrastructure that facilitates the adoption of these

practices undermines the confidence of production companies, which are reluctant to reinvent operations on a case-by-case basis. From an organisational perspective, productions operate with siloed budgets. This is reflected in the set-up of supply chains, which do not consider potential synergies to share material or catering supplies. Finally, in many contexts, split incentives between studios and productions make it hard to make the case for the retrofit of studio facilities and a shift towards more sustainable solutions.

A few productions have taken action to overcome some of these challenges by appointing 'eco-managers' or 'green runners', who are responsible for sourcing and implementing sustainable solutions throughout the production life cycle.[19] In reality, the people appointed to these roles often lack the agency to integrate with the decision-making power of production managers, who perceive their recommendations as an imposition.[20] As a result, sustainability measures tend to be confined to damage-reduction as opposed to positive value creation and largely focus on more easily-achievable solutions that have one-off impact and struggle to scale to the wider industry.

As physical production faces complex challenges, technological advances in screen resolution, visual effects (VFX), computer generated imaging (CGI) and remote collaboration services mean that film productions are shifting larger proportions of production to virtual environments. ▷

▷ These practices have the potential to reduce carbon emissions and waste resulting from the transport and fabrication of sets and props. They even have the potential to reduce shoot periods by introducing efficiencies in creative development. Yet they also have implications on the overall energy demand of the industry, due to the exponentially increasing volumes of real-time data processing required by digital production.

Energy optimisation solutions for data centres are widely adopted by leading cloud services providers, and can be applied to render farms used for film production. Hybrid on site and cloud-based models have been in use since the early 2010s due to the increased availability of high-speed internet access, which has helped to meet the increasing demand for computing power.[21] Optimising workflow management and distribution across cloud and on site render facilities are key factors that influence process efficiency and cost and energy consumption, of both on site and in remote server farms.

While data available for this research did not allow for an in-depth analysis of render farms energy consumption, this subject is explored in detail as part of a review of 30 low-carbon technologies led Interreg Europe's Green Screen initiative. The study also suggests other innovative practices tailored to the needs of the film industry. [22] [23]

This report outlines an alternative vision for the future of film production that acknowledges the importance of systemic change across all aspects that influence the film production ecosystem, from studio building design to stakeholder collaboration. It adopts a holistic vision for sustainability inspired by the United Nations Sustainable Development Goals,[24] which equally embrace environmental, social and economic aspects. The interventions proposed draw from circular economy principles that seek to design out waste and pollution, keep products and materials in use, and regenerate natural systems.[25] The aim is to help the industry achieve sustainable practices that support human wellbeing, environmental restoration and economic prosperity. ▢

▷ **UN Sustainable Development Goals**

The 17 Sustainable Development Goals of the 2030 Agenda for Sustainable Development. Since 2016, these Goals have been used to mobilise efforts globally to tackle climate change while promoting economic development and addressing social needs.

Image adapted from United Nations

Image by Joshua Rawson-Harris on Unsplash

introduction

planning for sustainability

The COVID-19 pandemic has caused the most significant disruption to the film industry in a generation with filming stopping almost entirely. In the UK, thanks to guidance from the British Film Commission on managing COVID-19-specific risk in producing film and high-end TV drama, filming is however beginning to start back up again.[26]

While audiences have temporarily adapted to low-resolution, socially distant content with remarkable ease, this does not foretell a reduction in appetite for high-end glossy production values associated with film, drama and entertainment shows. What is apparent is that a decision to shoot with large crews, especially while there are social distancing measures in place, must be more deliberate than ever.

So, what might these high investment, socially distant crews need for a new sterilised industry? It seems certain that more planning will be required, along with tighter controls about materials and people who enter and leave spaces.

As this report highlights, planning of this sort is exactly what is required to tackle the industry's sustainability challenges. The film industry has an opportunity to consider sustainability not as 'the straw that broke the camel's back' in the context of a more tangible crisis, but as a window into a more responsible and informed industry. ◻

data analysis

resource consumption

The data presented in this report is taken from 19 tentpole productions. The number of data contributors is a sign within the industry that productions are more willing than ever to engage in sustainability initiatives.

The anonymised data consisted of both production resource consumption data and carbon emissions data. The resource consumption data included figures for fuel use, energy utilities (specifically electricity and gas) as well as the amount of plywood used and air miles. The carbon emissions were calculated by applying carbon factors to some of resource consumption data that falls within the carbon reporting scope.

The analysis focuses on tentpole productions – the highest budget category – to highlight the maximum potential impact of a single given production. ◻

For a typical tentpole production, resource consumption data analysis shows that its total:

▷ **energy consumption** could power Times Square for 5 days

▷ **fuel consumption** could fill an average car tank 11,478 times

▷ **air miles** equates to 11 one way trips from the Earth to the moon

▷ **waste generation** equates to the weight of 313.5 blue whales

▷ **plywood** use amounts to the volume of 2.5 cargo planes

▷ **plastic bottle** usage equates to yearly average use of 168 people

data analysis

carbon emissions

one average tentpole film production generates **2840 tonnes of CO$_2$e**

fuel 50%

is equivalent to 3.4 million miles driven by a passenger vehicle

production energy utilities 30%

is equivalent to 450 tonnes of coal burned

air travel 16%

is the equivalent of 75 return flights from London to New York

accommodation 4%

is equivalent to the yearly electricity use of 34 homes

carbon emissions data breakdown

The breakdown uses tentpole production data reported under the PEAR[27] sustainability reporting framework

fuel

70% due to fuel used in car journeys

30% due to diesel used in generators

production energy utilities
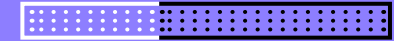
30% due to gas usage

70% due to electricity usage

air travel

90% due to commercial air travel

10% due to chartered air travel

accommodation

100% due to temporary accommodation in hotels and rented apartments

the vision

sustainable film production

An empowered film industry has adopted new physical infrastructure, new digital infrastructure and new working practices to make sustainability a reality.

Studios know they have a critical role to play for sustainability to be achieved by the industry. Their sites are designed or have been retrofitted with functional requirements that create smart, productive spaces for productions, suppliers, service providers, creative teams, academia and others to occupy. Buildings are designed for flexibility and adaptability to ensure they can meet the changing requirements of occupants. This is achieved by adopting a long-life, loose-fit design approach, which is in part realised by procuring building services and fit out through product-as-a-service contracts. Base build infrastructure supports the unique needs of a film shoot, including dynamic loads, acoustic isolation and ambient light control to reduce production overlays that compensate lacking infrastructure.

When it comes to utility provisions, studios are designed to minimise demand. Water demand from mains supply is reduced by installing rainwater harvesting and greywater recycling units. Energy demand is reduced by incorporating passive design measures, integrating green infrastructure, and implementing low energy fittings and technology. On site renewable energy meets energy demand, and where this is not economically feasible, renewable energy tariffs are chosen from energy suppliers. As one of the leaders in the transition,

studios feel confident in setting requirements for their tenants to operate purely on renewable energy by banning diesel generators on site.

Meanwhile, production managers take ownership of delivering net zero carbon and zero waste productions, which are now mandated by investors. They start by setting up a collaboration platform to manage and coordinate across all departments. The platform is a space for planning, co-creating, communicating and capturing information. Heads of production allocate budgets and schedule sufficient time in the programme to enable all departments to plan for net zero carbon and zero waste from the beginning.

In line with this, art departments put a viable plan together for how their materials are sourced responsibly and put back into a reuse system or donated at the end of their use. Set designers minimise material use through digital design and construction, use existing materials available from reuse networks, and design sets so they can be easily disassembled. Pre-production crew members make use of virtual planning to take creative decisions around set design and optimal film angles before production starts. This minimises filming time on set and ensures minimum set construction and procurement. Meanwhile, digital technologies, such as augmented reality and photorealistic effects are used once sets are built to inform any last-minute creative decisions on aspects like specific

prop sizes and colours without having to bring multiple physical options onto site.

Suppliers step up to the challenge and are able to provide sustainable alternatives. Individuals in charge of procurement have access to directories on responsible and sustainable suppliers to inform their choices. Location libraries are available for location managers to help them scout more sustainable filming sites based on proximity to transport hubs to encourage the use of public transport.

These online location libraries also provide information regarding access to the grid, to help eliminate the use of generators, as well as information on nearby building spaces that can accommodate crowd preparation to reduce transport from the unit base to the film location. Locations meet as much energy demand from solar power and biodiesel as possible, making up the remainder from mains energy supply.

When productions occupy studios, building management systems are in place to optimise utility flows and building performance. A studio-production interface for building management systems creates transparency between the two entities and supports productions in making more sustainable adjustments and choices within their own operations. Other studio-production interfaces exist to improve the user experience on site. This includes a digital concierge service available to download on users' ▷

▷ phones for efficient communication with studio management, along with an interactive wayfinding strategy deployed across the site to make it easier for both studios and production management to communicate with users on site.

Part of the user experience on site is also about supporting occupants' productivity. The use of standard industry waste signage, easily recognisable to those working on tight schedules, ensures better separation of materials and therefore higher recycling rates. It also means providing work-life services on site such as delivery lockers and canteens that double up as meeting spaces, with appropriate social-distancing protocols in place where required.

Being the home to productions, studios provide shared industry services for them on site such as reuse networks and shared procurement systems that they operate themselves or get third party businesses to operate. This consolidates logistics to and from site while providing new revenue generating opportunities for studios. Alternatively, studios could encourage productions to use shared industry services located nearby.

Reuse networks comprise dedicated storage space for props, costumes and sets that are digitally tagged to create a browsable online database and to monitor their whereabouts. This facilitates material reuse between productions using the same or nearby studio sites. Shared procurement systems linked to sustainable suppliers consolidates orders, deliveries and returns made by productions working in close proximity to each other. These systems should be underpinned by digitised procurement databases for seamless information sharing. Shared industry services might be financed by existing film industry investors, studios, infrastructure investors or industry bodies.

At the end of filming on set, production managers allocate a generous amount of time for dismantling and clearing out stages using the plans set out at the beginning to divert material to reuse networks, donations or – as a final resort – recycling.
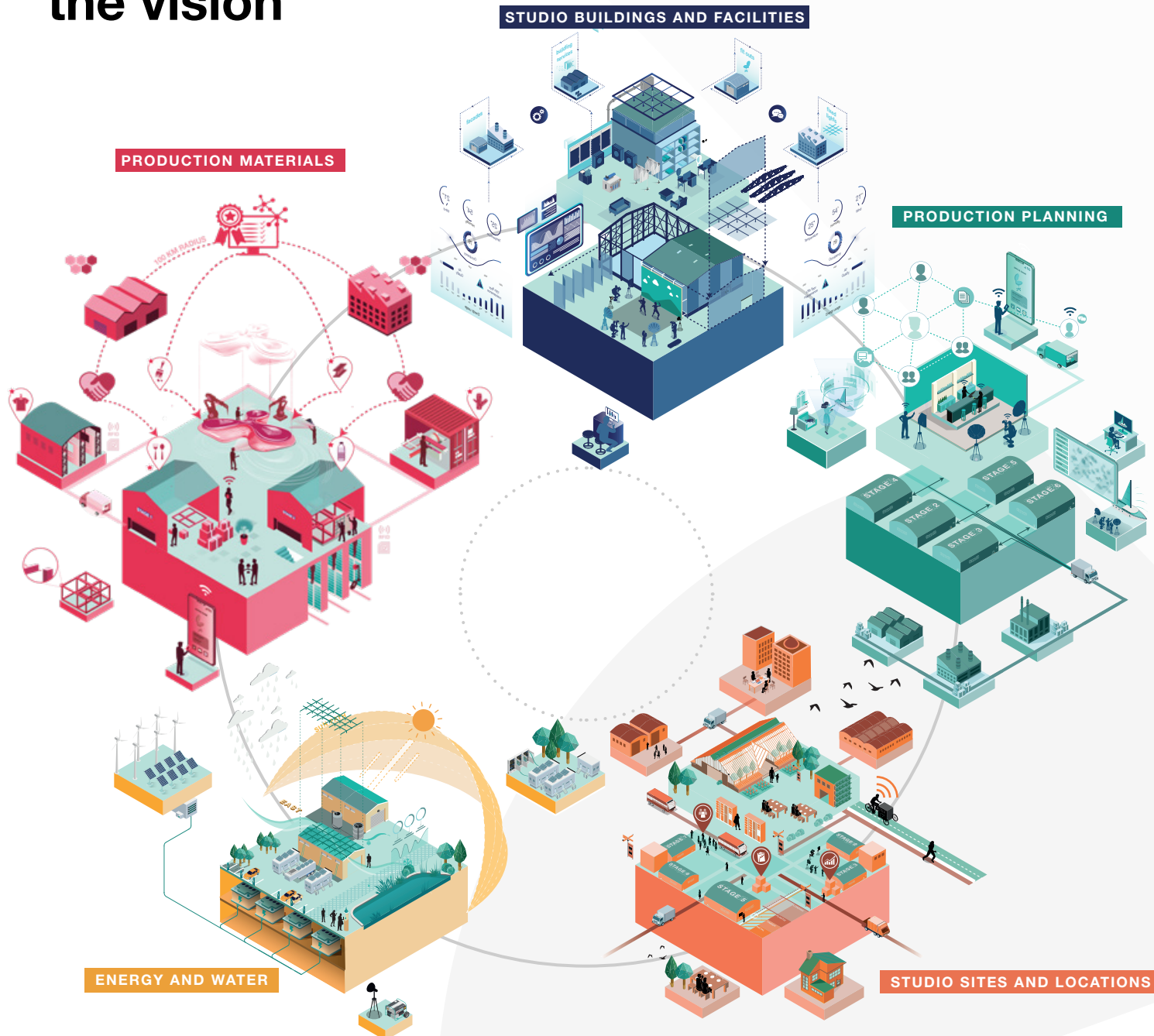
Throughout the production life cycle, the collaboration platform helps productions to operate seamlessly and with agility while tracking budget, consumption and carbon footprint. With the support of such digital infrastructure together with support from studios, delivering sustainable film productions has become the industry norm. ◻

"We see a world of abundance, not limits. In the midst of a great deal of talk about reducing the human ecological footprint, we offer a different vision. What if humans designed products and systems that celebrate an abundance of human creativity, culture, and productivity? That are so intelligent and safe, our species leaves an ecological footprint to delight in, not lament?"

Michael Braungart
Cradle to Cradle,
Remaking the Way We Make Things

the vision

PRODUCTION MATERIALS

STUDIO BUILDINGS AND FACILITIES

PRODUCTION PLANNING

ENERGY AND WATER

STUDIO SITES AND LOCATIONS

01 production materials
the industry creates zero waste and adopts a life cycle approach for all its materials while still meeting creative and financial requirements.

02 energy and water
energy demand is reduced by adopting building design measures with the remaining demand met by on site or off site renewable energy.

03 studio buildings and facilities
buildings are designed, procured and operated with flexibility and adaptability in mind to accommodate changing tenant requirements.

04 studio sites and locations
user-centred solutions encourage a work-life balance, support people's productivity and optimise the multimodal mobility of people and goods.

05 production planning
digital tools and shared industry infrastructure are used to critically plan how the production will significantly reduce carbon emissions and produce zero waste from the outset.

opportunities

Insights into the current sustainability challenges within the industry have highlighted five transformational opportunity areas: production materials, energy and water, studio buildings and facilities, studio sites and locations, and production planning. Three individual interventions have been identified for each opportunity area that, if implemented as a system, could result in a significant step change. This would not only reduce negative environmental impacts but have a positive influence on people and the economy.

01 production materials
reuse of materials
buying virgin materials responsibly
resource-efficient set construction

02 energy and water
energy demand reduction
sustainable energy sources
water demand reduction

03 studio buildings and facilities
repurposing buildings
buying products as a service
smart building management

04 studio sites and locations
consolidated movement
wayfinding and communication
health and wellbeing services

05 production planning
collaboration tools
virtual planning
shared infrastructure

01 production materials

the materials, components and tools
used by productions

current status

Procurement of materials focuses on supporting artistic
freedom. This means that a large proportion of materials
are purchased or made to specification, while reuse is
perceived as a limiting factor.

Regardless of their low recyclability, synthetic foam
and adhesives are popular as they can be rapidly
crafted into a desired shape with manual tools. Digital
fabrication, which could achieve similar results with
less waste, can sound expensive to art departments so is
not commonly used.

Production studios do not play a role in the
procurement or disposal of material, while production
managers do not have oversight of individual
department purchasing, where small last-minute
purchases are often made via online marketplaces.
Productions sharing studio space do not share other
amenities. This leads to lack of coordinated and
informed sustainable procurement choices.

Materials left at the end of productions are recycled
where possible, with some reuse through charity
donations. The remainder is sent to processing for energy
generation from waste, or to landfill. Reuse initiatives
are led by environmentally-conscious individuals.
Productions have limited capacity and allocate
insufficient budgets for end-of-use planning. Key factors
limiting material reuse include short strike times; a lack
of shared information on available materials, due to
the separation of studios and productions and lack of
digitised inventories; high storage costs; and the limited
numbers of reuse service providers.

vision

▷ dramatic reduction of virgin material use by
sourcing materials from reuse networks

▷ sustainable and responsibly-sourced material
use where virgin materials are required

▷ design for deconstruction is adopted so that
materials can be returned to reuse networks
in the same quality as they were received

opportunities

▷ reuse of materials

▷ buying virgin materials responsibly

▷ resource-efficient set construction

reuse of materials

materials such as set components, costumes and props should be tagged and traced throughout and between productions to preserve their value and enable reuse

Networks that connect existing material stocks with industry demand are required in order to facilitate reuse of materials at scale. Online sharing platforms can allow separate productions to exchange materials with each other and connect them with other productions, similar performing arts industries, secondary material warehouses and businesses or charities that can further extend material use.

Warehouses with logistics and quality control functions will be required to appropriately store these materials between uses. The warehouses may use robotic storage and retrieval systems that part-automate operations and compress the volume taken up by stocked items. Warehouse locations need to be optimised to reduce transport logistics and the overall cost of the reuse network. This could mean locating them on studio sites or nearby.

A key enabler of reuse networks are material passports, which provide information about a material and its history – for example, the original material source and specification, its current specification and location as well as any operational requirements, such as suitable design for deconstruction options. Recording this information and making it available digitally gives productions confidence that the materials are fit for purpose. Material passports can be linked to production schedules to create stock inventories that allow upcoming productions to plan for the reuse of secondary materials.

benefits

▷ **financial**
creates business opportunity for new or existing service providers

▷ **environmental**
keeps materials in use and reduces waste

▷ **social**
supports production-to-production communication

OFFSITE STORAGE
RFID

SHARING PLATFORMS
OFFICE CHAIR
5G

MATERIAL PASSPORTS
RFID

STAGE 1
STAGE 2
RFID

STUDIO

WAREHOUSES

case studies

© DRESD

DRESD
Set Deconstruction and Reuse, *UK*

DRESD specialises in the sustainable reuse of film and television production waste streams. The circular economy-inspired service aims for a 'full circle of reuse', which includes storing, reusing and upcycling set elements to reduce waste within the industry. The company is able to reclaim sets, props and waste materials that would otherwise be disposed of and ensure they are used on future sets. A large storage space at their headquarters in Wales allows materials to be kept and rented to productions aiming to reduce their waste. The main benefit of this model is the reuse of materials that would previously have been disposed of or destroyed. This helps to normalise sustainability for film companies as well as save money. As well as supporting reuse and waste reduction, the service also demonstrates creativity and initiative in crafting effective props and sets from upcycled materials.

similar initiatives: CAMA, Buurman, Rotor Deconstruction, Emagispace, Set Exchange

© Laura Fuchs

Materials for the Arts
Film and TV Materials Reuse Centre, *New York*

Materials for the Arts (MFTA) is a reuse centre based in New York that provides local art charities, public schools and city agencies with access to free film and television materials. When film and television productions have finished using materials, props or sets, they can donate them to MFTA, where they are stored and reused rather than disposed of. With a 25,000 sq ft storage facility funded by the city and an online platform that provides information on the materials and items stored, MFTA facilitates a successful reuse network and system. While the primary benefit of the service is the reduction in landfill waste, the centre also helps to educate people on the importance of reuse and inspires creatives to use materials with a greater awareness of their afterlife.

similar initiatives: Globechain, Earth Angel: Good Riddance, Set-a-side

critical implementation requirements

▷ studios and third-party service providers create reuse networks for productions to use

▷ accessible secondary material warehouses are provided as part of reuse networks

▷ online sharing platforms containing secondary material inventories are provided to facilitate information exchange

▷ a critical mass of productions subscribe to and use the sharing platforms

▷ during the planning stage of the production, production managers allocate sufficient time and budget for set and costume designers to consider end-of-use

▷ set and costume designers adopt material, design and fabrication practices that facilitate reuse

▷ a new function is created in the set design team or a third-party service provider is paid to dismantle sets at end-of-use and place materials back into reuse networks

▷ location managers provide temporary storage spaces at unit bases to store reusable materials before they re-enter reuse networks

# buying virgin materials responsibly

environmental and social factors should be considered when buying set components, costumes and props for effective and ethical supply chain management

The film industry makes use of both local and global supply chains. The procurement power of studios and productions should influence the sustainable conduct of its suppliers and therefore the sustainability credentials of the industry.

Responsible sourcing should cover all materials and products. This involves ensuring supply chains are transparent around their legal, ethical, environmental and social compliance. Selected suppliers should conform with national regulations and have policies in place for human rights, working conditions, health, safety and the environment.

Sustainable materials are part of responsible sourcing. These materials do not deplete finite natural sources and do not have adverse impacts on the environment, both when extracted and used. Examples of sustainable materials include those manufactured using biodegradable components and easily reusable or recyclable materials. Durable materials should be selected if they are likely to enter reuse networks, whereas biodegradable materials should be selected if they are likely to be single use.

Although sometimes not possible, local sourcing creates shorter supply chains. A shorter distance between the manufacturing facility and production reduces cost, carbon emissions and risk related to delivery logistics. It also means samples can be viewed in real life before purchase, avoiding potential waste generation.
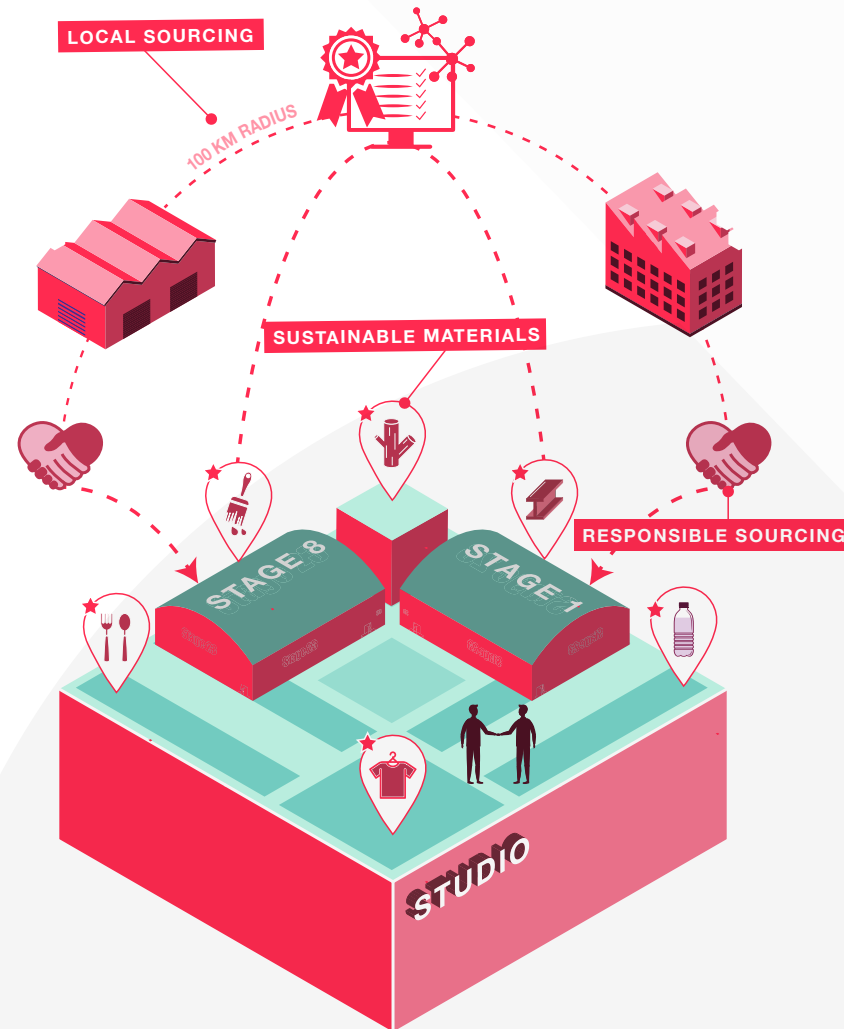
benefits

▷ **financial**
informed procurement reduces chance of reputational risk and associated financial implications

▷ **environmental**
positive procurement decisions reduce the life cycle impact of materials on land, air, water and living things

▷ **social**
supports worker rights in the supply chain, companies involved in material innovation and the local economy

case studies

CC0 Adolfo Félix

ECOR
Cradle-to-Cradle Certified Waste Cellulose Fibre Material, *Global*

The ECOR foundation develops green building materials to support a circular economy. Its primary product line, ECOR panels, provide a sustainable alternative to wood and paper-based materials for a range of applications. ECOR collaborated with Twentieth Century Fox to minimise solid waste to landfill and to reduce the quantity of tropical hardwoods used in film set construction. Led by the Art Director in partnership with Noble Environmental Technologies, a 100% sustainable ECOR composite panel set was built for a popular television series. The panels were found to be the most sustainable and cost-efficient alternative to the forest products conventionally used in Hollywood. The team also used sustainable bamboo veneers and environmentally-friendly paint, wallpaper and glue, making the entire set recyclable at end-of-use.

similar initiatives: C2C Certified Registry

© Madhav Kidao

The Costume Directory
Open Resource, *Global*

The Costume Directory, led by costume designer Sinéad Kidao, connects designers and buyers with suppliers that aim to prioritise sustainability, environmental responsibility and fair trade. This open resource advises users what to consider when choosing a supplier, brand or factory. By providing links to sustainable co-operatives, artisans and traditional weavers, the resource also helps its users to find environmentally-conscious suppliers more quickly. The Costumer Directory also encourages the reuse of fabric, supporting a less wasteful industry. An online repository of similar initiatives would benefit the industry.

similar initiatives: ECO-Production Guide, Green Production Guide

critical implementation requirements

▷ productions and studios put in place a responsible sourcing policy based on international guidance such as the ISO 20400:2017 Sustainable Procurement – Guidance

▷ suppliers develop new sustainable material alternatives that achieve comparable performance to those traditionally used by the industry

▷ sustainable material suppliers identified by individuals working in the industry are shared with the rest of the industry

▷ set designers are in dialogue with sustainable material suppliers to improve material performance and suitability for desired applications

resource-efficient set construction

set design and construction methods should reduce demand for material and facilitate reuse

Reducing the demand for virgin materials and ensuring their sustained reuse are key to reducing the environmental footprint of material consumption and waste generation. New design approaches and advances in digital technologies are facilitating this process without compromising creativity.

The adoption of design for deconstruction is critical for material reuse. From the beginning, set departments should be encouraged to plan for deconstruction during strike to ensure that the materials remain in a reusable condition. This is made possible by making use of mechanical connections, standard-sized modular components and durable non-toxic materials.

To maximise the use of existing materials, set departments can make use of parametric design tools. Using generative algorithms, these tools can explore thousands of design options in seconds and find optimal solutions that combine material constraints with creative, spatial and other requirements. Where designs are more complex and cannot integrate existing materials, parametric design tools can be used to generate design options that minimise virgin material use.

Digital fabrication can help build, deconstruct and support reuse more quickly, with less material. Robots can perform additive manufacturing – also known as 3D printing – with bioplastics that can be shredded and reused, or subtractive manufacturing like Computer Numerically Controlled (CNC) milling and laser cutting of diverse materials, such as bio-composites, plywood, bioplastics, and metal.

DESIGN FOR DECONSTRUCTION

PARAMETRIC DESIGN

DIGITAL FABRICATION

CONSTRUCTION WORKSPACE
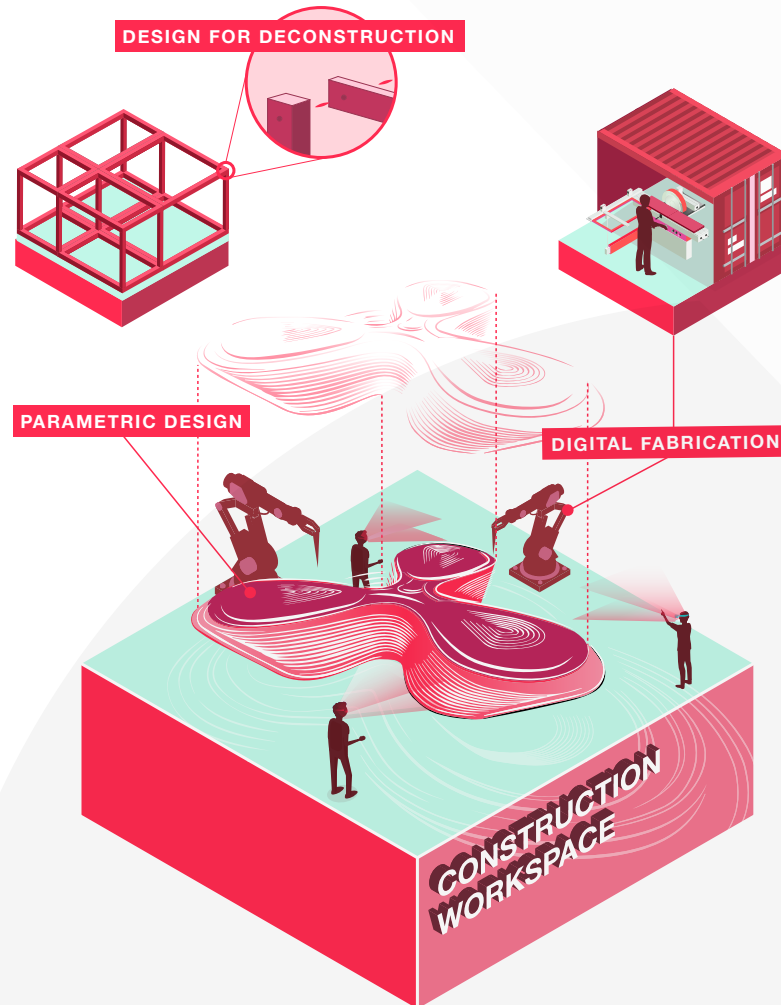
benefits

▷ **financial**
overall material cost savings

▷ **environmental**
reduces material consumption and waste generation

▷ **social**
upskilling industry to use new creative tools

case studies

© Ged Finch

X-Frame System
Designed for Disassembly, *New Zealand*

Developed by PHD candidate Ged Finch at the University of Wellington, the X-Frame is a prefabricated laterally resilient and highly flexible structural framing solution that supports a zero-waste ecosystem. It can be used interchangeably as a floor, wall or ceiling. Thanks to its design, this system enables the reuse of all materials used for construction. Its mechanical junctions eliminate all use of adhesive and single-use fixings. The modularity of its elements encourages rapid and low-cost scalability, adaptability, assembly and disassembly using low skilled labour. The optimised grid proportions are designed to maximise the use of standard plywood sheets for CNC milling. Intended as a research project, X-Frame aims to reduce end of life building waste. This system or similar principles can be adopted for set construction.

similar initiatives: Wikihouse, MOD's MCB Brussels

Photo from pxfuel
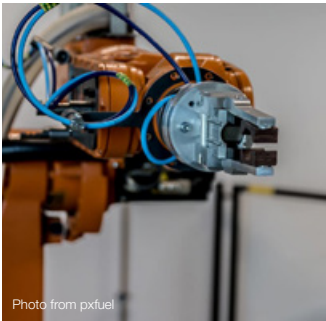
Odico
Pop-Up Robotic Manufacturing Unit, *Denmark*

Robotics company Odico is making advances in the use of hot wire-cutting to develop concrete formwork. Odico's autonomous wire-cutting approach achieves an overall fabrication time around 100 times faster than CNC milling. When used on the construction of a Danish investment firm headquarters, the unit not only saved a substantial amount of time but also enabled more complex geometries. It can also reduce the overall cost, as formwork construction can comprise as much as 75% of a concrete project's total cost. This and other similar approaches could be hugely beneficial to set construction, for example if used to wire cut timber for use in set design, significantly improving the fabrication time and accuracy of large-scale sets, while also producing less waste.

similar initiatives: R-O-B, Makerlabexpress, Sprung

critical implementation requirements

▷ industry bodies develop guidance and training on materials, design and construction approaches that support zero waste generation, and ensure collective adoption

▷ the art director supports set designers and their construction teams to adopt new design and construction techniques

▷ set designers seek funding from production budgets or industry innovation initiatives, in which they test parametric design and digital fabrication techniques with leading designers and makers

▷ set designers have working knowledge of parametric design tools and design for deconstruction approaches

▷ set designers make use of digital fabrication techniques, either investing in their own kit or working with suppliers who already have the kit

▷ production designers and set designers share their experiences with others in the industry

02 energy and water

the operational energy and water consumed by the production process

current status

In the UK, productions can be charged flat rates for electricity and heating, with little transparency around consumption. As such there is no incentive to reduce energy use during production. In the USA, as productions and studios are more integrated, they have clearer oversight of consumption.

Few studios operate on renewable energy tariffs, while only a handful generate renewable energy on site. There is reluctance to incorporate passive design solutions, such as natural lighting and heat recovery, in fear of jeopardising the suitability of facilities for filming. However, some studios have demonstrated this is possible.

Fossil-fuel derived diesel generators are widely used on location and on studio sites because of flexibility and convenience. Traditional filming equipment (i.e. halogen lights) have a high energy demand which makes using solar- and battery-powered generators harder. Some studios provide mains electricity and water connections for productions to use in place of diesel generators and water bowsers, but are incentivised to only provide baseline capacity to avoid unnecessary maintenance and operation costs. In the UK, studios see themselves as unobtrusive landlords that focus on enabling productions to work with their own requirements, including the use of diesel generators on site.

Total water consumption is not reported and often left out of sustainability discussions, despite being critical. The current focus is on reducing bottled water, but mainly to reduce plastic waste.

vision

▷ energy and water demand from mains supply are reduced through building design measures and on site infrastructure

▷ energy demand is met by renewable energy generated either on or off site

opportunities

▷ energy demand reduction

▷ sustainable energy sources

▷ water demand reduction

energy demand reduction

energy demand should be reduced through integrated strategies that combine passive design, green infrastructure and behavioural changes

Energy supply is critical for film production. Studio sites and buildings should incorporate passive design solutions such as daylighting, natural ventilation, solar shading and solar gain to reduce the need for energy-intensive systems such as electric lights and forced-air heating, ventilation and cooling that require a power source. Hybrid systems also exist such as heat recovery ventilation, economiser ventilation, solar thermal systems, radiant façades and ground source heat pumps.

Additionally, green infrastructure can reduce energy demand while also improving climate change resilience and enhancing biodiversity. Green spaces with local flora and fauna can naturally balance the microclimate, and provide space to relax, socialise and film. Green building envelopes can form an added layer of insulation and combat the urban heat island effect. Some can also naturally attenuate water runoff to reduce the demand on new and existing drainage systems.

The high energy demand attributed to lighting during production can be reduced with design and management strategies. A growing range of low energy lighting can also meet the diverse requirements of photography directors, with consistency indexes allowing immediate translation from traditional tungsten lighting outputs to equivalent low energy sources.[28] Meanwhile, modern lighting technologies can help reliably power down equipment when not in use and to have it ready on short notice. Finally, monitoring equipment can be installed to understand usage patterns, identify waste and make more accurate estimates for future productions.

LOW ENERGY LIGHTING

SUN PATH

GREEN INFRASTRUCTURE

EAST

PASSIVE DESIGN

STUDIO
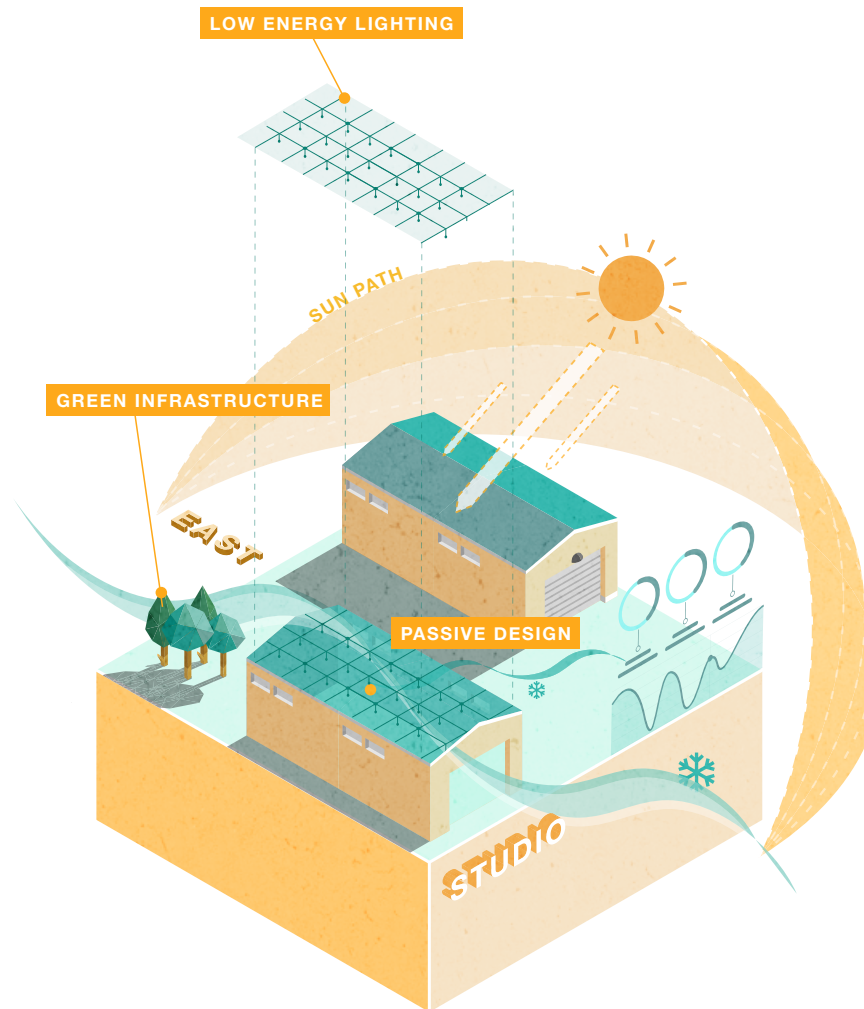
benefits

▷ **financial**
reduces operational cost of energy

▷ **environmental**
reduces overall energy demand and associated carbon emissions

▷ **social**
health, wellbeing and productivity benefits of proximity to green spaces, plants and trees

case studies

© Arup

Sky Harlequin 1
Broadcasting Studio, *UK*

Sky's Harlequin 1 is one of the most sustainable broadcasting studio and data-centre buildings. The passive design solutions implemented in this building help to reduce both energy demand and its associated operational cost. The design choices also benefit building users by providing them with a healthier work environment. The scheme includes eight state-of-the-art naturally-ventilated studios, offices and free-cooled data rooms. Mechanical systems use heat from studio lights to heat the recording studios. All the post-production and technical spaces are located in the core of the building, while office spaces are distributed around the perimeter of the building. This strategic positioning exposes office areas to natural daylight, fresh air, and outdoor views.

similar initiatives: Vancouver Studios

CC-BY-SA Ryan Somma

PEG and Verti.Gro
Green Roof and Wall Systems, *Singapore*

The Singapore Government Housing and Development Board has developed a suite of solutions to increase the amount of green space in urban areas. Their Prefabricated Extensive Green (PEG) roof system is a set of 'green tiles' that can be tailored to the shape of any roof. The structure provides the roof with extra insulation and physical protection from the elements. Plants can be grown off site, ensuring instant greening at installation. 'Verti.Gro' is a similar solution that can be installed on vertical surfaces. Its design allows for ventilation as well as incorporating water storage, reducing the need for constant irrigation. Given the large surface area of stage envelopes, these solutions could be easily and quickly adopted to reduce the energy demand of stages and support local biodiversity. They could also help to attenuate rainfall to reduce the demand on drainage systems.

similar initiatives: Pinewood ecological roofs, Quai Branly Museum vertical garden facade

critical implementation requirements

▷ new studios include passive design and green infrastructure requirements in studio development briefs

▷ architects, engineers and consultants develop passive design solutions that meet sound and light requirements for productions

▷ landscape designers and ecologists design green infrastructure solutions that match local climate and environmental conditions

▷ existing studios identify and implement small-scale green infrastructure solutions such as mobile planters

▷ directors of photography are trained to achieve artistic freedom with low energy lighting equipment

▷ a studio space energy manager is appointed to ensure that equipment is powered down when not required or not in use

sustainable energy sources

there should be a more intensive use of renewable energy sources both on studio sites and on location, using battery storage and microgrids to increase supply reliability

A move towards renewable energy sources is required at both centralised and decentralised scales to achieve a zero-carbon economy. On studio sites, this could involve installing reliable micro renewable technologies such as solar photovoltaics on roofs or mounted onto building façades, and wind turbines designed with quieter frequencies so as not to disturb filming. Where this is not feasible, studios could switch to green energy suppliers. Trailers with solar roof installations, biodiesel- or battery-powered generators are available from suppliers. With the gradual shift to renewable energy, these solutions are becoming increasingly available at lower costs.

Renewable energy generation coupled with battery storage ensures energy is used when rates are most convenient and stored to meet demand peaks. Batteries also provide reserve capacity in the event of exceptionally high demand or excessive pressure on the main grid. Innovation in battery technology is making them an increasingly viable alternative to diesel generators.

Microgrids are decentralised systems that match energy supply and demand safely, effectively and reliably. A key component of microgrids are off-grid battery storage systems that capture, store and share local energy across facilities on site; they also adapt to fluctuating demand and operate independently from the grid, making them resilient and well-suited to productions' energy consumption patterns.

BATTERY STORAGE

RENEWABLE ENERGY

FILMING

LOCATION UNIT BASE

STUDIO

MICROGRIDS
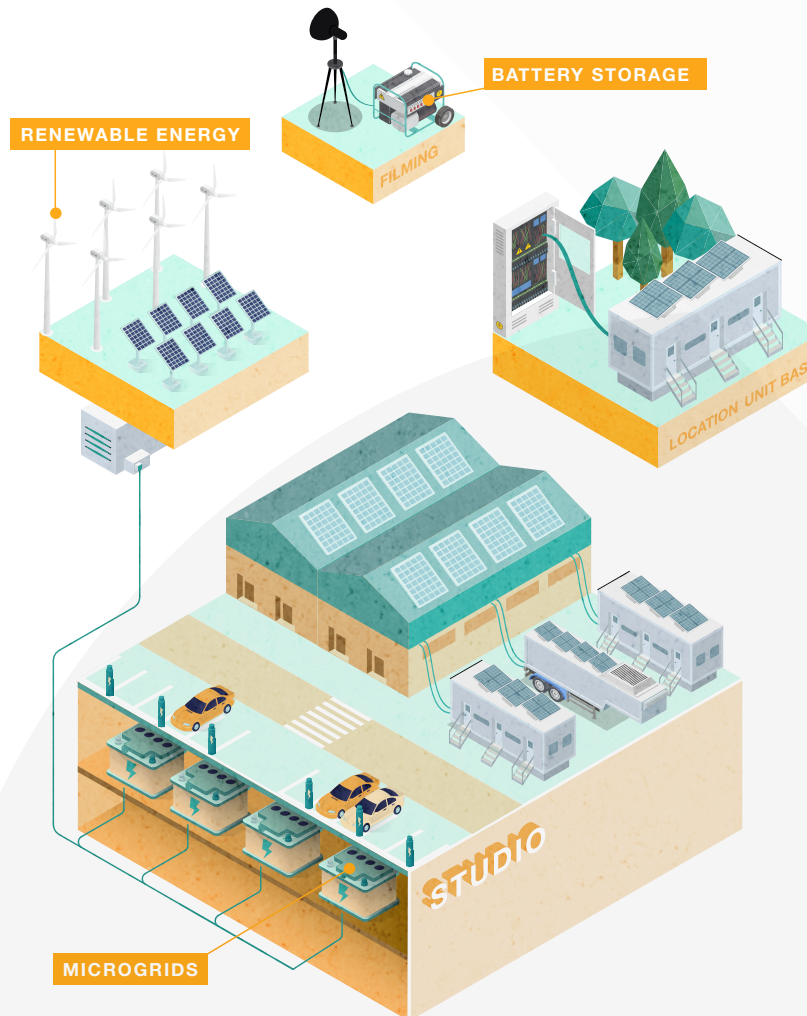
benefits

▷ **financial**
creates revenue generation potential from providing services to the grid

▷ **environmental**
supports net zero operational carbon targets

▷ **social**
provides reliable and resilient local energy supply for continued film operations

case studies

Apple Headquarters
Clean Energy-Powered, *USA*

In 2018, Apple announced that its global facilities were entirely powered using 100% clean energy. This includes Apple Park, the company's 260,000m^2 headquarters which opened to employees in 2017 and is now the largest LEED Platinum-certified office building in North America. The four-storey ring-shaped building is partially powered by a 17MW solar installation on its roof and 4MW of biogas fuel cells. The use of a microgrid with battery storage allows Apple Park to redistribute clean energy across the public grid during periods of low use. Apple's use of 100% clean energy also applies to its retail stores, offices and facilities across 43 countries, demonstrating a commitment to environmentally responsible energy use and providing a replicable model for other large firms.

similar initiatives: SunPower Solar Rooftop System Culver City Centrestage, The Bavaria Film Studios, Green Film Shooting
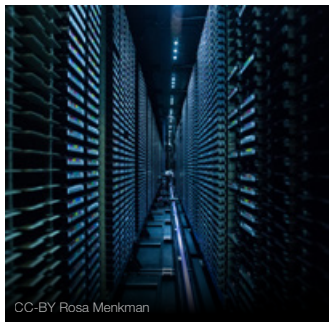
The Spark
Sustainable Data Centre Concept, *Norway*

The 'Spark' concept proposes the use of excess thermal energy from data centres to heat local communities. Conceived by architecture and design firm Snøhetta, 'Spark' is a 2MW capacity data centre situated at the heart of a community rather than in a remote location. The large amount of excess thermal energy produced is used in district heating systems and household water tanks. Once the thermal energy has dissipated, the cold water returns to the data centre to cool the servers. The designers claim that the system could provide a 40% reduction in energy use compared to a standard data centre. A prototype is currently under construction in Lyseparken, Norway, where it will form part of an energy positive town. With the film industry relying heavily on data centres to power and process post-production this could be a viable innovation to consider. Off site or even on site excess thermal energy from post-production servers could be reused in district heating or studio site heating.

similar initiatives: Eco Data Centre

critical implementation requirements

▷ studios set operational carbon reduction targets

▷ studios and productions prioritise use of renewable energy sources over carbon offsetting

▷ new studios include microgrids with on site renewable energy generation in studio development briefs or select renewable energy suppliers

▷ existing studios switch to renewable energy tariffs where retrofit of renewable energy installations are not possible

▷ studios provide sufficient energy supply to the site to meet production requirements

▷ studios ban diesel generators on their sites

▷ studios and location managers procure trailers and generators powered by renewable energy sources

water demand reduction

water systems should be designed to capture and reuse or recycle water to reduce the demand from mains water supplies

Potable water is required at studio sites for drinking and cooking purposes while non-potable uses include building cooling, equipment washing, filling water tanks used for filming, flushing toilets, washing machines and irrigation of any landscaped areas on site.

Rainwater harvesting involves the collection, treatment, storage and distribution of rainwater collected from the roofs of buildings for local potable or non-potable reuse depending on the level of treatment. This reduces the demand on water supply and drainage systems since rainwater run-off is captured and used by the system.

Greywater is all the wastewater generated from buildings except wastewater from toilets and kitchens. As with rainwater harvesting, greywater recycling involves the collection, treatment, storage and distribution of greywater captured using separate plumbing to standard sewage systems. Treatment includes filtration, biological treatment and disinfection.

Mobile sanitation solutions are needed by film productions on studio and location unit bases. Several waterless toilet solutions exist that minimise water demand with chemical toilets being the most prevalent. However, innovation in the design of composting toilets, such as the Bio-Drum, are making them an increasingly viable alternative with a compost product generated at the end that can be sold. They also eliminate the use of chemicals while retaining hygiene standards.

COMPOSTING TOILETS

LOCATION UNIT BASE

RAINWATER HARVESTING

STUDIO

GREY WATER RECYCLING
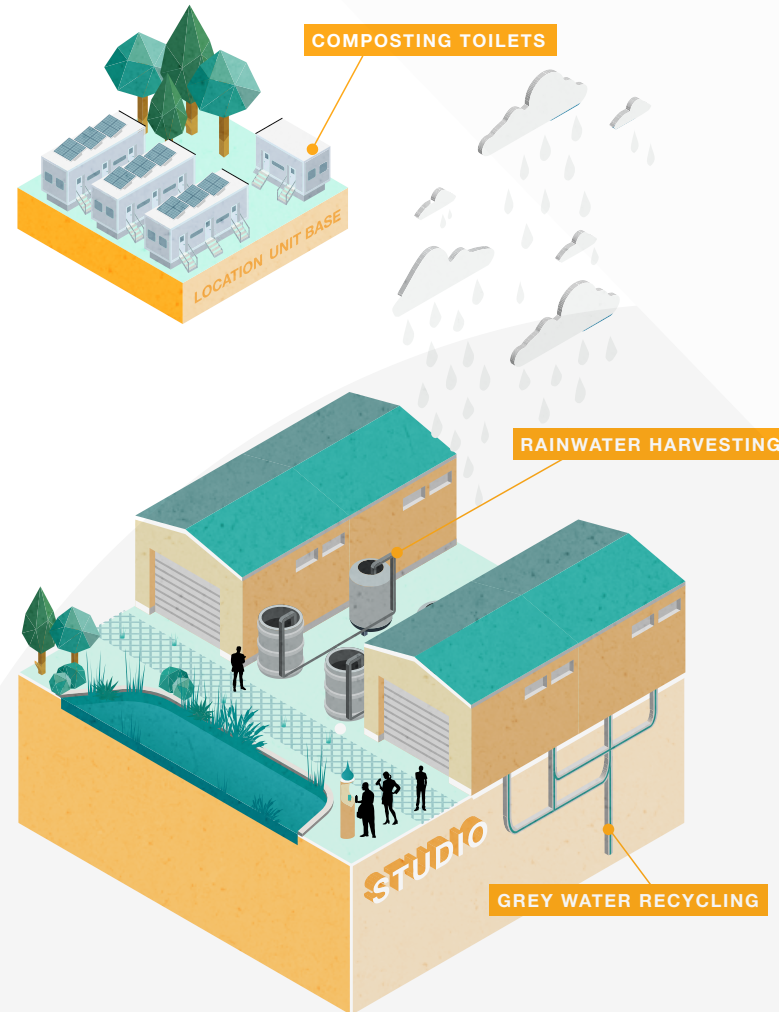
benefits

▷ **financial**
reduces operational cost associated with water

▷ **environmental**
reduces water abstraction levels that stress the environment

▷ **social**
rainwater collected in ponds could form a central outdoor space for staff to enjoy

case studies

CC-BY-SA Max Baars

The Living Machine
Cradle-to-Cradle Wastewater Treatment system, *USA*

The Living Machine is a decentralised water purification system for the San Francisco Public Utilities Commission building. This ecologically-engineered system combines elements of conventional wastewater technology with purification processes simulating wetland ecosystems. This has helped treat the building's wastewater so it can be recycled for use in toilets, landscape irrigation and other non-potable uses. The system has enabled the building to reduce its water consumption by 65%. Currently designed to cater for single buildings (7,500 litres of wastewater) the system has the potential to be applied on larger sites such as film studios. This could equip studios with a renewable source of water as well as providing production companies with significant financial and ecological benefits. It could also provide water when required for certain scenes.

similar initiatives: Urban Sponge Park

© Loowatt

Loowatt
Waterless Portable Toilet System, *UK*

Loowatt is a toilet equipped with a closed-loop waterless flushing system, aiming to increase hygiene and reduce waste, as well as helping to generate energy. Rather than using water, Loowatt captures and seals waste in an airtight biodegradable polymer film. This reduces odour and maintains hygiene, and enables transportation of the waste to an anaerobic digester for use in generating biogas, fertiliser and electricity (included in the hire cost). The toilets come in three formats: mobile, outdoor and indoor. The system brings crucial hygiene, accessibility and sustainability to off-grid toilets. The pods are easily situated on any type of location, do not require a water hook-up and never need to be accessed by a vacuum-truck, thereby offering significant savings on transport as well as less servicing. These could be a sustainable alternative to current on-location toilets that either use chemical solutions or significant amounts of water. More permanent waterless toilets could also be considered for installation on studio sites.

similar initiatives: Urimat, DyeCoo

critical implementation requirements

▷ studios include on site rainwater harvesting and / or greywater recycling in studio development briefs

▷ engineers working on studio designs assess optimal locations to install water tanks

▷ location managers procure composting or waterless toilets

▷ production, set and costume designers engage with sustainable material suppliers to improve material performance and suitability for desired applications

03 studio buildings and facilities

the design of stages, offices, post-production facilities
and other ancillary buildings

current status

Operational alterations over the years and changing
requirements from production to production mean
that studio spaces are sometimes underutilised
(e.g. canteens), that there is insufficient capacity
of a certain use (e.g. car parking), or that a specific
use is not available on the studio site (e.g. outdoor
filming space).

The flexibility and adaptability of buildings
has not been a priority for studios over the past
few decades, with the needs of film production
remaining relatively stable. However, likely
changes in technological, operational and overall
industry requirements may see studios benefiting
from flexible and adaptable design strategies for
new and retrofitted buildings.

Studios typically choose new builds rather than
retrofitted warehouses when developing stages,
as the latter are less likely to meet the required
specification. However an increasing number of
retrofit examples show their potential as a lower cost
alternative to new builds. Older studios are not fitted
with latest building management systems, preventing
their teams – both management and leadership –
from understanding the operation and performance
of buildings on site. Despite this, studios can be
averse to renovating existing stages due to the loss of
income while renovation takes place.

vision

▷   the industry drives the retrofit first approach

▷   studio spaces accommodate different uses
    to increase space utilisation, maintaining the
    performance of buildings

▷   components are procured through
    performance-based contracts

▷   building performance data enables
    efficient building management, while its
    communication through user interfaces
    supports sustainable behaviours

▷   stage infrastructure provides for fundamental
    production requirements to limit the addition
    of other equipment, and enable efficient
    construction and strike

opportunities

▷   repurposing buildings

▷   buying products as a service

▷   smart building management

repurposing buildings

buildings should be flexible and adaptable to increase space utilisation and to keep building assets in use for as long as possible to avoid demolition and rebuild

The demand for stage space is increasing globally. However, building new stages can be expensive. Retrofitting existing large open plan shells has become a cost-effective and quicker alternative. This is referred to as building retrofit. This can be done for stages by fitting existing warehouses with acoustic insulation, rigging and sufficient energy supply.

Flexible spaces are designed to be used for multiple functions to increase space utilisation and rentability. This includes using removable partitions to split stages into different spaces with each space being used by different productions. Instances could include using day-time staff canteens as an event space during the evening, or fitting stage façades with rails to offer an extendable outdoor green screen. These examples are best delivered through flexible fit-out solutions, reconfigurable façade systems and appropriate building management systems.

Adaptable buildings can accommodate more than one use in their lifetime through retrofit rather than demolition by taking a long-life, loose-fit approach to building design. The shell and core of the building should be sufficiently adaptable to allow a rapid and cost-effective change in use. Key design parameters include floor height, floor plate depth, core positions and entrances, riser sizing, and plant room sizing and positioning. With the film industry rapidly evolving, asset owners need to ensure that their buildings remain fully functional by adopting adaptable design principles.

BUILDING RETROFIT

ADAPTABLE BUILDINGS

FLEXIBLE SPACES
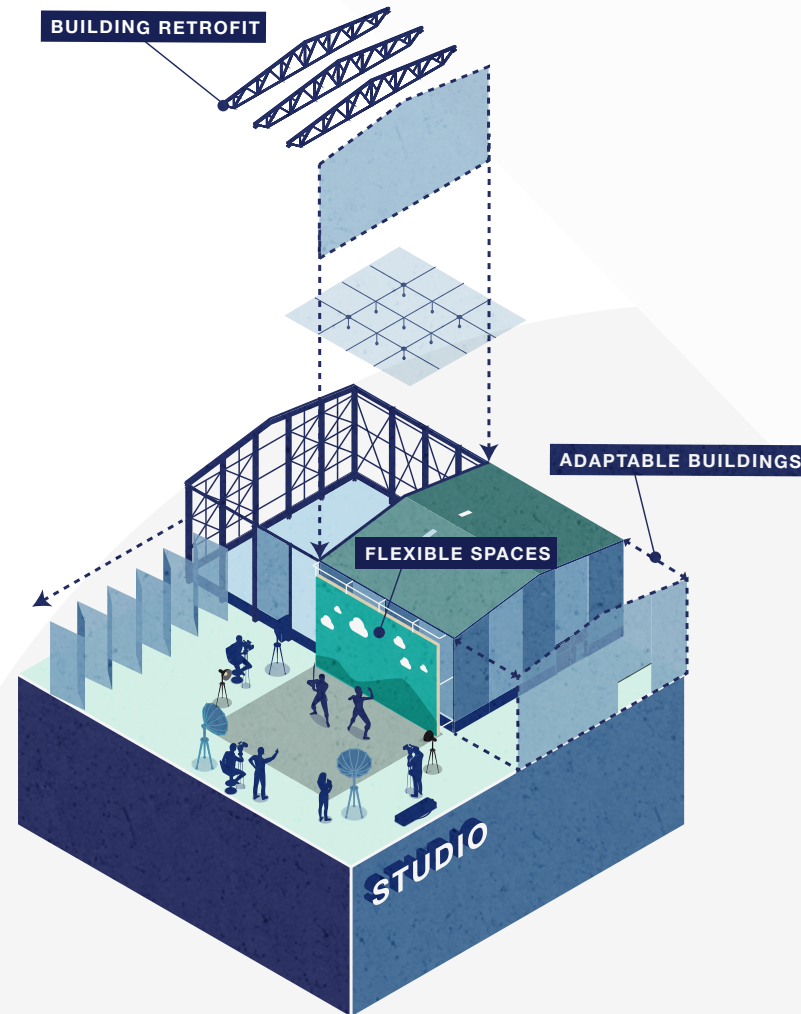
STUDIO

benefits

▷ **financial**
increases revenue-generating potential of studio site

▷ **environmental**
reduces demand and waste generation related to construction materials through the continued use of buildings

▷ **social**
preservation of building heritage and local identity

case studies

© Andy Marshall

Space Studios
Retrofitted Storage Facilities, *UK*

Space Studios is an award-winning regeneration project that transformed Manchester's 1970s Fujitsu production factories into a 360,000 sq ft television studio complex with stages, workshops, catering facilities and office space for small creative businesses. The project was also intended to catalyse improvement in the surrounding deprived neighbourhood, offering opportunities to locals. The project cost £27m to convert and adapt the site. To ensure costs were kept down, the factory was stripped down to its principal structure and left 'raw'. With increasing demand for stage space, factories and old warehouses can be beneficial and sustainable solutions if repurposed and retrofitted to a high and permanent standard. Retrofitting will also typically also offer waste and cost reduction compared to building new stages. Expanding on the definition of a circular economy, Space Studios also highlights how a retrofit can serve to revive and regenerate neglected neighbourhoods.

similar initiatives: Wildflower Studios, Architect's Journal RetroFirst Campaign, Ashford's Newtown Works Redevelopment

CC BY Michael Sheehan

Bridge Studios
Outdoor Green Screen Façade, *Canada*

Bridge Studios, Vancouver, has created an exterior size-able green screen that overhangs 4ft off the façade of one of its stages. Situated close to one of the backlots, the screen offers plenty of space for partial sets to be built and for filming to take place, maximising the amount of available filming area. Instead of relying solely on the interior of a stage to serve for filming, this solution uses the large exterior surface area of a stage building to its full potential. This approach could easily be retrofitted onto existing studio stages by adding a rail around the parapet from which an exterior green screen could be hung. Implementing this solution could also encourage the increased use of green screens which in turn would reduce the amount of material otherwise used building full sets.

critical implementation requirements

▷ studios select retrofit over new build, where suitable building stock is available

▷ studios include flexible and adaptable building requirements in studio development briefs

▷ architects, engineers and consultants adopt scenario planning for studio sites to inform plausible alternatives for flexible and adaptable design measures

▷ studios include material passports within building information modelling (BIM) requirements in studio development briefs to facilitate future building adaptation

buying products as a service

the components of a building should be designed, procured, constructed, operated and maintained for high performance across the entire use phase

The film industry is accustomed to renting costumes, props, generators and vehicles. There is an opportunity to extend this practice to temporary and permanent building components through product-as-a-service contracts with construction suppliers. Instead of building owners and production companies buying and owning products, they pay a subscription service to suppliers who retain ownership. Fees are linked to key performance indicators and include operation, maintenance, repair, upgrade and end-of-use cost. These contracts are available for lighting systems, air conditioning units, electrical distribution kits, elevators, façades and office fitout.

As suppliers are paid for performance under product-as-a-service contracts, they are incentivised to use real-time remote monitoring to deliver predictive maintenance. This approach uses sensors and data to detect possible defects and fix them before they result in failure. In doing so, costs and downtime related to reactive maintenance are kept to a minimum.

Modular construction involves manufacturing building components off site for assembly on site. This method can considerably reduce construction time on site, cost and waste generated, compared with traditional methods. Repeated and dismountable components, potentially procured through product-as-a-service contracts, support the reconfiguration and relocation of structures to meet changing occupant requirements. This could be relevant for new on site multi-storey car parks, for example, that will need to adapt as policies reducing private car use take effect.
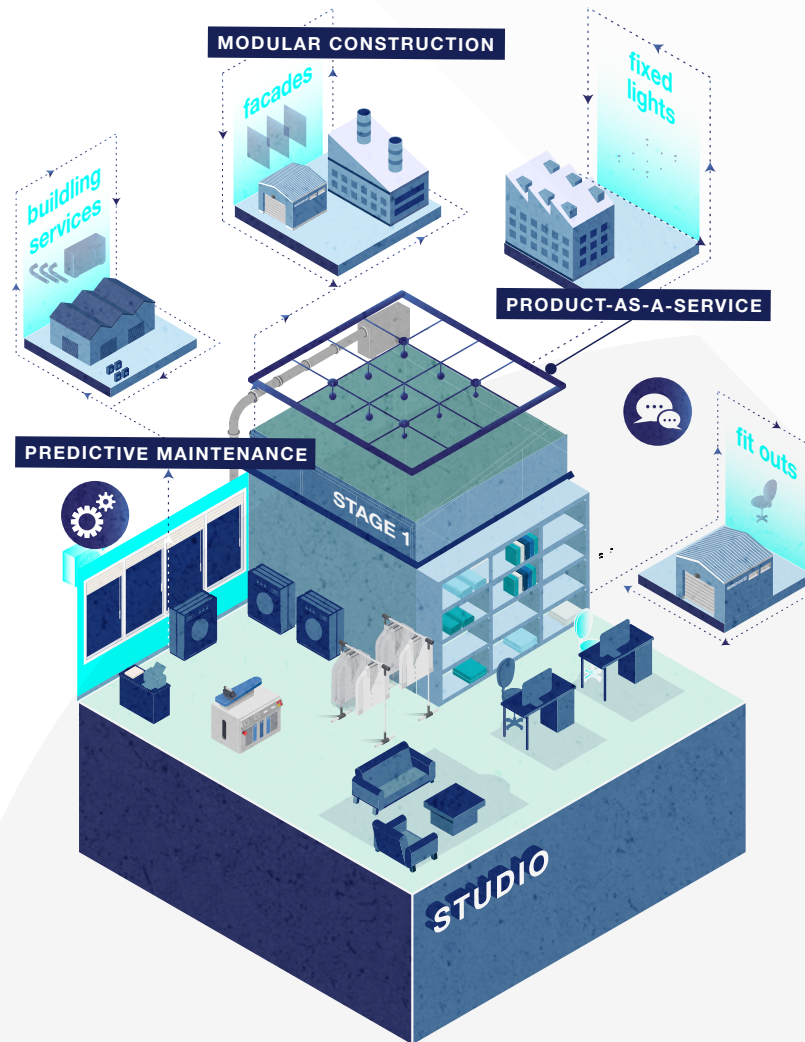
benefits

▷ **financial**
operational costs are only linked to usage and service performance

▷ **environmental**
suppliers incentivised to create high performance products and systems that last

▷ **social**
builds stronger on-going relationship between studios and their suppliers

MODULAR CONSTRUCTION

facades

fixed lights

buildling services

PRODUCT-AS-A-SERVICE

PREDICTIVE MAINTENANCE

STAGE 1

fit outs

STUDIO

case studies

CC0 Evan-Smogor

Signify
Circular Lighting, *Global*

Signify, previously known as Phillips Lighting, is supporting a transition to a circular economy through its lighting offering. Signify takes on the initial cost and ownership of the fixtures and fittings and remains responsible for the system's maintenance throughout the contract. Clients then only pay for the light that they use. Signify also reuses fixtures at the end of their lifespan as all its products are designed to be dismantlable and recycled. Additionally, its energy efficient LEDs coupled with intelligent lighting systems reduce energy consumption. Schiphol Airport saw a 50% reduction in energy consumption when using this model. Similar models could be adopted for film-specific services such as LED lighting, washing machines and dyeing infrastructure. This would be an appealing model for both studios and production companies, as the assets would not be owned or managed by either party. The studio would pay a subscription to the service but pass this cost on to the productions that would pay based on use. This would ensure higher quality products that are not short-lived or wasted.

similar initiatives: Kaer, Steelcase, Bundles

© Simon Kennedy

Sky Believe in Better Building
Modular Timber Construction, *UK*

Sky's Believe in Better Building demonstrates the use of a glue-laminated (glulam) timber frame and cross-laminated timber slabs to construct a net zero-embodied carbon multi-storey building in under one year. Arup's design focused on off site fabrication and modular construction to allow for the building to be assembled swiftly and efficiently on site. Such an adaptive fitting creates flexible spaces which allow for transitions between office, breakout and event spaces. The building also hosts a large, open-plan and column-free space that can accommodate large meetings and gatherings. This space can also be partitioned to achieve enhanced acoustic separation. This modular construction method has the potential to considerably reduce cost, time on site and waste generated compared with traditional on site construction methods. It is a viable solution for new builds as well as for phased retrofits of existing sound stages, as the reduced construction time would ensure reduced impact on filming time on that stage as well as causing less disruption for adjacent stages.

similar initiatives: The Circular Building, The Toronto Tree Tower, Netball Central Headquarters

critical implementation requirements

▷ studios adopt a life cycle approach to the procurement of building components through product-as-a-service contracts and predictive maintenance requirements

▷ suppliers install necessary sensor technology to monitor building component performance

▷ studios engage with existing suppliers to assess where sensors can be installed to monitor building component performance

▷ studios include modular construction requirements in studio development briefs

smart building management

sensor networks and real-time monitoring can reveal granular occupancy or usage patterns and help improve the efficiency of buildings

The digitisation of the built environment has increased due to better computing power, cheaper sensors, the Internet of Things (IoT), advanced analytics and more sophisticated 3D visualisations.

Building information modelling (BIM) is an established 3D model-based process that gives architects, engineers, contractors and asset managers the insight to more efficiently plan, design, construct and operate buildings. BIM can communicate information relating to all phases of a building's life cycle, which can facilitate planning for future uses and rapid adaptation.

Sensors can be embedded into many building components and systems, forming an IoT network. The data produced can be analysed in real time to provide insight on how to improve building operations; it can also be integrated and cross-referenced with other data, including BIM models and weather and transport data, creating a digital model of complex systems. Historical and real-time data can inform predictions about energy use, occupancy and logistic patterns, helping to optimise capacity.

Like sensors, smart meters provide near real-time use and cost information. They can show high, medium or low energy use to nudge people to turn off kit when not needed or to use natural ventilation if filming has paused. Information from sensors and smart meters can be visualised on dashboards giving studio and production managers a granular understanding and influence on operations.
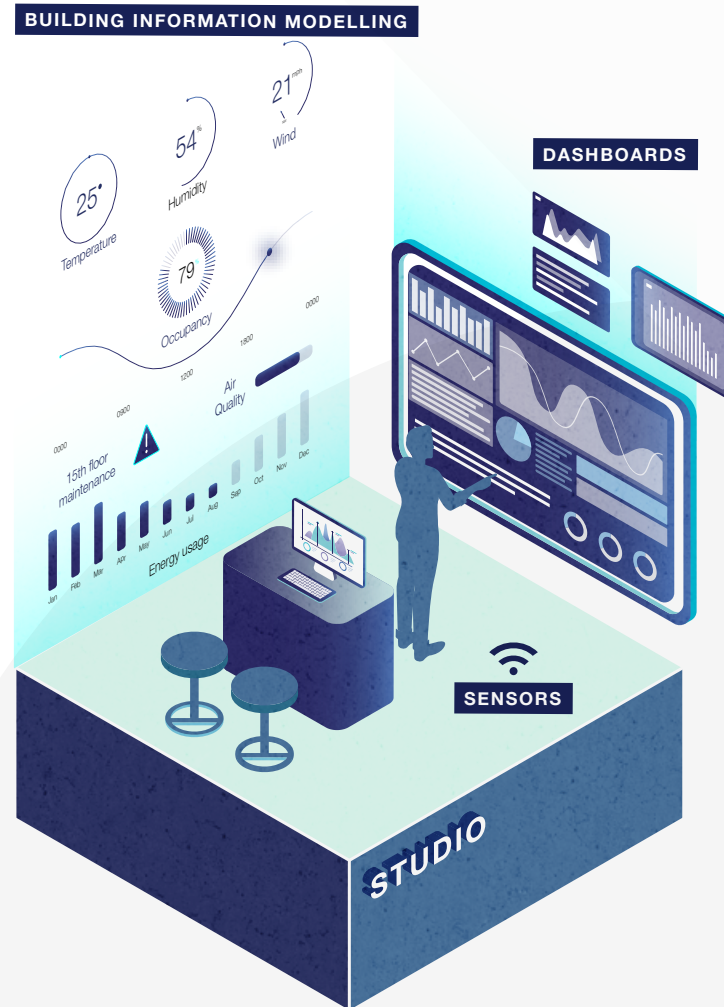
benefits

▷ **financial**
data can inform actions that reduce operational costs including energy costs

▷ **environmental**
data can be used to reduce energy consumption and inform predictive maintenance

▷ **social**
supports collaborative and integrated delivery of buildings across the supply chain

case studies

CC0 Dennis M2

The Edge
IoT Enabled Building Operation, *Netherlands*

The Edge is an office building designed to improve user experience and wellbeing. Its adaptable workspaces harvest data from the building's IoT system which lies at the heart of the design, while a mobile app allows users to control their environment, including light and temperature settings. This digital layer also enables building managers to optimise energy usage, for example environmental controls, cleaning and lighting, and shutting down whole sections when they are not in use. Having such an integrated technology can also help implement safer environments due to integrated strategies and easier dissemination of information in the event of an emergency. Implementing sensors and pervasive connectivity across studio sites could work towards collecting data for an integrated IoT system. This could help analyse and operate the site more efficiently (i.e. ensuring underused spaces do not waste energy) as well as enable managers and productions on site to communicate more transparently between and amongst themselves.

similar initiatives: White Collar Factory, Smart Climate Assistant

© Willow and Investa Property Group 2019

Willow Building Transparency
Digital Twin Solution, *Australia*

Willow has created a digital twin for a landmark office building in Sydney. The 3D-modelled replica of the building maps out every physical feature of the structure but also captures and tracks real-time data provided by the building's users and smart meters. By using a digital twin, the owners and occupiers of a building gain complete transparency of the building's function and use. Current and prospective issues can be responded to faster, saving money that might otherwise be lost due to delayed responses or missing information. This technology can be adopted by studios to help improve visibility for facilities managers in turn driving operational costs down. Having a digital twin is also known to improve tenant retention or in the case of studios, ensuring returning production companies. This would result from more timely processing of tenant service requests, improved visibility of the performance of facility managers and by providing production companies with access to data analytics of space utilisation and usage patterns to track their performance.

similar initiatives: Digital Twin, Water Cube Beijing

critical implementation requirements

▷ studios digitise the design, construction, operation and management of each building using BIM

▷ BIM models are shared with all stakeholders involved in building design, construction and operation

▷ existing studios ask utility service providers to install smart meters

▷ dashboards are designed based on requirements of different user groups

▷ studios use real utility consumption data to charge productions

04 studio sites and locations

the system of buildings, infrastructure, and shared spaces that support logistics, mobility and people's livelihoods

current status

The transport of people and goods to and from studio sites and locations is planned by individual productions and is not coordinated efficiently. This is partly due to a lack of transport data collection throughout production, or across studio and location sites. Some studios house film suppliers but these are not imposed on productions. The majority of production staff commute to work with their personal cars and make ad-hoc journeys to collect and drop off materials. The fuel cost is expensed back.

Signage at studios provides essential wayfinding information and caters for minimum required health and safety. There is no universal film industry signage for waste management. Productions are time constrained, which often leads to incorrect waste disposal and making studios reluctant to manage productions' waste contracts.

Studios are designed to maximise revenue generation, but this sometimes comes at the cost of staff and crew health and wellbeing. Few amenities and spaces for rest or recreation are available to staff. As a result, people are inclined to make additional trips to and from studio sites to access services for their personal needs. In the UK, studios allow productions to provide individual catering, which multiplies food waste. This also results in a lack of shared cafés or canteens offering fresh food and beverages throughout the day.
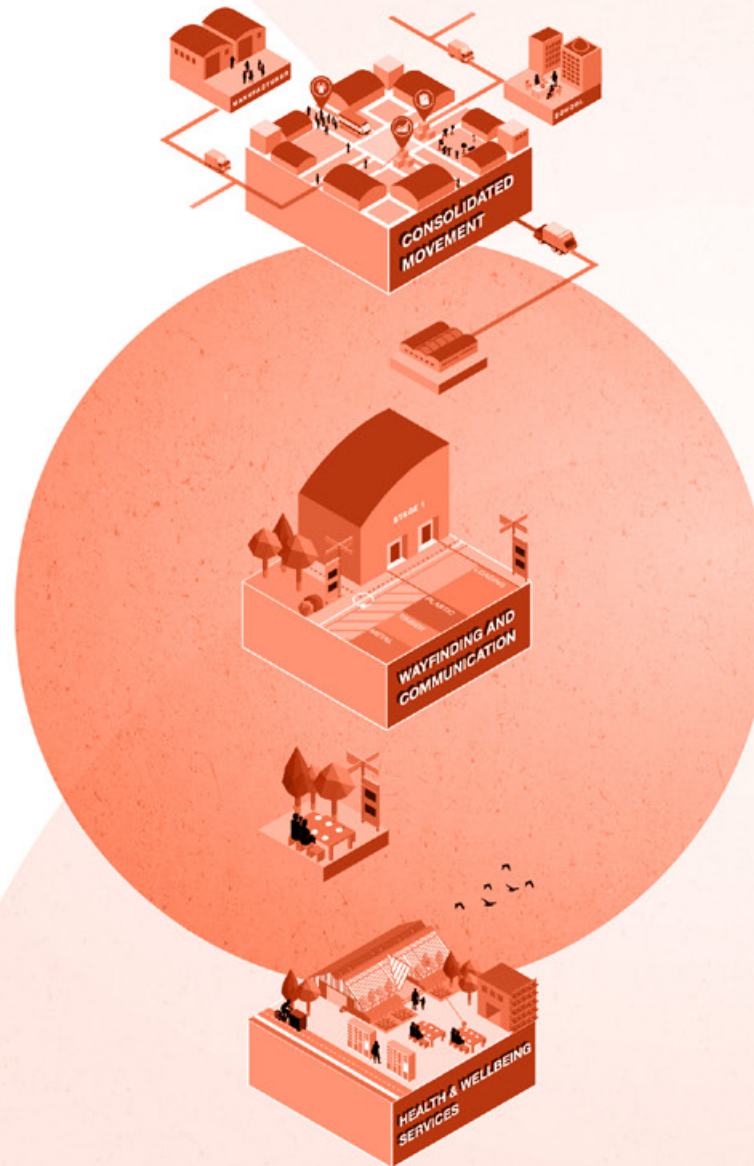
vision

▷ vehicle movement is reduced both on and off site

▷ user-centred wayfinding strategies facilitate logistics and correct waste disposal

▷ planned multimodal mobility allows people to confidently use public or shared vehicles and active forms of transport

▷ individual wellbeing supported by the provision of work-life facilities and healthy spaces

opportunities

▷ consolidated movement

▷ wayfinding and communication

▷ health and wellbeing services

consolidated movement

data should be used to predict transport demand and logistics patterns to reduce vehicle movements and associated emissions

The increasing availability of transport data from smartphones and satellite tracking offers greater insight into mobility patterns. Demand prediction enables routes and vehicle provision to adapt based on capacity; studios and production companies can use this data to provide infrastructure that supports more sustainable transport modes, such as bicycle storage and shuttle services from public transport stops. Demand prediction can also help create consolidated logistic centres that optimise delivery routes. This reduces vehicle movements on the road and on site, in turn reducing costs and air pollution. Consolidated centres could be an additional service provided by studios to mitigate the likely increase of transport resulting from a shift towards reuse networks.

The use of shared transport and ride-hailing platforms has increased in the past decade due to the ease of matching supply and demand via digital platforms. While consumer offers are widely used, variants such as corporate carpooling apps are emerging to provide flexible solutions targeted to the needs of specific businesses. If multiple transport options are available near studio sites, multimodal transport apps can direct people to their best option.

Transport distances can be reduced by integrating a production business hub within or near the studio site, or close to popular film locations. The hubs can include manufacturing, rental and educational functions. Such business ecosystems can activate innovative resource and skills exchanges for the industry with lower investment and risk.

PRODUCTION BUSINESS HUB

MANUFACTURER

MANUFACTURER

SHARED TRANSPORT

STAGE 8

STAGE 1

STAGE 7

STAGE 2

STAGE 6

STAGE 3

DEMAND PREDICTION

STAGE 5

STAGE 4

STUDIO

benefits

▷ **financial**
   reduces logistics costs for each production from reduced fuel use

▷ **environmental**
   improves air quality from reduced vehicle emissions

▷ **social**
   increases staff interaction

case studies

© Arup

MOPRIM
Advanced Travel Data Insight, *Global*

Moprim uses advanced analytics and GPS to create insights that help planners understand transport users in terms of their experience, needs and how they move through a city. Combining this type of quantitative data (from mobile phone GPS logs, gathered using apps) and qualitative data (from interviews) on transport users with machine learning can help yield insight on societal travel behaviour and patterns. These insights can help assess emissions and understand the complex ways people travel to reveal a true picture of the transport people use, need and could adopt. This approach could be adopted by studios or production companies to understand transport use and movements across and to their site or location. This could help studios and production companies plan for better infrastructure and transport design on and to their site. It could also inform which regulations or policies to enforce to encourage the more consolidated movement of people and goods without hindering their needs or experience.

similar initiatives: Citymapper, TFL Open Data

CC0 Claudio Schwarz

Transmetrics
Predictive Logistics Analytics, *Europe*

Twenty per cent of all trucks run empty across Europe.[25] This is caused predominantly by low visibility of future orders by freight providers. Transmetrics uses big data and predictive analytics to increase transparency in the logistics sector. Transmetrics' services are able to provide accurate demand forecasts generated by processing historical logistics data combined with other factors, such as weather and seasonal demand trends. These forecasts can be used by logistics providers and other companies to optimise entire fleets or logistic networks, allowing them to transport products with fewer vehicles. The result is an average transportation cost reduction between 6 and 10%. Fewer vehicles on the road also means lower carbon emissions and better air quality. For production companies, the use of predictive analytics and consolidated freight could reduce the number and size of transports required, lowering costs and environmental impact.

similar initiatives: Most, DHL Reverse Logistics

critical implementation requirements

▷ studios and location managers collect anonymised transport data to develop a transport plan for the studio site and location, respectively

▷ studios and location managers are in dialogue with local authorities to share mobility insight and inform transport strategies

▷ studios and production managers engage with corporate shared mobility providers to find optimal shared transport solutions that fill public transport capacity gaps

▷ transport plans encourage the use of public transport, shared transport and active forms of travel

▷ reuse network logistics providers use consolidation centres if warehouses are located far from filming sites

▷ studios include allocation of space to industry suppliers and service providers in studio development briefs

▷ studios and production companies introduce policies, build capabilities and build infrastructure to harvest data with state-of-the-art standards that allow their interoperability with external data sources, such as open transport data

wayfinding and communication

wayfinding across the site should be visible and intuitive to encourage more sustainable behaviours and choices

Encouraging individuals to create new habits and maintain them through wayfinding and nudging strategies is key to successfully implementing sustainable practices. Physical wayfinding graphics are a simple yet powerful way to signal the presence and location of sustainable initiatives across studio sites. These might include consistent waste and recycling points or health and safety requirements. Intuitive floor marks and clear images or colours will help those working on tight schedules. A unified semantic language across studios can further facilitate the adoption of these practices.

Real-time information display can be used to show live information on route diversions, public transport timetables, production schedules and other temporary initiatives. They could be full-motion or dot matrix screens located on the exterior of buildings or on purpose-built units. The screens could be interactive and allow people to log incidents or call specific people, similar to a concierge service.

Digital concierge services use interactive signage or mobile applications to inform individual users of what spaces and services are available on site and allow them to book and use them in minutes. Besides enabling a more intensive use of facilities, digital concierge systems can integrate personal data, subject to users' informed consent. Linking data such as corporate records, social media, or location data to building performance analytics can enable more responsive and personalised services, and increase people's awareness of their personal impact on environmental performance.
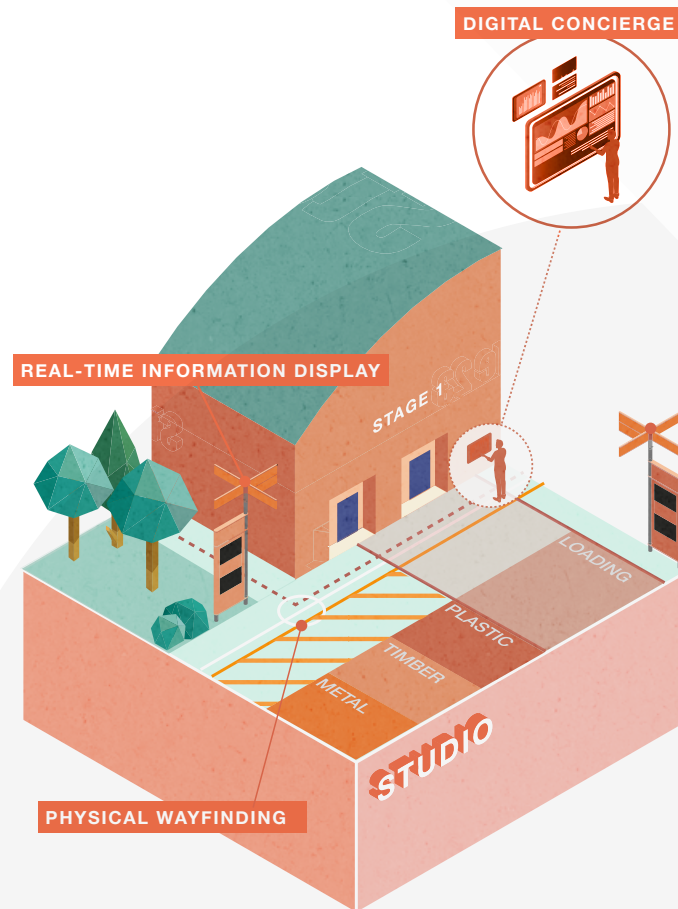
benefits

▷ **financial**
reduces operational cost related to managing services and spaces

▷ **environmental**
encourages sustainable behaviours and outcomes

▷ **social**
strengthens communication between studio owners and production staff

DIGITAL CONCIERGE

REAL-TIME INFORMATION DISPLAY

STAGE 1

LOADING

PLASTIC

TIMBER

METAL

STUDIO

PHYSICAL WAYFINDING

case studies

Waste Aware Construction
National Colour Coding Scheme for Construction Waste, *UK*

The UK's Waste Aware Construction and the Institution of Civil Engineers (ICE) have introduced a colour coding scheme for construction sites. Each material is attributed a colour and every site worker is expected to be familiar with the system to ensure waste is correctly separated on site. The scheme includes intuitive colour-coded signs and infrastructure that should be placed in strategic locations across the constructions sites to facilitate correct waste disposal with minimal effort. A similar colour-coding system, standardised and tailored to the film industry, could be adopted across studio sites and locations. Its implementation could reduce waste sent to landfill, carbon emissions and waste disposal costs, while increasing recycling and reuse opportunities. Using a unified signage language across the industry will help contractors and freelancers in adopting consistent practices for waste disposal, as it will not require constant adaptation to different disposal systems.

similar initiatives: SmartSegregate System, WRAP signage
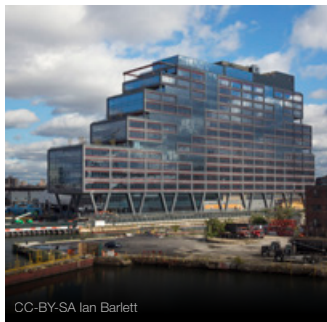
Dock 72 by Boston Properties and Rudin Management
Digital Concierge by Prescriptive Data, *USA*

As more and more people seek convenience day to day, landlords of large-scale developments increasingly invest in strategies to attract and retain tenants. These include offering experiences, cultural amenities and services within their buildings. A new building in Brooklyn, Dock 72, uses proprietary technology to support the tenants and employees who occupy the building. A mobile app acts as a digital concierge service, with tenants and employees using it to register guests, book in-house fitness classes, reserve event spaces and log maintenance issues. The data collected by the app feeds back real-time insight to property managers, providing insight into user patterns that helps to improve services, user experience and performance of the building. A similar system could be adopted by studios to offer their tenants more visibility, availability and accessibility of services and spaces across the site.

similar initiatives: Dexus, TFL Applied Wayfinding, Mapbox Augmented Reality

---

critical implementation requirements

▷ industry bodies develop industry-wide waste signage or adopt existing waste signage from other industries

▷ studios use industry-agreed or other universal waste signage on their sites

▷ studios and production companies adopt transparent terms and conditions for data harvesting and use

▷ studios build digital infrastructure that enables the interoperability of data from different sources, including building sensors, mobile location data, weather, production schedules and more

▷ studios and production companies engage with service design consultants to create outcome-focused services that respond to user needs

health and wellbeing services

facilities should be provided that allow staff working at studios to be healthy and productive, enhancing their experience at work

Introducing centralised catering facilities at studio sites, which provide convenient and healthy food with reduced meat options, can curb individual productions arranging their own catering. The provision of these centralised facilities could significantly reduce single use crockery and cutlery waste as well as target initiatives to reduce food waste. The space could also double up as a meeting space. Alternatively, if productions would like to continue with their own catering, there are provisions for permanent kitchen spaces that use lower carbon cooking fuel than mobile catering facilities.

Locating work-life facilities on studio sites supports the more practical aspects of people's lives. Examples include lockers for online shopping or grocery deliveries, childcare services and laundry services. Such facilities provide studio and production staff with greater flexibility, which can reduce their stress levels and support their work-life balance. It also reduces the number of trips they would have to make individually to otherwise meet their needs.

Physical activity for staff on site should be encouraged by providing crew and staff changing rooms with showers and lockers. This would allow staff using active forms of travel to get to work, such as walking, running or cycling, and those wanting to exercise during their break times, to shower before working. This will be increasingly important as more staff seek a work-life balance.

CENTRALISED CATERING FACILITIES

CHANGING ROOMS

WORK-LIFE FACILITIES

STUDIO

benefits

▷ **financial**
additional retail or other commercial services increases rental income for the studio

▷ **environmental**
reduces vehicle carbon emissions as services now provided on site

▷ **social**
promotes healthier lifestyles and supports employee wellbeing

case studies

© Garrett Rowland

Dropbox Headquarters
Central Cafeteria, *USA*

Dropbox's new cafeteria and coffee bar in its San Francisco headquarters was designed by AvroKO to provide a central space for relaxation away from the hustle of work. To achieve this, the canteen area was given a domestic feel to make it an appealing place for a break, away from work but still on the premises. Employees at tech companies often face long working hours, and as a result many have adopted a similar offering to ensure staff can take a break and feel relaxed. With food becoming increasingly recognised as an important point of convergence for people to socialise and relax, studios could consider offering a similar form of common area for all production employees on site to retreat from work duties throughout the day. This could be in the form of a canteen or another form of relaxation space that helps differentiate work from breaks.

similar initiatives: Facebook Cafeteria

© The WonderWorks

Warner Bros Studios
On site Nursery, *UK*

The first dedicated, on site childcare facility at a UK studio is expected to open at Warner Brothers in Leavesden. With 45 places available for production and studio staff children, the service intends to support working parents and help them better manage their time. This initiative was led by Charlotte Riley and Mark Radcliffe, co-founders of Wonderworks, and Emily Stillman at Warner Bros. Wonderworks was founded in 2019 and has been providing similar on site childcare facilities for workers in creative industries. It has even considered the off site needs of the industry by designing a WonderBus nursery that can accompany productions wherever they may be (i.e. on location). Offering this service can improve accessibility, affordability and flexibility to working parents as well as drive equality. This can alleviate stress and offer parents a better work-life balance in their day-to-day lives on set.

similar initiatives: Amazon lockers, Samsung nap pods

critical implementation requirements

▷ studios include a shared canteen and cafés that provide healthy food throughout the day

▷ studios integrate work-life facilities and changing facilities for occupants in studio development briefs

▷ studios incentivise the use of centralised catering services by productions

05 production planning

the systems, processes and information behind the
delivery of productions

current status

Digital tools, which enable better planning and scene
design before physical construction begins, are not
widely used. Currently everyone has to be in the
same place for set design and creation, which can
mean a lot of travel.

Lower budget films tend to use emails, and share
information in separate documents, as subscriptions
to digital production planning tools are seen as an
unnecessary cost. Updates to schedules and scripts
are emailed to everyone. They are sometimes printed
following revisions, creating paper waste. This results
in slow, fragmented and repetitive communication,
which undermines the ability of productions to
respond rapidly to changing circumstances.

There is little capacity in the industry to collect data
consistently at large scale and across regions. Data
sharing and communication across production is
very limited, mainly due to confidentiality issues.
Communication between productions is based on
personal networks.

Industry sustainability benchmarks do not exist, but
there are several sustainability certification schemes
that productions can be part of. The US model, in
which studios and productions are more integrated,
enables production data to be benchmarked by the
larger studios for use in improving sustainability
across their productions.
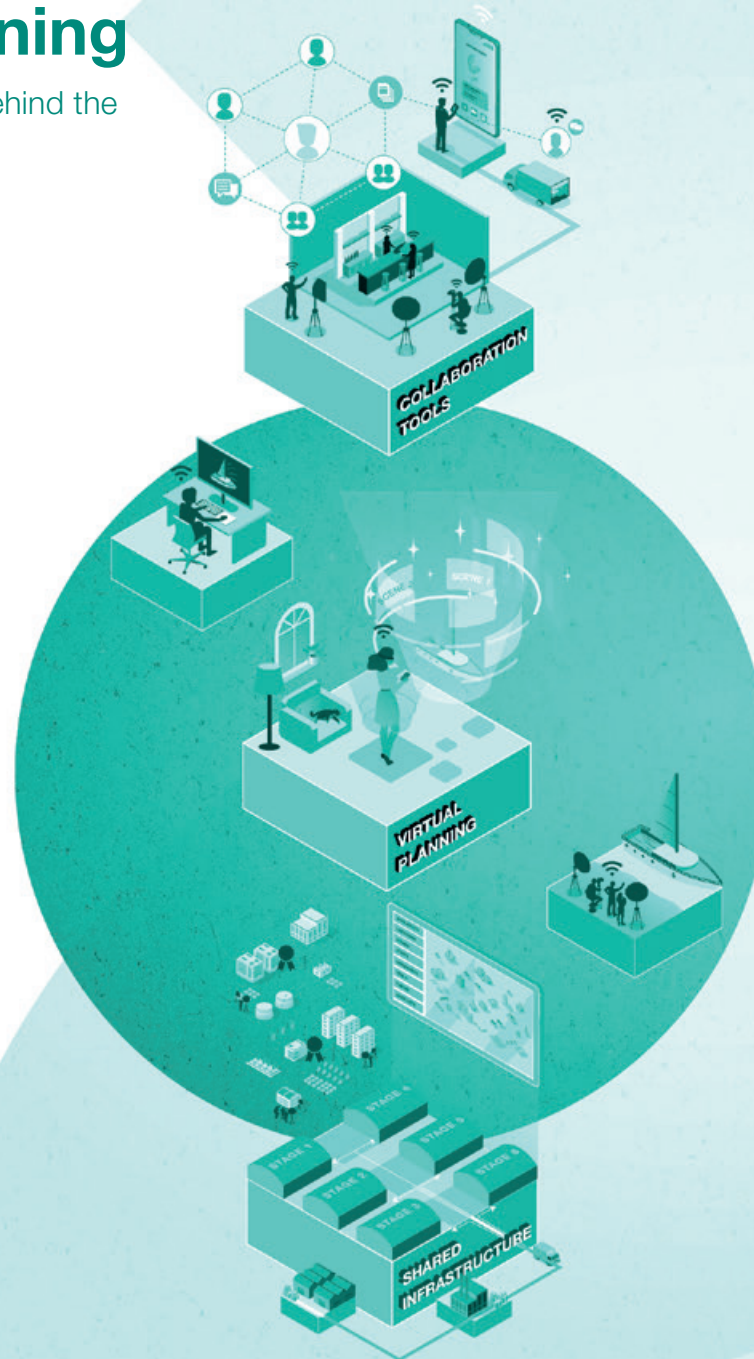
vision

▷ communication platforms support seamless
collaboration throughout the production
life cycle

▷ data from production operations is collected
and anonymised by independent industry
bodies and used to promote collaboration
initiatives and create industry-wide
sustainability standards

▷ previsualisation is adopted by all direction
departments to test shots virtually and avoid
waste generation

▷ environmental impact is forecasted during
design development and de-construction
plans developed

▷ film industry to consider whether a
sustainability fund – funded by the industry for
the industry – in order to support industry-wide
infrastructure projects would be helpful

opportunities

▷ collaboration tools

▷ virtual planning

▷ shared infrastructure

collaboration tools

communicating and sharing information on digital platforms allows for better coordination and more rapid responses

Collaboration platforms allow everyone on a production to communicate and share files from a single point. They avoid parallel conversations and information asymmetries typical of email exchanges. These platforms integrate scheduling tools to allow more responsive and agile coordination. They can also have sustainability reporting functions built into them, such as automatic reporting based on available data. Collaboration platforms rely on cloud infrastructure and data-sharing protocols to function.

Cloud computing uses remote servers for the storage and manipulation of data via an internet connection. It provides a single access point for storing and analysing large datasets originating from disparate sources. Cloud computing has unlocked the potential for stakeholder collaboration, allowing information to be accessed simultaneously by multiple devices. To enable this, studios will have to provide sufficient network infrastructure coverage.

Digitising and sharing data produced from collaboration platforms or other sources such as carbon reporting tools serve many functions. Sharing data related to production schedules means that existing production material databases that feed into sharing platforms can be kept up to date. The data required by carbon reporting tools could be collected by collaboration platforms for accurate reporting and for widespread sharing to better understand the sustainability challenges the industry faces. When confidentiality does not permit sharing data across productions, independent third parties can provide a layer of anonymisation.

COLLABORATIVE PLATFORMS

CLOUD COMPUTING

SHARED DATA

STUDIO
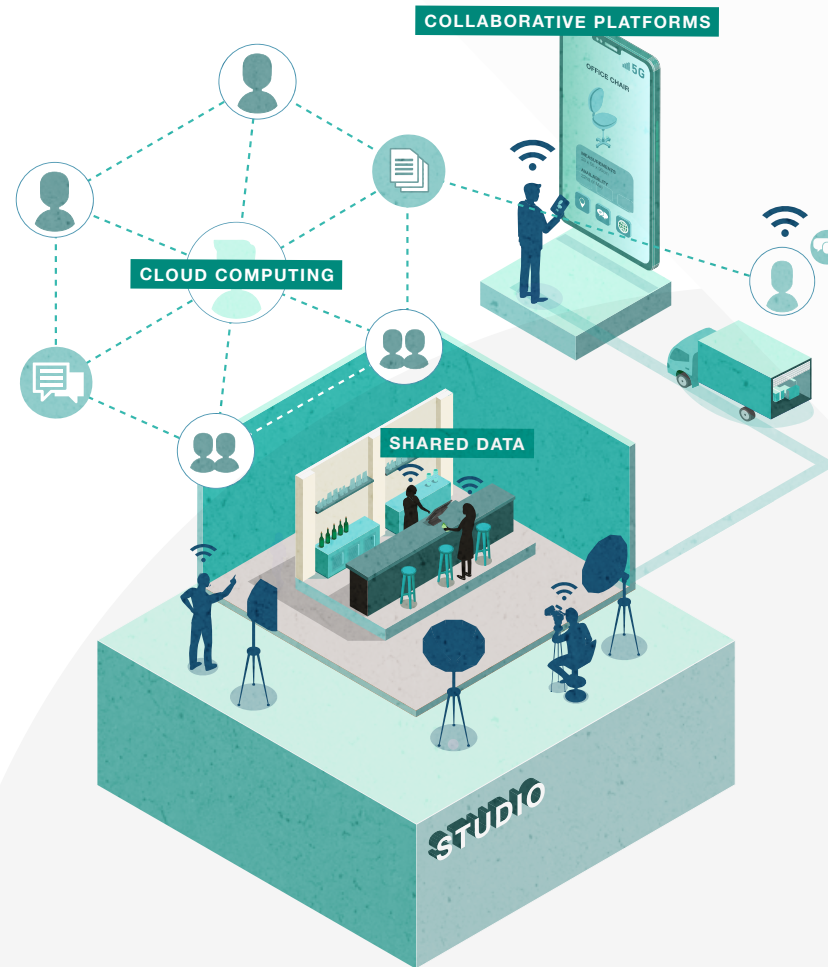
benefits

▷ **financial**
supports effective communication for more efficient and rapid operations, saving time and money during production

▷ **environmental**
reduces waste generation from buying redundant materials and equipment

▷ **social**
provides a single platform for all staff to work from, collaborate on remotely and communicate

case studies

Photo by rawpixel.com form PxHere

StudioBinder
Web-based Workflow and Planning Tool, *Global*

StudioBinder is a web-based workflow and planning tool bespoke for video, television and film production. It brings together all parts of a production – making the process more manageable and seamless. Offering an overarching view of progress across all stages of production helps to identify potential conflicts more quickly and plan more effectively. Functions include creating and sending personalised call sheets, attributing or tagging props and wardrobe to parts of a script or to a specific shot and disseminating shooting schedules, contacts, tasks, calendars and files. StudioBinder can also help to storyboard collaboratively, digitally and remotely; this helps directors as well as producers visualise scenes and plan and change them over time without having to be in the same place, or having to build it, and enables more agile working habits while still maintaining a clear picture of progress.

similar initiatives: Yamdu, Celtx, Storyboard That, Move Magic Scheduling

CC0 Peter Stumpf

Bait Studio
Collaboration Platform Research Project at Clwstwr, *UK*

Clwstwr is a research and development programme intending to foster innovation in the film industry and to encourage sharing and collaboration. It is part of the Industrial Strategy Challenge Fund and is being delivered by the Art and Humanities Research Council on behalf of UK Research and Innovation. Projects being researched and developed range from a new production management platform to an interactive storytelling tool, to a remote working environment for creative editing. One interesting project is "Bait Studio" which could act as a collaboration platform for productions to integrate into their everyday working. Unlike existing software solutions on the market which are often fragmented, this would provide an end-to-end solution. A standardised production management platform could help small visual effects/motion design studios to work more efficiently and compete more easily with their larger counterparts.

similar initiatives: Plan V

critical implementation requirements

▷ productions adopt digital collaboration platforms for planning and coordinating productions

▷ studios provide sufficient internet coverage for everyone on site to use collaboration platforms

▷ studios and productions share their sustainability data with industry bodies

▷ industry bodies develop data contracts giving confidence to productions that the data they provide will be anonymised to the required and agreed level before being published to the wider industry

virtual planning

digital previsualisation (or pre-vis) allows directors and producers to test shots ahead of production planning, reducing unnecessary set construction or procurement

Virtual reality allows directors and producers to test the viability of their concepts, storyboards, sets and scenes before they go into production. It also helps them explore camera shot angles and lighting through virtual sandboxes before real-world shooting. The high computational power of modern graphic processing units allows directors to interact accurately and manipulate visualised shots. This results in fewer unnecessary set constructions, better consolidated logistics, and reduced time and costs. Virtual reality can further enhance this experience by allowing directors to collaborate remotely on virtual scenes in a shared digital environment. High quality remote collaboration can improve the industry's resilience to disruptions such as that experienced during the COVID-19 pandemic.

5G connectivity can allow mobile devices to transfer large volumes of data at high speed. For film production this means quicker transfers of footage after shooting, allowing for more rapid reviews and edits, and compressing timelines for new iterations of scenes. This is especially useful in locations that do not have wired connectivity.

3D capture of existing props or other set components through photogrammetry is a rapid solution to compile high-fidelity asset banks that can be accessed by productions. 3D visualisations, combined with information on availability, frequency of use, current conditions and locations, can help set designers extend the use of props from previous productions.

benefits

▷ **financial**
reduces costs as more accurate planning results in less mistakes and requires fewer contingencies

▷ **environmental**
reduces material use as less trial and error with physical construction

▷ **social**
supports collaborative visioning from the outset

case studies

CC0 Stella Jacob

The Third Floor
Previsualisation Studio, *USA*

The Third Floor is a visualisation studio which specialises in the previsualisation of games, films and television. The studio helps its clients imagine and plan stories, solving design problems from storyboarding through to post-production. Using virtual reality and 3D-modelling sets or scenes, the studio allows directors and producers to explore their own narrative and design shots at the onset of a project (pre-production). This facilitates testing of creative preferences and uses technical analysis to help assess how scenes could be most effectively and efficiently shot. This digital process also supports remote collaboration in design and editing. The studio can also provide digital planning through services such as virtual location scouting, with visualisation reducing the need to travel and time spent building variations of a set (reducing cost and material use) as well as the number of takes of a shot or scene because the angle can be optimally predetermined digitally.

similar initiatives: Framestore VR Studio, Halon Entertainment, MPC R&D

CC-BY Mark Hillary
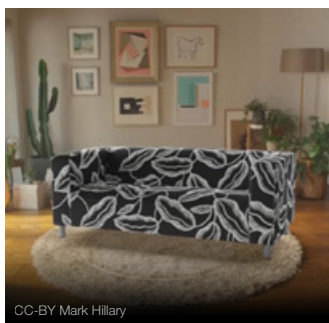
IKEA Place
Augmented Reality Application, *Global*

IKEA Place is an augmented reality app that can be used alongside IKEA's online catalogue to show users what specific items would look like in their home. Using mobile phone sensors and embedded cameras, this service scans interior environments and overlaps digital models of furniture to scale onto the room visualised on phone displays. The app allows users to both browse and test interior decoration ideas through their devices. IKEA Place is a significant step in the merging of augmented reality with potential applications for the film industry where props and costumes could be digitally mapped against a live film set on location or in a studio. This would help make more rapid decisions for spatial design and construction requirements. It could also reduce transport cost and emissions by reducing the need to bring props to be tested on site.

similar initiatives: Cylindo, TrueViewVisuals

critical implementation requirements

▷ direction and art departments adopt previsualisation practices during the planning phase of every production to inform their work

▷ 5G networks are available in the locations where previsualisations are being undertaken

shared infrastructure

physical and digital services funded by the industry to support widespread adoption of sustainable practices across the industry

The successful adoption of sustainable practices requires shared industry infrastructure that supports information sharing along with new logistics systems organised around reuse networks. Regional online location libraries that include information such as sustainability credentials, building ratings and performance, available energy sources and proximity to water can help location managers make more informed decisions.

There is an opportunity for studios to provide shared procurement services for productions located on their premises to consolidate orders and deliveries from local and global suppliers. This service can also make sourcing of costumes, props and equipment quicker. A digitised database can store supplier information, including responsible sourcing certifications, supplier take back information and other sustainability credentials for buyers to make informed procurement decisions.

Introducing new initiatives can be a business opportunity for existing or new players. The film industry should consider whether an industry sustainability fund would be helpful. This could help to reduce the associated enterprise risk for those who take the initiative, potentially covering initial set up costs and part-funding operations. Fund contributions could be proportional to the financial means of subscribing studios and productions to incentivise their use. The fund could be administered by an independent industry body to ensure transparency and fairness. Stakeholders with working knowledge of the industry are well placed to provide these services. A similar approach has facilitated change in other industries, such as packaging.
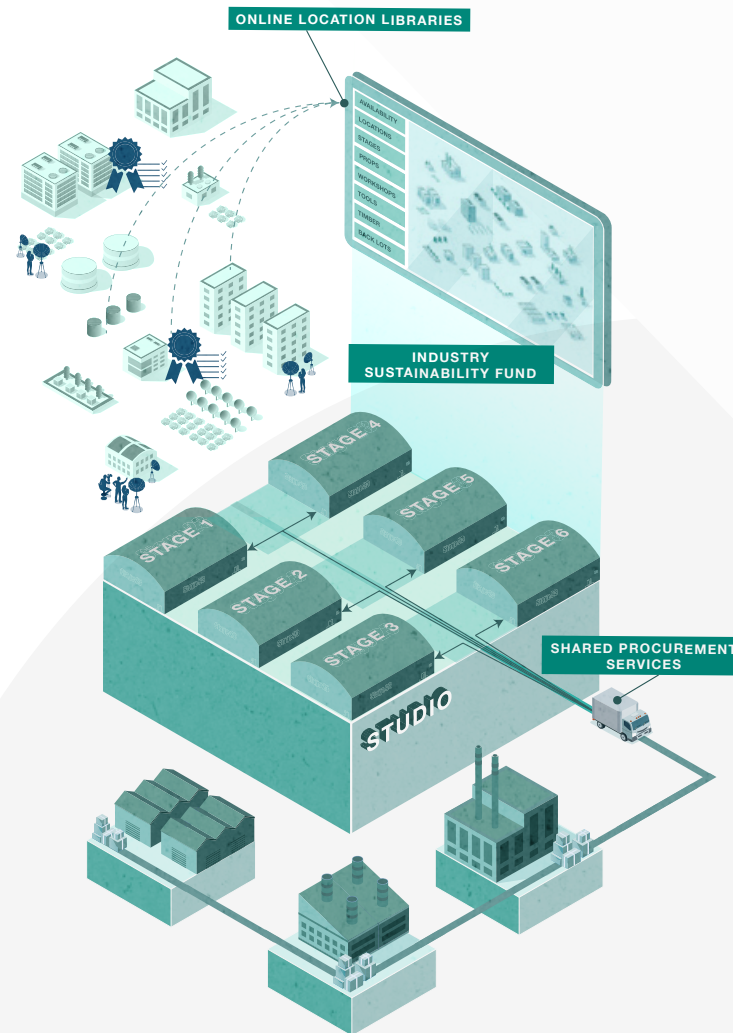
benefits

▷ **financial**
capital investment shared by the industry

▷ **environmental**
infrastructure to support sustainable actions

▷ **social**
responsibility to be sustainable feels shared across the ecosystem

case studies

© Dartmoor National Park Authority

Creative England Location Library
Online Location Library, *UK*

Creative England's location library is an online platform with a database of over 10,000 filming locations and a list of crew and facility companies across England. This openly available resource ensures productions can find suitable places to film as well as contacts for production services which provide on-location equipment and services (i.e. runners, honey wagons, hairdressers, caterers and camera operators). Creative England also offers production information, support and specialist local expertise to film and high-end television productions to ensure they have everything they need on site. Their capacity to track production across the English regions enables them to deliver their services free of charge, supporting industry and policy development and investment. Initiatives to make location filming more accessible and connect people locally can reduce cost and emissions associated with moving equipment to locations.

similar initiatives: Screen Yorkshire, Film London, Screen Scotland, Lavish Locations Wales, Northern Ireland Screen, The Location Guide, Set Scouter

CC0 Alfonso Navarro

UK Packaging Waste Regulations Producer Responsibility Scheme
Responsibility Scheme, *UK*

Producer responsibility is a concept that aims to ensure businesses take responsibility for their products in the economy that have reached the end of their life. Under the UK's Producer Responsibility Obligations (Packaging Waste) Regulations, businesses that have a turnover of more than £2m and handle more than 50 tonnes of packaging in any one year must pay into a registered compliance scheme based on the amount of packaging they handle. The revenue generated by the compliance schemes is distributed among eligible packaging waste collection, recovery and recycling infrastructure providers. In 2014, the revenue generated through the regulations was £63.8m. In the film industry, a service provider could collect revenues based on the tonnage of costume or plywood used by a given production, for example, to fund reuse networks. The culture of shared responsibility that this setup creates would benefit the film industry as costs incurred to productions would be proportional to their potential impact.

similar initiatives: European Union End of Life Vehicles Directive, Canada-wide Action Plan for Extended Producer Responsibility, California's Paint Stewardship Law

---

critical implementation requirements

▷ the film industry should consider whether a sustainability fund would be helpful

▷ existing location library providers expand scope to include sustainability ratings of locations

▷ studios or third-party service providers provide shared procurement services for productions

recommendations

For the film production industry to move towards a sustainable future, reducing its impact on the environment and embracing the opportunities outlined in this report, changes need to be made across the whole ecosystem. These range from everyday practices and choices that are relatively simple to adopt, to structural industry-wide shifts. For each, it will rely on stakeholders within the industry to invest time and effort to make these a reality. It is important to understand which groups or individuals within the industry play a role in realising each opportunity, and their specific responsibilities.

To facilitate prioritisation and decision-making, the recommendations set out in the following pages have been categorised into three groups (now, new, next) that illustrate their readiness for adoption in the current context of the film production industry. The recommendations can help stakeholders further define the role they can play in sustainable film production, convening conversations with the right people, collaborating and acting to make the crucial impact needed. ◻

▷ **now:** interventions that could be implemented immediately. It is done within other industries and could be translated into the context of film production without the need for large-scale change within the industry

▷ **new:** interventions that are common in other industries and could be implemented into the film industry with some adaptation and thoughtful planning

▷ **next:** interventions that introduce new technologies and ways of working. Implementing these interventions successfully in the film industry would require radical change and drive

now
opportunity can be implemented immediately

new
opportunity can be translated into the film industry

next
radical change and drive needed to implement opportunity
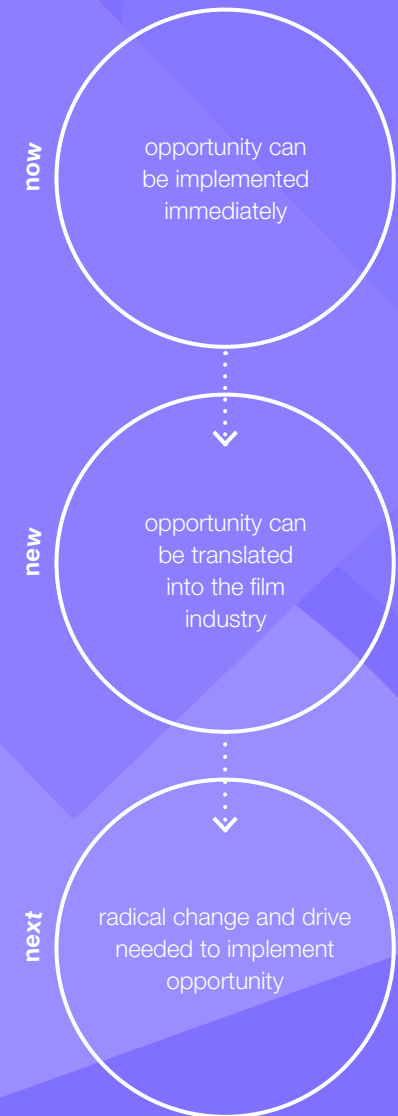
production materials recommendations

art, styling, sound and lighting departments

opportunities	interventions	readiness now, new, next	stakeholders artistic departments	production department	direction department	studio management	third party service provider	👤 key stakeholder
reuse of materials	**sharing platforms**	new	*all departments* use sharing platforms as first option when procuring materials	👤 create a new function to ensure sets are dismantled at end of use and place materials back into reuse networks			offer reuse networks	
	warehouses	now	*location department* provide temporary spaces at unit bases to store materials before they enter reuse networks	utilise warehouses before and after production			👤 provide storage space	
	material passports	new	*arts department* ensure material passports are used diligently when handling materials				👤 ensure the use of material passports with all created, procured and leased materials	
buying virgin materials responsibly	**responsible sourcing**	now	*all departments* engage supply chain for greater transparency	👤 put in place responsible sourcing policy to be followed across all departments			develop new sustainable material alternatives that achieve comparable performance to those traditionally used by the industry	
	sustainable materials	now	*all departments* procure sustainably and share supplier information with the industry	👤 procure sustainably and measure impact				
	local sourcing	now	*all departments* procure locally and share supplier info with the industry	👤 procure locally				
resource-efficient set construction	**design for deconstruction**	now	👤 *set design department* always consider deconstruction when planning sets		crucial design choice in the creative planning process			
	parametric design	new	👤 *set design department* utilise these design tools in collaboration with the director		utilise these tools to translate creative direction into optimised geometries		develop a more competitive market of parametric design tools specific to film production	
	digital fabrication	new	👤 *set design department* set designers make use of parametric techniques	support set designers adopting new design for deconstruction approaches			develop a more competitive market of digital fabrication tools specific to film production	

energy and water recommendations

art, styling, sound and lighting departments

opportunities	interventions	readiness now, new, next	stakeholders artistic departments	production department	direction department	studio management	third party service provider
energy demand reduction	**passive design**	now				👤 incorporate into the design of structures and buildings on site	architects, engineers and consultants develop passive design solutions that meet sound and light requirements of productions
	green infrastructure	now				👤 incorporate into the urban design of studios and filming areas	
	low energy lighting	now				👤 select specific fittings for areas of the studio built environment	industry could manufacture low energy lighting options specific to the needs of the film industry
sustainable energy sources	**renewable energy**	now				👤 set operational carbon benefits, switch to a green energy supplier and ban diesel generators on site	suppliers switch from fossil to renewable energy generation
	battery storage	new		👤 select battery charging generators for power on location			utilise battery storage to conserve energy taken from the grid
	microgrids	new				👤 switch to renewable energy tariffs where retrofit of renewable energy installations are not possible	
water demand reduction	**rainwater harvesting**	now	*location department* install infrastructure on location shooting			👤 install permanent infrastructure on buildings	engineers working on studio design assess optimal location to install water tanks
	greywater recycling	now				👤 integrate grey water recycling infrastructure into buildings	
	composting toilets	now	👤 *location department* install temporary infrastructure on location shooting			👤 provide composting toilets for the studio	

👤 key stakeholder

studio buildings and facilities recommendations

art, styling, sound and lighting departments

key stakeholder

opportunities	interventions	readiness (now, new, next)	stakeholders: artistic departments	production department	direction department	studio management	third party service provider
repurposing buildings	**building retrofit**	now				seek opportunities to retrofit existing buildings and prioritise retrofit over new build	architects, engineers and consultants to undertake scenario planning for studio to inform flexible design measures
	flexible spaces	now				provide spaces within the studio that can be reprogrammed or arranged for different uses	
	adaptable buildings	now				create buildings with adaptable shell and core	
buying products as a service	**product-as-a-service contracts**	new				procure studio services through product-as-a-service contracts	
	predictive maintenance	new				utilise the data that is supplied by building performance sensors to carry out predictive maintenance	suppliers install necessary sensor technology to monitor the performance of building components
	modular construction	new	*set design department* work to create construction designs that utilise modular construction		suppliers switch from fossil to renewable energy generation	studios adopt a lifecycle approach to the procurement of building components	move to off site modular construction to reduce waste and increase efficiency
smart building management	**building information modelling**	now	*location department* install infrastructure on location shooting			use BIM to efficiently plan, design and operate buildings on site	
	sensors	new				embed sensors across site	
	dashboards	new		utilise dashboards to understand the production's resource consumption		provide dashboards to visualise usage data for productions and studio operations	

studio sites and locations recommendations

art, styling, sound and lighting departments

opportunities	interventions	readiness (now, new, next)	stakeholders — artistic departments	production department	direction department	studio management	third party service provider
consolidated movement	**demand prediction**	new				👤 use demand prediction tools to inform logistics on site	provide tools to collect and analyse demand data
	shared transport	now	*location department* collate data on crew journeys to create transport plan	👤 coordinate and encourage the uptake of shared transport within production team			
	production business hub	now		encourage the use of services and products from business hubs	encourage the use of production hubs to enhance creativity	coordinate and incentivise the creation of production hubs	
wayfinding and communication	**physical wayfinding**	new				invest in industry-wide uniform signage to enhance productivity and waste management	
	real-time information display	new		offer production data that is generated on studio sites, to integrate into real-time information displays		👤 utilise data from movement, building use, environment to display real-time inforomation	
	digital concierge	new				👤 provide digital concierge services within studio premises	
health and wellbeing services	**centralised catering facilities**	now				👤 provide centralised canteen services and mandate their use by productions	
	work-life facilities	now				👤 provide work-life facilities within studio premises	supply amenities to be installed on site
	crew and staff changing rooms	now				👤 provide changing rooms for crew and staff within studio premises	

👤 key stakeholder

production planning recommendations

art, styling, sound and lighting departments

opportunities	interventions	readiness (now, new, next)	stakeholders — artistic departments	production department	direction department	studio management	third party service provider
collaboration tools	**collaboration platforms**	now	*all departments* utilise digital platforms relevant to their work	👤 ensure all relevant data is made available on the platform and create plan of use at production outset		studios provide sufficient internet coverage for everyone on site to use collaboration platforms	
	cloud platforms	now		👤 plan for the use of cloud platforms from the outset and utilise them throughout production			
	sharing data	new		digitise production schedule data and share to enable coordinated logistics			
virtual planning	**virtual reality**	new			👤 use virtual reality to enable remote direction or enhanced planning		provide competitive tools specific to the film industry
	5G	next					
	previsualisation	next	*art department* use previsualisation during the planning phase of every production	use insight from previsualisation to optimise material procurement	👤 use previsualisation tools and methods to enable filming		provide competitive tools specific to the film industry
shared infrastructure	**online location libraries**	new	*location department* location managers to use online libraries to make more informed choices				
	shared procurement services	new		👤 ensure productions feed procurement data into shared procurement platforms		provide shared procurement services for productions located on the same site	
	industry sustainability fund	new		productions would pay a percentage to create an industry sustainability fund			

👤 key stakeholder

conclusion

This report sets out a vision for sustainable film production, proposing a step change in the way the industry is organised and operated. The time to act is now as governments around the world are looking to meet legally-binding carbon reduction commitments, which will impact all industries and society. In late 2018, BlackRock CEO Larry Fink claimed that within the next five years, all investors will measure an investment's impact on environmental, social and governance factors to determine its worth.[21] Some investors have already started to voluntarily disclose their climate-related financial risks in anticipation of future requirements. Film investors are likely to follow suit with productions having to accurately measure and report on their carbon footprint.

From reviewing current sustainability reporting practices as part of this project, it is clear that resource consumption and associated carbon emissions are underreported by productions, and in some cases not reported at all. The industry needs to take significant steps to change this. The first step is for industry bodies located across the world to agree to align carbon accounting practices with recognised methodologies such as the Greenhouse Gas Protocol. Productions can report on Scope 1 emissions (direct emissions from an organisation's facilities and vehicles), Scope 2 emissions (indirect emissions from purchasing energy for own use) and Scope 3 emissions (related to both upstream

and downstream activities including purchased goods, waste generation, employee commuting and distribution). The impact of the film industry on global supply chains means that Scope 3 emissions would be most applicable.

This means that productions have changes to make across the production life cycle, which requires decision makers such as production managers, department leads, artists, and producers, to drive the agenda on productions and create the enabling environment for all crew to make sustainable choices. A key part of this is using cloud-based collaboration platforms to enable crew to communicate effectively and work on content together in a shared environment. This will create teams that have more confidence in their ability to respond rapidly to changing circumstances and avoid redundant actions and procurement. The data captured by this central platform over the course of the production can be used to automate sustainability reporting.

Another key element is reallocating budgets and schedules to allow crew to take a life cycle approach to their work. This typically means departments spending more money and time planning for end-of-use or end-of-productions up front, with a view to saving more money and reducing impact overall. What does this new way of working mean for different departments? ▷

▷ It means production departments making use of virtual planning tools, art departments being deeply embedded in reuse networks, and location managers selecting unit bases and filming locations based on their sustainability credentials.

Productions, however, will not be successful without the support of studios. Studios are the foundation for a large proportion of production so it is critical they provide the physical and digital infrastructure that productions can thrive on. Studios need to think holistically about the services they provide on site or work with third party service providers to meet the changing needs of productions both now and in the future. By taking a circular economy approach to their building design, they can offer productive spaces with an engaging user experience that supports sustainable outcomes. By providing renewable energy sources to meet energy demand, the carbon footprint is automatically reduced. By accommodating secondary material storage and centralised procurement services,

vehicle movements to and from site are considerably reduced. These requirements need to be included in studio development briefs so they come to fruition. Climate change is a shared problem, with shared solutions. Stakeholders in the industry need to align incentives and step up to the challenge. Industry bodies internationally need to set the direction of travel for sustainability in the industry by aligning agendas and developing non-competing incentives. This would avoid productions choosing to film in one country over another due to less stringent sustainability requirements. Larger productions with typically higher budgets, higher profits and most importantly, greater environmental impact, should take greater ownership and lead by example. By doing this, they create the demand and markets that allow smaller productions to feasibly follow in their footsteps.

The film industry is an industry that inspires. It has a responsibility to engage the world with sustainability by demonstrating the art of the possible. ◻

the screen new deal

01   measuring true impact
aligning carbon accounting practices with globally recognised methodologies

02   digital collaboration
using cloud-based collaboration platforms to enable crew to collaborate and communicate more effectively

03   end-of-life planning
shifting schedules and reallocating budgets that support production departments to plan for end-of-use from the beginning

04   studios support productions
studio sites provide the physical and digital infrastructure to support sustainable film production

05   leadership
industry bodies, investors, studios and larger production entities lead the net zero carbon and zero waste agenda

06   shared responsibility
stakeholders align incentives to make the business case

acknowledgements

references

1. NASA (2020). Climate Change: How Do We Know? Available at: https://climate.nasa.gov/evidence/
2. United Nations (2019). Report of the secretary-general on the 2019 climate action summit and the way forward in 2020. Climate Action Summit. Available at: https://www.un.org/en/climatechange/assets/pdf/cas_report_11_dec.pdf
3. Pidcock, R., Pearce, R., McSweeney, R. (2019). Mapped: How climate change affects extreme weather around the world. Carbon Brief. Available at: https://www.carbonbrief.org/mapped-how-climate-change-affects-extreme-weather-around-the-world
4. Ibid. 1
5. UCLA Institute of the Environment (2006). Sustainability in the Motion Picture Industry. Integrated Waste Management Board. Available at: https://www.ioes.ucla.edu/wp-content/uploads/mpisreport.pdf
6. Aftab, K. (2007). Emission impossible: Why Hollywood is one of the worst polluters. The Independent. Available at: https://www.independent.co.uk/arts-entertainment/films/features/emission-impossible-why-hollywood-is-one-of-the-worst-polluters-400493.html
7. BFI (2019). Statistical Yearbook 2019. Available at: https://www.bfi.org.uk/industry-data-insights/statistical-yearbook
8. Statista (2020).Video Streaming (SVoD), Worldwide. Available at: https://www.statista.com/outlook/206/100/video-streaming--svod-/worldwide
9. Sweney, M. (2019). Netflix and Amazon double their spending on UK-made TV shows. The Guardian. Available at: https://www.theguardian.com/media/2019/sep/06/netflix-and-amazon-double-their-spending-on-uk-made-tv-shows
10. Statista (2019). Leading film markets worldwide from 2007 to 2018, by number of films produced. Available at: https://www.statista.com/statistics/252727/leading-film-markets-worldwide-by-number-of-films-produced/
11. UNESCO (2018). Feature Films (full dataset). Available at: http://data.uis.unesco.org/Index.aspx?DataSetCode=CUL_DS
12. Central Board of Film Certification (2019). Indian feature films certified from 1-4-2018 to 31-3-2019. Available at: http://www.filmfed.org/downloads/Language-wise-Region-2018-19-26062019.pdf
13. Producers Guild of America Foundation (2020). Green Production Guide. Available at: https://www.greenproductionguide.com/
14. Interreg Europe (N/A). Green Screen. European Union. Available at: https://www.interregeurope.eu/greenscreen/
15. Interreg Europe (2019). Greening the movie business through grid connection. Available at: https://www.interregeurope.eu/policylearning/news/7584/greening-the-movie-business-through-grid-connection/?no_cache=1&cHash=5a95d3ac7448c542f95957f00539dac2
16. albert (N/A). albert Calculation. Available at: https://calc.wearealbert.org/uk/
17. albert (N/A). Green Rider. Available at: https://wearealbert.org/green-rider/
18. Screen Flanders (N/A). Sustainable Filmmaking. Available at: https://screenflanders.be/en/economic-fund/sustainable-filmmaking/
19. Victory, J. (2015). Green Shoots: Environmental Sustainability and Contemporary Film Production. Studies in Arts and Humanities. VOL01/ISSUE01/2015
20. Chiarini, L., Khedachi, N. (2019). Sustainability reporting in project-based industries – a European study with a focus on the motion picture industry. Malmö University.
21. White, M. (2010). Luring Hollywood to Cloud Computing. Bloomberg Businessweek. Available at: https://www.bloomberg.com/news/articles/2010-12-02/luring-hollywood-to-cloud-computing
22. CineRegio (2020). Green Report 2020 on Sustainability in the European Regions. Available at: https://www.cineregio.org/dyn/files/pdf_download/11-file/CineRegio_GreenReport2020_25022020_SinglePages.pdf
23. Interreg Europe (2020). Shorten assessment of 30 low-carbon technologies.
24. United Nations (2015). The 17 Goals. Available at: https://sdgs.un.org/goals
25. Ellen MacArthur Foundation (N/A). What is a circular economy? Available at: https://www.ellenmacarthurfoundation.org/circular-economy/concept
26. British Film Commission (2020). Working Safely During COVID-19 in Film and High-end TV Drama Production. Available at: http://britishfilmcommission.org.uk/guidance/regarding-covid-19-coronavirus/
27. Green Production Guide (N/A). Green Production Guide Toolkit. Available at: https://www.greenproductionguide.com/tools/
28. Arup, BBC (2014). Low Energy Lighting Guide for TV Productions. Available at: https://downloads.bbc.co.uk/outreach/BBC_LEL_Guidelines_2014.pdf