IBC2024 x ecoflow

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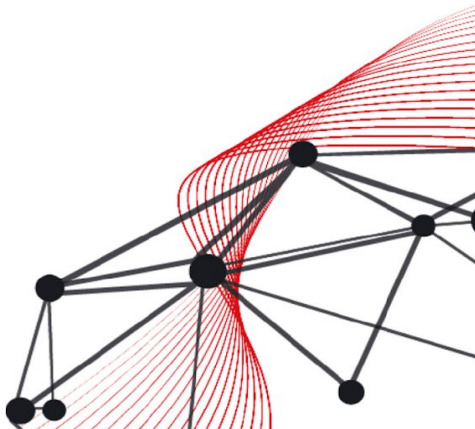
IBC Accelerator Programme Project

Ecoflow

Measure, Impact and Educate on Energy consumption in Streaming



September | 2024

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Project Goal

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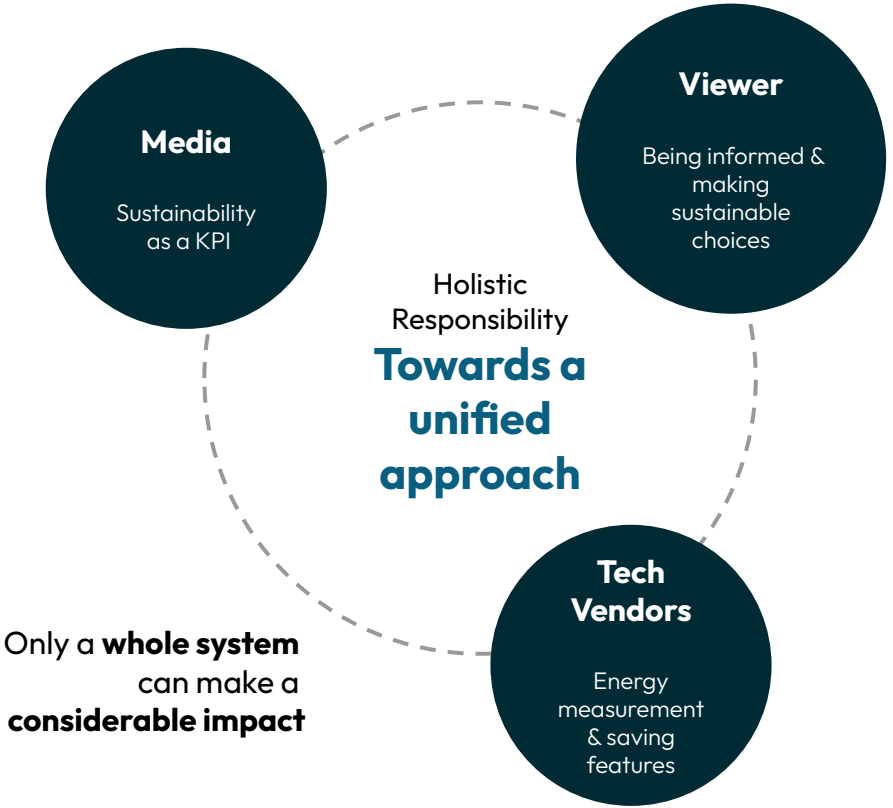
ECOFLOW confronts the Media & Entertainment industry's critical challenge:
the **environmental impact of streaming.**

Problem Statement

Many available frameworks & research

Environmental impact of the Media industry

Lack of unified approach



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Land of Challenges

Challenges of *Data Collection*

Driving a transition from ***modelling to measurement***, moving from proxies to first party data measurement where possible, and improving quality, accuracy, completeness and timeliness of data gathered.

Using ***appropriate*** information depending on the audience, reporting full Scope 1/2/3 carbon impact for Corporate Disclosure but focussing on energy usage to drive engineering, product development and efficiency improvements in a way that allows users to see the impact of change.

Educating on the differences between ***attributional and consequential*** improvements, when each is relevant, and how that contributes to decarbonisation strategies.

Challenges of *Industry Alignment*

Framing near term change in the context of overall traffic and workload ***growth and efficiency***, enabling whole system improvements.

Working collaboratively towards ***standardisation*** of calculation, ensuring that similar services report similar information in a way that allows transparency, comparability and visibility.

Positioning change alongside overall ***grid decarbonisation*** to enable modelling of progress against SBTi and similar targets.

Recognising that each of us has a part to play, but only by ***collaborating*** and working together can we achieve significant measurable improvements.

Challenges of *Positive Impact*

Creating a ***data ecosystem*** that allows engineering and product teams to measure and track improvement of systems in a way that is reactive to change and allows for predictive modelling of different scenarios.

Empowering and incentivising teams to drive sustainability, ***squaring the triangle*** of Cost, Time and Quality to include Sustainability as a pillar of successful design.

Reconciling the relative roles of ***industry and consumers*** in driving change, empowering individuals to make sustainable choices without transferring responsibility.

Continuing to drive ***education*** across the media industry and beyond, influencing positive cha through the content that we produce and distribute and the stories that we tell.

Project Map

Validate Measurement	Demonstrate Impact	Educate Industry

Understanding what and how to measure

Normalise data points

Provide data for other working groups

Baselined Data →

ecoflow

Website Demo App

← Knowledge Base Findings

Best Practices

Media Sustainability Map

Presentations

Signposting

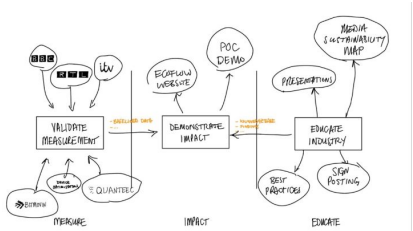
Demo App Features Selected for Testing

FAMIUM GreenView	Bitmovin Eco-Mode	HDR Toggle	Sustainability Information and Engagement
Quanteec P2P	Audio-Only Stream	Eco UI	

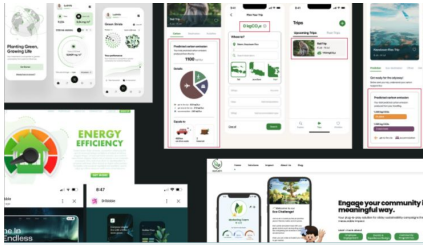
Research & Approach

As part of the design and product development external contacts, including teams from RTL, BBC Blue Room, EBU members, and ITV, were invited from August 12th to 21st, 2024, to provide feedback on the Ecoflow demo app.

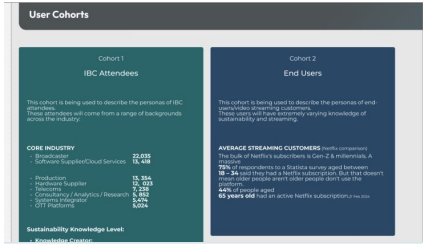
- Roles represented: Designers, Product Owners, Engineers, and Business Analysts.
- The external teams were given an overview of the project, highlighting current challenges and questions.
- Feedback consistently acknowledged the value of the initiative, noting that the topic of sustainability in streaming was not one they commonly consider.
- Attendees appreciated the effort to initiate the discussion, despite the potentially limited impact of some features due to varying factors.
- Discussions and workshops helped refine the understanding of challenges and opportunities related to sustainability in the streaming industry.



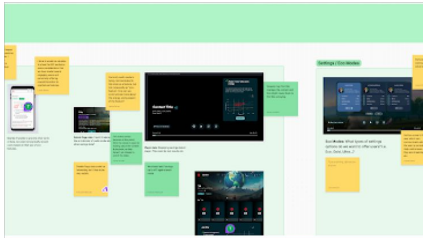
Initial workshops established appropriate working groups and there primary and secondary goals



Market analysis was conducted to establish some standards and strategies for communication and interaction.



Establishing user cohorts for the project helped gain an understanding of the fundamental issues and goals of both those in the industry and end-users.



Multiple workshops and collaborations between participants were conducted to define the visual design and methods of interaction for the Ecoflow app.

Measure Application Features

Given that previous research tends to point towards end-user devices being a hotspot for energy consumption, we have based our testing on existing and new features created specifically for this project.

GreenView

Saving energy by adjusting streaming playback dynamically without changing the original content, using AI to optimise settings based on various factors.

Audio Only Mode

Allowing users, on recommended/all content, to stream in audio-mode only, strippping back the video feed to reduce energy consumption.

Quanteec P2P

Peer-to-peer streaming, using a decentralised approach to stream video, aiming to reduce energy footprint and reliance on CDN servers.

Sustainability Information and Engagement

Streaming apps also provide the opportunity to educate audiences, increasing awareness while also boosting engagement.

HDR Toggle

HDR content requires higher brightness, enhanced color depth, and more complex processing, while SDR content, with its moderate brightness and simpler processing needs, uses less energy.

Bitmovin Eco-mode

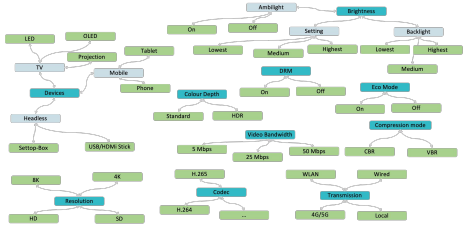
Reduces streaming bandwidth, bitrate and limiting resolution to lower values.

Eco UI

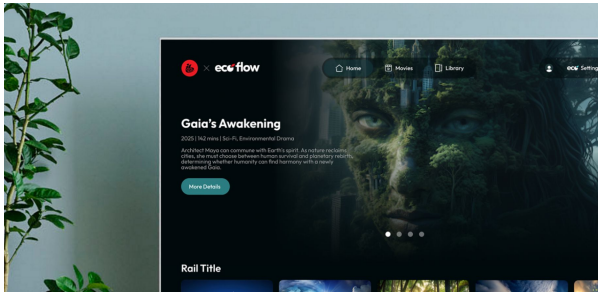
Using darker colours in the UI of an app can have an impact on its energy consumption.

Direct Device Measurement Approach

We conducted comprehensive lab tests to measure and evaluate the impact of various factors on the energy consumption of end devices, including UI settings, display characteristics, streaming format parameters, resolution, bitrate, device settings, delivery modes, and more. By utilizing the Fraunhofer Green Streaming measurement framework and analytics dashboards, we were able to develop a suitable Ecoflow test application in partnership with Accedo to investigate energy-saving potential. This approach enabled real-time data visualization and the capture of extensive power-focused data points throughout our tests.



Measurement variants



ecoflow test application

Direct Device Measurement Approach

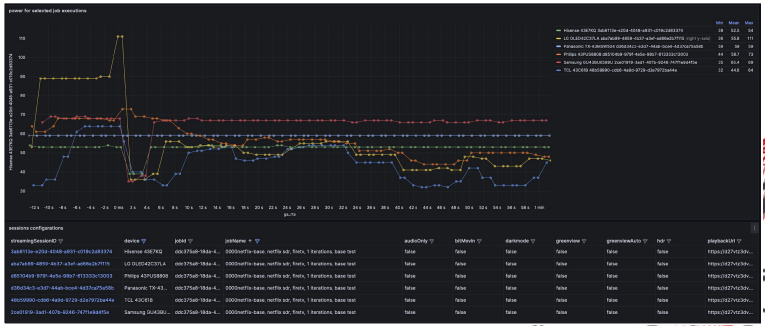
Approach

- Controlled, synchronized, automated
- Combining energy measurements (real-time power meter data) with streaming session data

Analytics dashboard

Attributes

- **Content Attributes**
  complexity, luma, color histograms, codec, frame-rate, gop size, encryption, container, packaging, ...
- **Device Attributes**
  display technology, brightness level, stationary/mobile, light conditions, player type, ABR algorithm, ...
- **Network Attributes** connectivity type, bandwidth, jitter, packet loss, ...



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Device Measurement Results

Findings / Observations

- The act of streaming is a very small proportion of the energy consumption in the home, the device and display used is much more significant.
- **Rendering SDR as HDR** can use an additional 10% to 30% more energy.
- Power Factor can have a significant impact on the power required to be generated to power the end device during operation, requiring anything **up to 10x more power**.
- Every display shows differing characteristics of power consumption, some along technology lines, some down to specific manufacturer decision, with some counter-intuitive behaviours.
- Reliable power consumption reduction can be seen when switching to **SDR content / not having HDR enabled** and using **Audio Only** mode.
- Varying the brightness of the room viewing conditions can result in significant power variation on displays - up to doubling power consumption in bright conditions.
- Multicast or peer to peer streaming had no significant display device energy impact on the device - e2e has not yet been evaluated but where we would expect to see impact.
- Bit rate reduction with devices like streaming sticks and TVs had **no significant reduction** in energy consumption.

Conclusions

- The display / device you use has a big impact on energy consumption
- **Manufacturer/OEM decisions** have a big impact on energy consumption
- Improvements to energy consumption requires applications to be able to be aware of the in-use display type - **this requires engagement from device and display manufacturers.**
- Emissive or high dimming zone displays have more promise in saving energy.
- Policy decisions by ODMs on streaming devices means that most default to Auto-HDR and this has a **significant impact on energy consumption without significant benefit**.
- LED based displays warrant more research on improvements to energy consumption due to the consumer popularity (lower cost displays).
- Consumer education could have a more significant impact than any of the measures investigated on device control, such as viewing in dimmer rooms or using devices that are optimised for viewing **(not Games Consoles or Gaming PCs)**
- It is a consumer education approach to propose the 'better' solutions for video consumption that should be used.
- Using **hardware decoding** provides the most power efficient approach.

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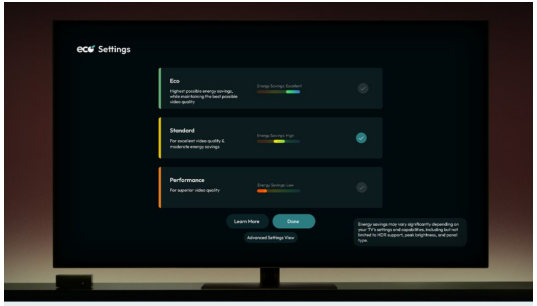
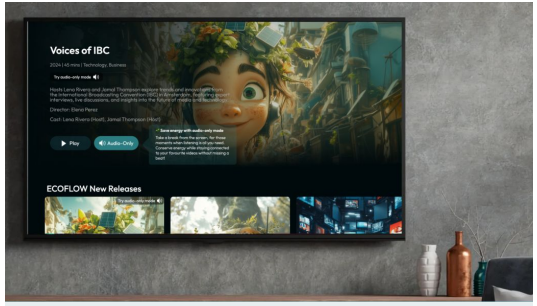
IBC Demo Application Features



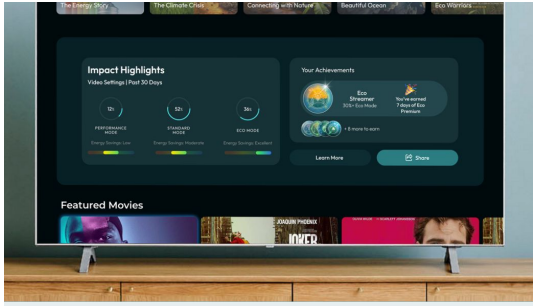
Eco Settings

Rather than allowing users to interact directly with energy reduction technologies, they have been customised into coherent “modes”. This approach ensures viewers aren’t too heavily distracted from their entertainment, making it easier for them to engage with eco-friendly practices.



Audio Only Mode

Offers users an additional, energy-efficient option tailored for content that can be consumed through listening alone. This mode was designed to show how energy-saving features can be seamless, allowing users to engage with their favourite content while conserving power.



User Engagement

By introducing elements such as badges, points, or achievements for using energy-efficient settings, users are incentivised to adopt sustainable habits in a fun and engaging way.
It enhances the viewing experience by adding an element of interaction and personalisation, creating a positive feedback loop that benefits both the user and the environment.

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Supply Chain Estimation: Approach

Broadcaster Data

Historical data including:

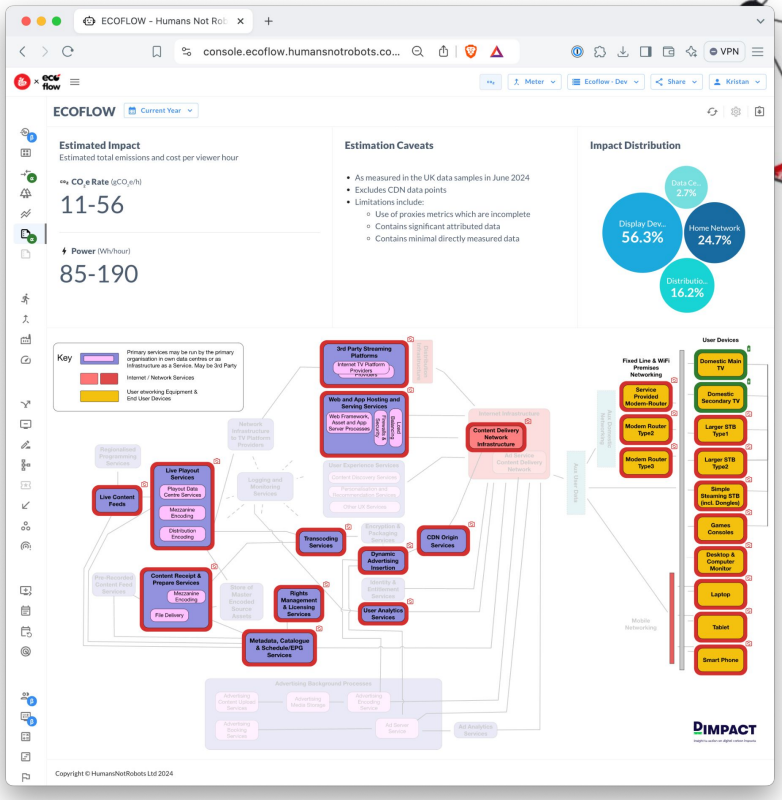
- Reported data from suppliers ranging from metered electricity usage, attributed carbon and cost report
- Proxy metric calculation of cloud services
- Attributional modelling of shared resources including networks
- Broadly modelled impact of user displays & peripherals

DIMPACT Methodology

Controlled Tests

Test Streams → **TV Device** → **Power Measurement Device**

Aggregated Results



Supply Chain Estimation : Results

	Data Centres / Cloud / SaaS	Content delivery networks	Data transmission networks	In-home networking	End-user devices
Energy estimate* watt/hour per hour of streaming	1 - 3	20 - 25		30 - 70	50 - 100
Carbon estimate*	1% - 3%	10 - 23%		25 - 38%	50% - 56%
Approach	Primary data gathered from suppliers	Primary data gathered from suppliers, with some measurements from own-operated CDN	Proxy estimates based on academic research using a data allocation approach (kWh/GB).	Assumed power of a router, with idle time allocated based on total data	Power of an assumed average TV screen (based on UK)
Challenges	Gathering energy consumption Granularity and timeliness of data	data ≠ energy Carbon-accounting style allocation method does not reflect the dynamics of the system Understanding variability between ISPs, unique journey of individual streams, impact of peaks		data ≠ energy Carbon-accounting style allocation method does not reflect the dynamics of the system Variation in home network setups (e.g. mesh networks, terminals, FTTx, Cable, etc.)	**Across the installed based** Updating proxy metrics to reflect shifting device mix over time (e.g. by audience, country) **Within a given device** Understanding multitude of factors that impact power (input source/peripherals, content type, codec, device settings and features)

***using the DIMPACT methodology**

Map of the Streaming Supply Chain

- Industry Players & Relationships
- Data Availability
- Organisations
- Scale of Opportunity

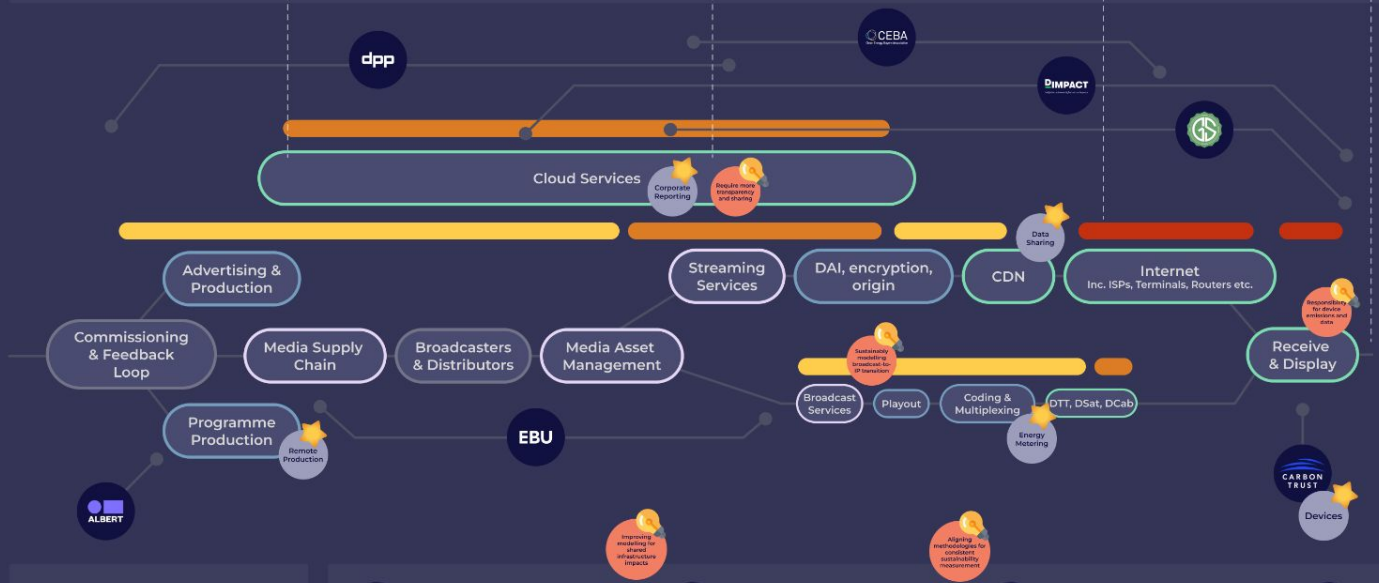
Facing Challenges: Key Insights on Barriers to Sustainable Media Practices

Cloud providers lack the granular data needed for informed design, complicating sustainable systems development. Transitioning from broadcast to IP infrastructure poses modelling challenges, while unclear responsibility for device emissions and limited energy data hinder emission reductions. Attributional modelling needs improvement, and aligning methodologies is crucial for consistency across sustainability models.

Celebrating Progress: Key Industry Achievements in Sustainable Media Practices

Content Delivery Networks are increasing transparency by sharing data on their environmental impact, while cloud providers are improving corporate-level carbon reporting for greater accountability. Virtual production is helping to reduce emissions by minimising the need for travel to filming locations. Broadcast distribution networks are metering power consumption and providing low level information, and the Carbon Trust is working with tech companies, Amazon, Meta, Microsoft, Samsung and Sky to develop an industry-first specification for measuring, accounting for and decarbonising the carbon emissions associated with connected devices while being used by customers.

Broadcaster Relationship with Industry Player	Operate data centres directly, collaborate with SaaS providers, or procure IaaS and Cloud services.	Directly Procure or operate CDN processes	Content delivery depends on data transmission, often partnering with ISPs to integrate CDNs for faster, more efficient content distribution to users.	No direct relationship, unless the broadcaster also serves as the ISP.	Develop apps on devices, sometimes with device partnerships with manufacturers / operating systems
Key Industry Players	**Cloud Service Providers** inc. Colocation Operators **Saas Providers** **Software & Equipment Suppliers**	**Cloud Services** **CDN Providers** Broadcaster Operated CDN	**Internet Service Providers** Network Operators (Mobile / Fixed)		**Consumer Electronics Manufacturers** Operating Systems



Scale of Opportunity

This key represents how much impact or benefit can be achieved by implementing certain sustainability practices in different areas of the supply chain.

- High
- Medium
- Low
- N/A

Primary Data Availability

- **Improving**
  The availability of data is increasing, with better transparency, granularity, and timeliness.
- **Medium**
  Some data is available, but there are gaps in granularity, timeliness, or reliability.
- **Low**
  Minimal or incomplete data regarding energy consumption and emissions from cloud services is accessible.

Digital Production Partnership
Promotes and standardises digital production, distribution, and business processes to enhance efficiency and collaboration.

DIMPACT
Focused on measuring and enhancing the environmental impact of digital content and services, aiming to promote sustainability in the media and entertainment industries.

Carbon Trust
Provides expertise and services to help businesses and governments reduce their carbon footprint, improve sustainability, and transition to low-carbon practices.

European Broadcasting Union
Alliance of public service media organisations across Europe that promotes collaboration, content exchange, and the development of media standards and innovation.

We Are Albert
Focuses on reducing the carbon footprint of media production by providing tools, guidelines, and support for more sustainable practices.

Clean Energy Buyers Association
Supports and advocates for large-scale clean energy purchasing and procurement, aiming to accelerate the transition to renewable energy sources.

Greening of Streaming
Focused on reducing the environmental impact of online streaming by promoting energy efficiency and sustainability practices within the industry.

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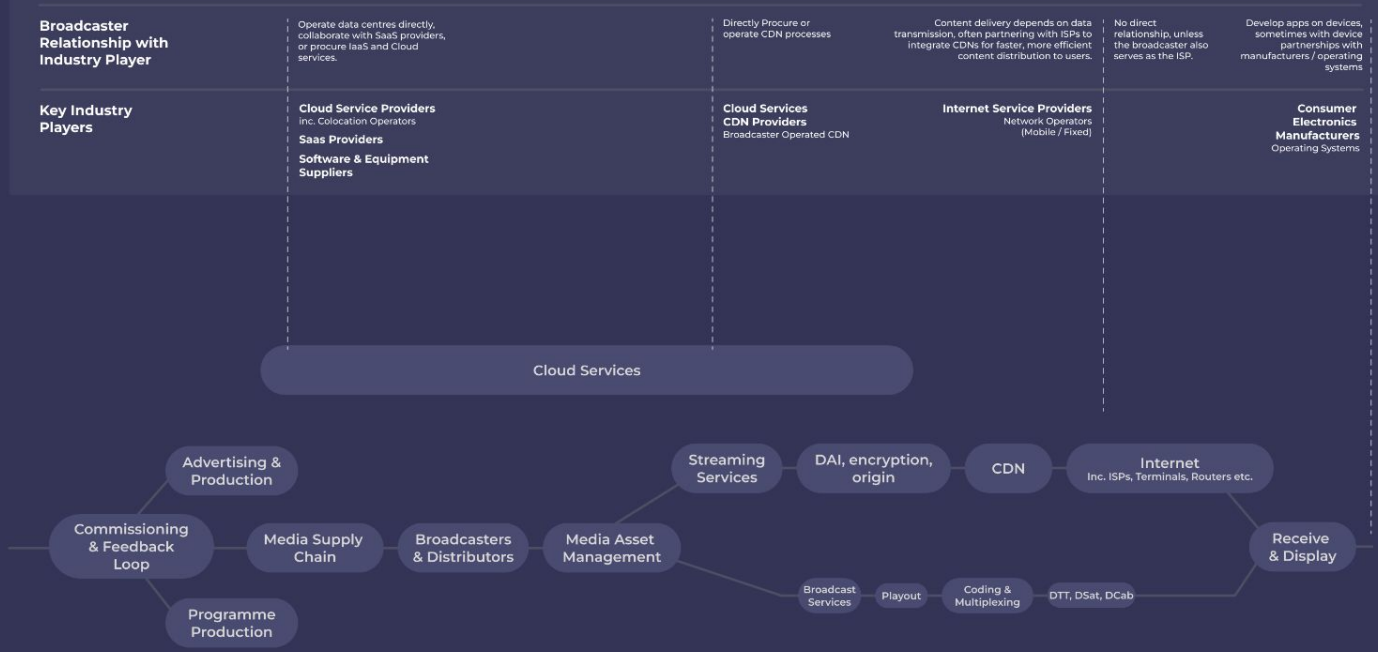

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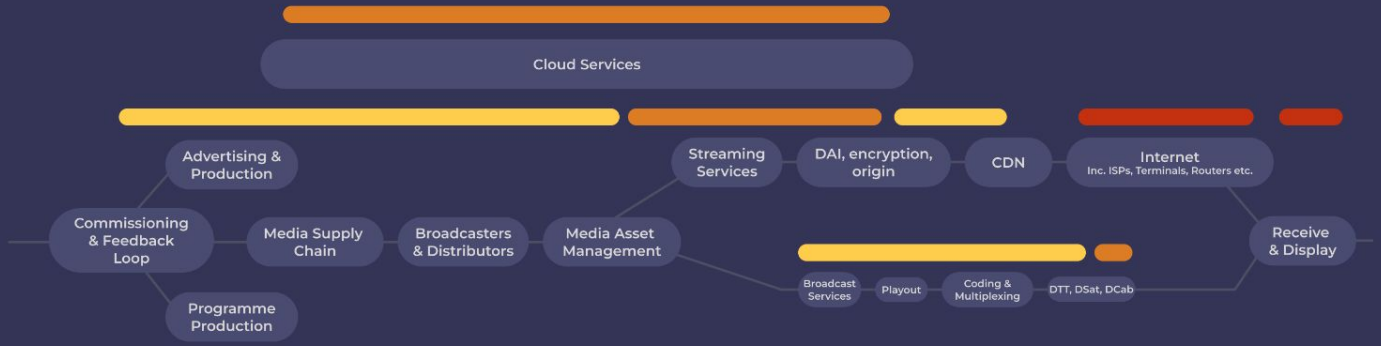

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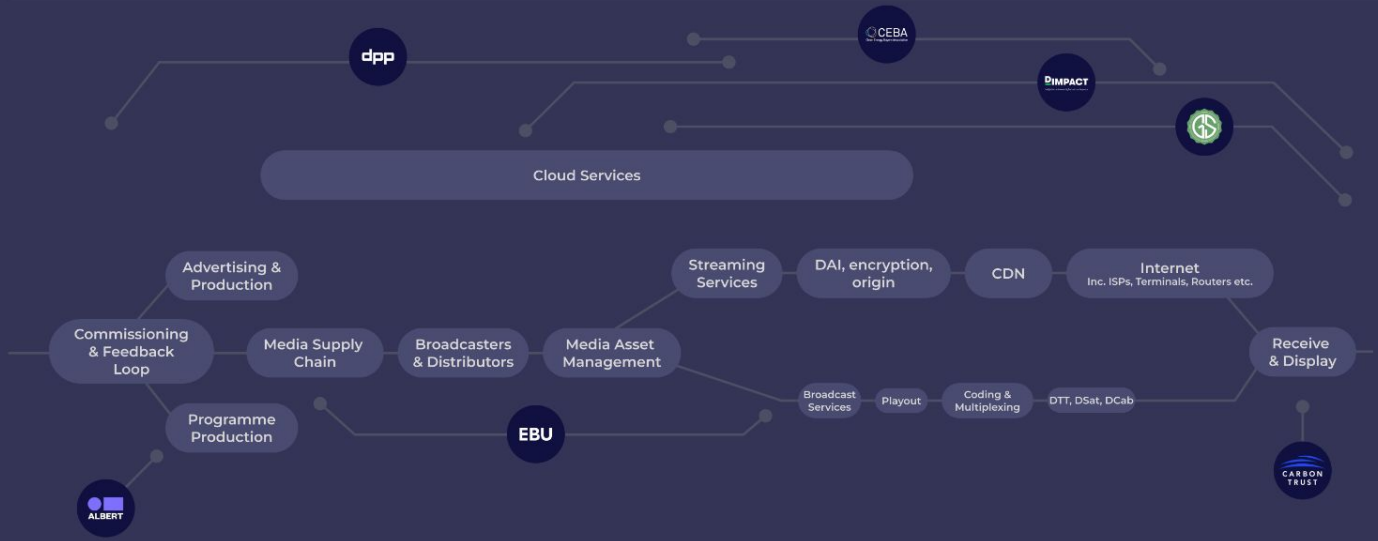

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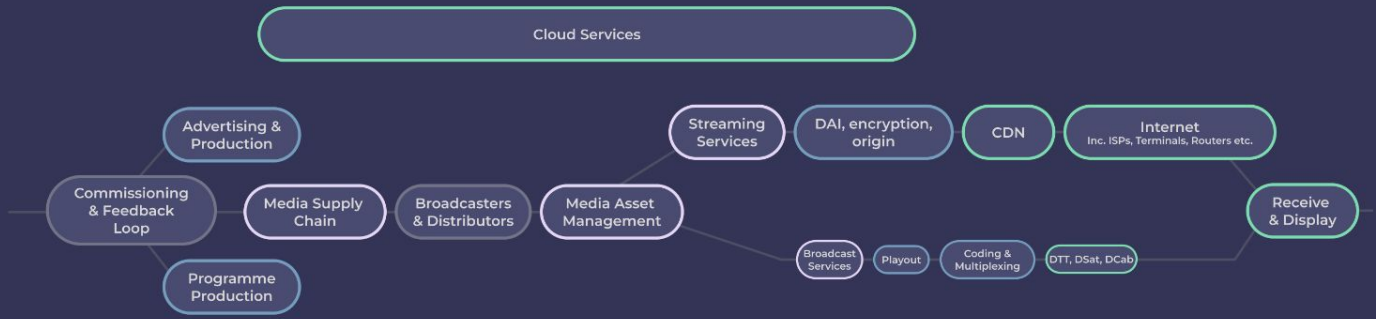

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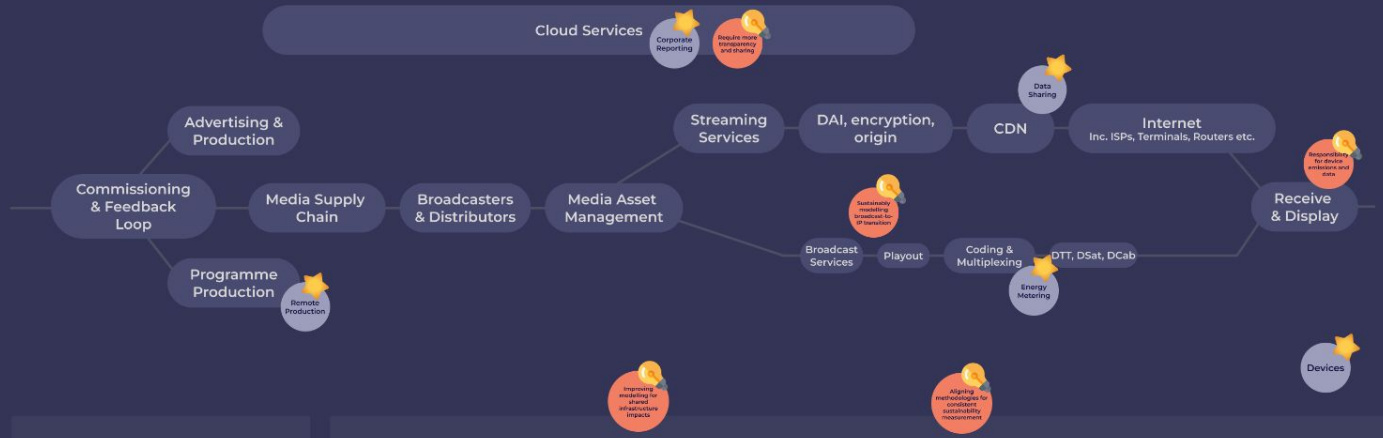

Project Outcomes & Conclusions

- **Successful collaborations** and knowledge sharing demonstrate a high level of commitment to minimise the impact of streaming.
- New and **tangible insights** to the range of data describing the impact of streaming for different content and per viewing hour.
- There are **limited solutions available** to reduce energy consumption on user devices, and they will be applicable to very specific viewing criteria.
- The **device manufacturers need to get more actively involved** to help with streaming peripherals energy efficiency.
- **Compelling user engagement** demonstrating potential impact of user choices.
- **Multiple learning points to be used** for involving and committing more partners and key players across the wider industry.
- There is value in continuing to strive for a **more reliable and consolidated data set** beyond TVs and consumer equipment.
- Our **capability to measure accurately and consistently** is very challenging with both technical and organisational barriers.

Considerations & Reflections

- To understand the full environmental impact of streaming…**we need full participation** from all the contributors, end-to-end.
- We should consider how to **include both an attributional and a consequential approach** to data collection and analysis.
- Shifting focus to **energy measurements, data insight and impact** of Content Delivery Networks and Cloud Services.
- We need to define the role of ECOFLOW better, to avoid duplication and overlap of purpose and efforts from other initiatives… maybe to become the **IBC Sustainability Forum**?
- This is what we started.. What are **your considerations**?
- Realisation that we only scratched the surface of the overall scope, and an early conclusion that **we would like to continue the work beyond IBC**.