### Carbon in Motion: Characterizing Open-Sora on the Sustainability of Generative Al for Video Generation

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#### **Rapid Rise of Generative AI (GenAI) Technologies**



Text Generation (OpenAl -2022)

Prompt: A Samoyed and a Golden Retriever dog are playfully romping through a futuristic neon city at night. The neon lights emitted from the nearby buildings glistens off of their fur.



Video Generation (OpenAl -2024)



#### **Overview of Video Generation Inference Architecture.**



#### **Experimental Methodology**



**Carbon footprint:** Carbon = Energy · Intensity +  $\frac{T_{gen}}{T_{life}}$  · Embodied

## RQ 1. Embodied and operational carbon for video generation inference.

The carbon footprint is mainly due to operational carbon.



Deploy the applications in datacenters powered by more renewable energy sources with power efficiency hardware.

## RQ 2. Carbon footprint of video generation compare against text generation with LLM.

Generating videos consumes significantly more carbon than generating text.



As GenAI technologies advance towards multi-modality, video generation will become a major contributor to the carbon footprint of GenAI in the future.

# RQ 3. Carbon footprint accounts for text encoding, diffusion denoising, and video decoding phases.

The carbon is dominated by the iterative diffusion

denoising phase. The length of the input prompt has almost no impact.



It would be a carbon-friendly practice for service providers to refine user prompts using language models before feeding them into the video generation model.

# RQ 4. The number of diffusion denoising steps to balance video quality and carbon emissions.



Service providers should standardize video generation quality metrics to help determine the appropriate number of denoising steps, balancing quality and carbon emissions.

## RQ 5. The impact of video resolution and length on the carbon footprint of video generation.



The carbon footprint of video generation scales almost quadratically with video resolution.

## RQ 5. The impact of video resolution and length on the carbon footprint of video generation.

The carbon footprint scales linearly with generated video duration.



Service providers should guide users to conduct trials at lower resolutions before generating high-resolution videos.

### **Summary of Key Contributions**

- This work is the first to investigate the carbon footprint of video generation applications.
- Our characterization provides operational insights for making video generation services eco-friendly.
- We offer insights from this study for video generation service providers to integrate sustainability into their pricing models.