

# Virtual Production

study on its environmental impact | Synthesis



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# INTRO

A virtual production set featuring a large blue LED wall and a truck on a stage.

**Virtual Production (VP) is a new concept that has expanded rapidly during the last 2 years, growing as much in 2020 as it had been predicted to grow in a decade.**

**The COVID crisis, which has notably constrained travel and made it much more difficult to shoot on location, was a key trigger to the virtual production growth.**

**Valued at \$1.6B in 2021, the Virtual Production market is expected to grow by almost 20% by 2030,** with many advertisers and studios committed to moving 70% of their production pipeline to VP over the next two years.

Lately, several popular movies and TV series such as *Thor*, *Love and Thunder*, *Bullet Train*, *Game of Thrones*, *Star Trek: Discovery*, *The Last Kingdom*, *Black Mirror*, and *Outlander* have extensively implemented visual graphics to create epic and historical scenes.

**Virtual Production is the latest step in cinema and TV technologies,** evolution that started with Georges Méliès and double exposure.

Matte paintings, rear projections or green screens were used to shoot scenes that would have been impossible in real life.

More recently, an interactive previsualization of 3D computer graphic environments, was designed to help creative decisions for film makers, using a physical camera to move inside the virtual world with a live preview such as James Cameron's *Simulcam*, or being



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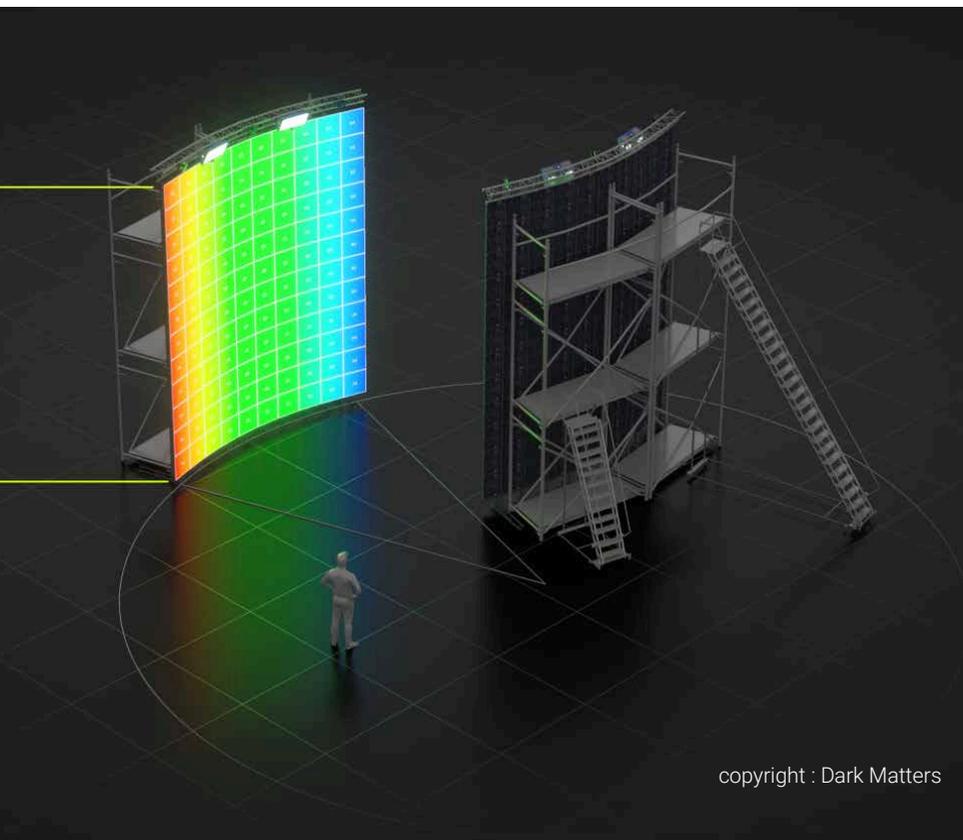
immersed using VR headsets in the case of Jon Favreau's *Lion King*. Television has also been using augmented reality technology where camera livestream is combined in real time with computer graphics to create interactive shows. *The Mandalorian*, which is widely considered to be the kick-starter for Virtual Production going mainstream, used a combination of all those technologies with large LED walls in order to create its environment.

**This study aims to provide an overview of the environmental impact of Virtual Production, while taking into consideration the technical, financial and artistic obligations of the field.**

We articulate the necessity of reducing significantly the industry's carbon emissions to be aligned with the Paris Agreements as the new geopolitical context will have a major impact over the way we produce content in Europe for years to come. Bringing cinema back into the studio after the French Nouvelle Vague got

it out, Virtual Production mitigates some of the environmental costs of filmmaking by reducing transport and location fuel usage.

**But is it the panacea the industry hopes for? Or will the ecological costs of new sound stages and mass data transfer wipe out the potential gains?**



## ┌ **Environmental context:**

Over the last decade, the audio-visual sector has finalised the first phase of its digital transition. A second phase, whose key factor is the increased use of digital processes and the resources they require (cloud, 5G, LED walls), is emerging and – as we will see – those resources consume a lot of technical components and critical materials that are becoming subjects of conflicts between countries.

Fixing a target of - 95 % emissions of greenhouse gases by 2050 (compared to the 1990 level) to decarbonise the European economy will intensify European environmental regulations.

On an international scale, **some broadcasters now recommend, or even impose, the sustainability measures of a production.** This is the case in the USA with SVOD platforms; in Germany with the RTL group and especially in the United Kingdom with the BBC.

# POSITIVE IMPACTS OF VIRTUAL PRODUCTION



## REDUCE TRANSPORTS

According to Albert's Screen New Deal Report, travel and transportation of crew and equipment account for about 50% of the total emissions of a tentpole movie. By reducing the need to move from location to location, Virtual Production has a direct influence over an important parameter in production emissions.



## REDUCE SET BUILDING

While it does not eliminate completely the necessity of building props and elements of a scene, Virtual Sets do reduce significantly the volume of waste generated by shooting a production.



## REDUCE SHOOTING DAYS

There are several reasons why Virtual Production can reduce the shooting time:

- **Using a virtual environment, teams can transition from one scene to the next with very limited interruptions** compared to traditional on location shooting. Digital assets can be changed quickly, allowing filmmakers to shoot several scenes with the same actors.
- **In a virtual location, the filmmaker has full control** over the weather, time of day, lighting, object position, and more. These conditions can be recreated at any time and are immediately available, saving a considerable amount of time.

Some productions, interviewed for this study, have reported **significant reduction in time**

of shooting and size of teams, with 20-25% reduction in workdays, but this is highly project dependent and should be validated by more research and production data analysis.



## REDUCE POST PRODUCTION

A lot of the content that is created on a virtual set would otherwise have been produced with green screen shooting, which requires a lot of post-production work to remove the green cast and reflections on the images and then to recreate natural looking. While Virtual Production does not cover all the use cases of green screen shooting, it certainly has a very positive impact on the number of days of work to replace backgrounds.



## OVERALL PRODUCTIVITY

A better vision over the complete project's art direction helps to reduce considerably the trial-and-error process: virtual production allows creatives to develop their vision earlier. This brings room for exploration by visualizing shots and environments before anyone steps foot on set, starting with low precision representations and building up. **Iterating on their vision helps studios bring people together so that everyone can have a more complete understanding, from previs to post.**

# NEGATIVE IMPACTS OF VIRTUAL PRODUCTION



## POWER CONSUMPTION

Typical LED Panels used for Virtual Stages have an average power consumption just below 100W and a Virtual Production LED project can assemble hundreds and even thousands of them depending on the volume needed.

They are also connected to a whole video and IT infrastructure that is comparable to a small TV stage added to a typical VFX post-production facility.

In a world where electricity will be more and more prone to disruptions, VP facilities will have to rely more and more on power generators, which have a disastrous carbon impact. It is also important to consider that a lot of the technology component of Virtual

Production are manufactured in China and Southeast Asia and don't have easily swappable alternatives.



## MANUFACTURING FOOTPRINT

IT and video equipment have a considerable manufacturing footprint that is generally cushioned after a short period of time. It is also important to consider the IT components that are present in the cloud services.

Though difficult to evaluate, they are not necessarily lighter on the emissions than their on-premise counterparts, since cloud services providers replicate the infrastructures over multiple datacentres to avoid service failure.

**Don't forget to use carbon calculators : it helps for planning!  
In the early days of budget preparation, for instance, it allows to  
have a rough idea of the emissions of the project and compare it  
with average numbers of productions the same genre**



## **REBOUND EFFECT**

Virtual production is, before anything else, a new creative tool for artists to deliver more exciting content. Whilst it helps save on financial and environmental costs compared to more traditional means of content production, it also offers opportunities to create more advanced productions for the same cost.

We must consider that the reduction of the environmental impact is a major topic and that Virtual Production might create a windfall effect. Communication today focuses on travel reduction, which is an important topic but does not talk so much about the power consumption and manufacturing footprint of Virtual Sets.

A proper global strategy could only happen in a framework where carbon emissions are regulated and targets well defined, then Virtual Production can become a great tool to reach those targets.

# GHG\* IMPACT OF A PRODUCTION

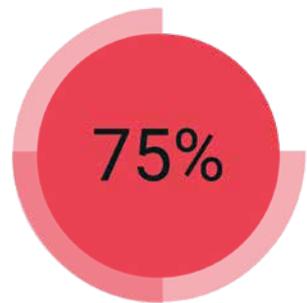
The full study is based on data from a recent article published by the Animation Institute of the Filmakademie Baden-Württemberg. It compares two student short films, *Sprout*, a VFX-intensive film shot with a traditional green screen approach, and *Awakening*, a project of comparable artistic ambition shot using a LED wall.

**On *Sprout*, 75% of the effort was spent on post-production, compared to 47% on *Awakening*, with 19% less overall time spent on the latter for almost 2.8 times more final images produced.**

The full study calculates the GHG impact of production by country, including the equipment manufacturing footprint.

When taking the countries with the least and most carbon intensive electricity mix:

## Part allowed to post-production:



## SPROUT

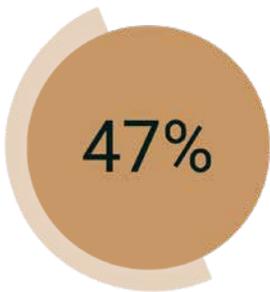
- Manufacturing *Sprout* in Sweden would have emitted 270 kgCO<sub>2</sub>e, while manufacturing *Awakening* would have emitted 185 kgCO<sub>2</sub>e
- Manufacturing *Sprout* in Poland would have emitted 4.08 tCO<sub>2</sub>e, while manufacturing *Awakening* would have emitted 1.38 tCO<sub>2</sub>.

Regarding CO<sub>2</sub> emissions, the impact of a day's shooting for a 400m<sup>2</sup> volume of LEDs will also differ from country to country: it will

\* Greenhouse Gaz

**IT equipment is also known to have a considerable impact as the overall GHG emissions of the sector represent 4% of the global world emissions and they continue to grow at a fast pace.**

## **INDIRECT EMISSIONS**



### **AWAKENING**

be equivalent to 89 days of work in Belgium for a VFX artist, and 222 days for a VFX artist in Poland. This shows how important it is to calculate the impact of a chosen LED volume before production in order to make the right decisions.

**That shows how much dimensioning is important and that we should calculate the impact before the production to make proper decisions.**

Most of the equipment used in Virtual Production is manufactured in Asia, such as the LED tiles that mostly come from Shenzhen in South China; and this equipment incorporates many critical materials. Thus, it is necessary to keep in mind that LED panel manufacturing is a complex industrial process which uses a lot of critical and toxic materials which therefore will have a significant environmental impact.

### **NOTE**

At the time of this study, no Lifecycle Assessment (LCA) of LED tiles was available to evaluate the carbon impact of LED tiles and manufacturers were unable (or unwilling) to provide the information

# GHG IMPACT OF A VIRTUAL SET

There are approximately 120 production size LED stages as of today with a majority in North America and Northern Europe, with a fast expansion in Asia. Universities and film schools also invest massively in the technology, encouraged by the programs from manufacturers and software editors. Most have been installed after 2020 and after *The Mandalorian* was released and largely promoted in the media.

There is a certain diversity in the options available on the market, which is logical as it matches the vast diversity in content production.

## 3 main profiles:

- **Large facilities with permanent installations** with more or less flexibility make sense for large projects. Managed by big companies working for big studios, partnering

with other companies to cover Virtual Art Department, Previs, Shooting supervision and VFX.

- **Smaller facilities with permanent installations** that fit small projects, commercials, car shots, music videos. They also usually partner with VFX companies to provide a good continuity of services.

- **Consulting and rental companies** that go with mobile equipment on the sound stage the production has picked, so they build a bespoke setup with the right size and configuration for the project.

To evaluate the impact of virtual sets, the study focuses on two French studios with radically different approaches:





### **Dark Matters (founded in 2021)**

The studio was designed with sustainability in mind: the site has hotels and accommodation close by so the crew does not have to travel much, and the studio is large enough so the whole production can be shot on site with minimal movement from people and equipment, saving time, energy and money. The stages were built with extra insulation that is good for both thermal and sonic performance. More importantly, the modular structures are enabled only when needed, so there is only power consumption for the necessary equipment.

### **Neoset (founded in 2020)**

The studio does not own a single LED tile; they work with rental companies and a group of experts to bring Virtual Production to shooting stages anywhere. It has been founded by experts in camera rig and technology that know the production environment very well. They fine tune the setup in advance with the production team and bring the equipment and team to operate it.

**L**

Both solutions are very valid because they address different parts of the market. There is a vast diversity in content creation and the Virtual Stages market shapes itself to become more flexible, offering a

full set of technologies and experts, or just the sub-part that ultimately makes the most sense for the project.

# POTENTIAL IMPROVEMENTS



## GHG EMISSION MEASUREMENTS

The state of play regarding the measurement of LED technology's GHG impact is poor. **As of yet, manufacturers do not publish the Lifecycle Assessment of their products** and as it is an important parameter in the equation, we are missing crucial information. Measuring power consumption is easy, so this should be a point of attention.



## TRAINING

In order to embrace Virtual Production, **a major challenge for the industry is to get enough technicians.** As there is already tension in the market today to recruit artists and engineers for animation and VFX, getting talent to operate virtual sets will also be challenging if everybody is looking for the same kind of profiles.

There are industry initiatives in place to get technicians and artists on-board with curated information. Software and hardware vendors also provide online training content for their tools and partner with universities and some VP service providers to propose training sessions on actual virtual sets.



## AUTOMATION

**Asset Management  
and the standardization  
of digital assets formats**

would significantly accelerate the building of the background environments.



## ANTICIPATING A WORLD OF SHORTAGE

An important aspect of sustainability is the capability to **adapt your business in a world that changes**. The current geopolitical situation is accelerating the supply chain disruption on energy and key hardware components.

# CONCLUSION

Are Virtual Production techniques applicable to any movie? Yes. Does this mean that every production will use them? No. However, in a world of increased worry and attention towards our environmental impact on the planet, all aspects of the audiovisual sector must come under scrutiny and if Virtual Production is going to be used as a “sustainable solution”, we must be able to know what impact it truly has.

Though the environmental equation of Virtual Production is a complex one, we must remember to consider the power consumption and manufacturing footprint. VP can certainly bring large benefits to a production if it is well planned and operated. It can also have a terrible impact if not well managed, especially because of its electricity consumption – and the energy source for this electricity should be

considered a critical point. Energy consumption remains a main concern as we can expect power shortages in Europe over different periods of time and having high power requirements means that it may be difficult to operate studios at certain times of the year.

Based on what has been observed, productions should establish a carbon budget to evaluate the environmental benefit of VP to their project but must remain careful about a potential rebound effect. Also, a proper regulation of carbon emissions for the sector is necessary if we do not want to see them get out of control. Moreover, having an accurate measurement of carbon emissions is extremely important and we are still missing important data, such as the LED tiles manufacturing footprint, which prevents us from making precise

calculations. Once the data is available, it is also important to get it integrated into the industry's carbon calculators.

As the ecosystem is shaping itself with leaner and more mobile solutions to adapt to the production needs, flexibility is the key. Also, training the technicians and production teams so they can make the most out of VP technologies, and better integrate the VP budget into the VFX budget, is the best way to anticipate environmental issues.

**In conclusion, Virtual Production is another creative tool brought to the creative community palette, like so many in the history of cinema and media. It is by being as efficient as possible, in all aspects mentioned in the study, that we will succeed in making VP a truly viable sustainable solution to the environmental issues the audiovisual sector faces.**

In collaboration with **W**orkflows

