Europe, February 2025

Urban Foundation Models (UFMs)

Introduction deck

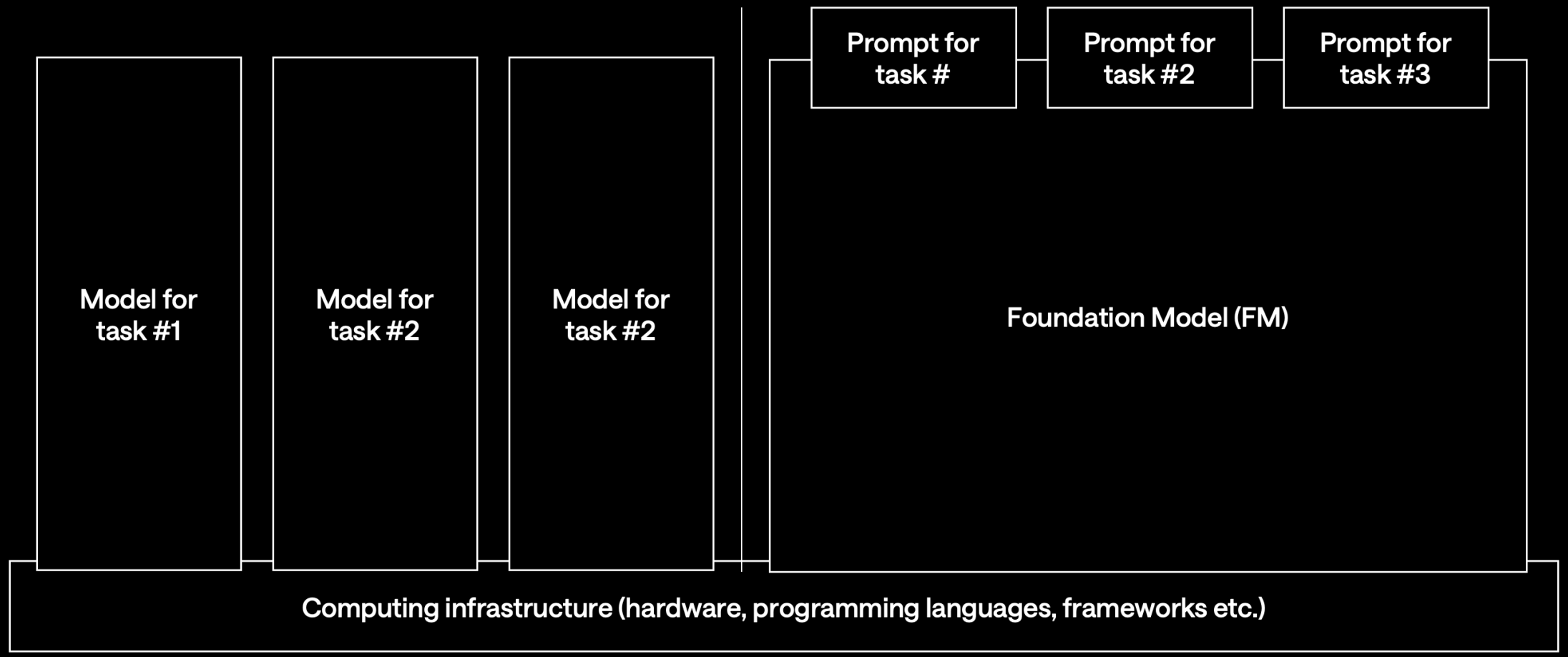
LUNAR

Executive summary

- Foundation models (FMs) or base models, are task-agnostic, pre-trained, large-scale neural networks that can be adapted to numerous downstream tasks.
- Within FMs, large language models (LLMs) trained on terabytes of internet-based textual datasets like CommonCrawl have become popular in recent years due to product examples like ChatGPT. As LLMs have attracted hundreds of billions of EUR, and FMs like GPT-3/GPT-4 have led to a myriad of derivative models tailored to specific downstream tasks (e.g., specific assistants). These recent investments in LLMs have also shed light on the unit economics in an AI-world: CAPEX required to train SOTA (state of the art) models increases~2,5x/annum[1], compute required to train SOTA models is growing at ~4,6x per year[1], rapid commoditization of models occurs due to open-source competition, different geographic regions tend to build their FMs[2], and rapid declines in token costs for existing models occur at -86%/annum[3].
- New categories of FMs will occur in the coming years, typically with alternative use cases. The main examples include geospatial foundation models (GFMs), time series foundation models (TFMs), and material foundation models (MFMs). An alternative way to segment foundation models is to focus on the data modality being used, the main categories using that logic are language foundation models, vision foundation models and multimodal foundation models – the latter category using multimodal input data and typically allowing multimodal generalizations (e.g. text to image, image to text).
- Urban Foundation Models (UFMs) are a very new category of foundation models focused on urban planning and management, with the first examples of models appearing today (e.g., CityFM, UrbanLLM, OpenCity), mostly from China. Note that this push comes at the same time where cities are installing virtual twins of their cities to simulate scenarios (e.g., Singapore, New York, Helsinki). Note ii that there is an overlap with other spatio-temporal models such as geospatial foundation models (GFMs). Although UFMs are in their early days, we believe they may have significant value for cities in the future around transportation planning, environmental monitoring, infrastructure development, energy management and public safety. Next to the obvious use cases, there are many additional use cases that could provide value, such as safety optimization, better management of healthcare crises, and localized emission reductions.
- Lastly, we dive into the AI economics making these use cases viable and highlight three main trends relevant to understanding AI economics: i) the increase in training costs for new state-of-the-art (SOTA) models, ii) the increase in the total amount of available models, and iii) the decrease in token costs over time. First, investment for developing foundation models is significant, with the first ~1bln EUR models in sight – while at the same time cheaper variants keep popping up (e.g., DeepSeek, Llama). Second, in the last four years open-source model repositories have grown very rapidly in with a 70X increase in the number of models available. Language-based models are still the dominant category, but this can change when more high-quality and affordable satellite data becomes available at scale. Finally, given the intense competition from open-source models, API token costs tend to fall rapidly, as was shown in recent years for GTP-3 and GPT-4 where token costs fell ~90% per year. These trends support the premise that geospatial models can have a wide set of economically viable use cases in the coming years, as the willingness to invest is present and usage costs are declining rapidly.

[1] Source: Epoch.ai; [2] ChatGPT in the US, Mistral in Europe, DeepSeek in China – with largely similar capabilities, [3] source: deeplearning.ai.

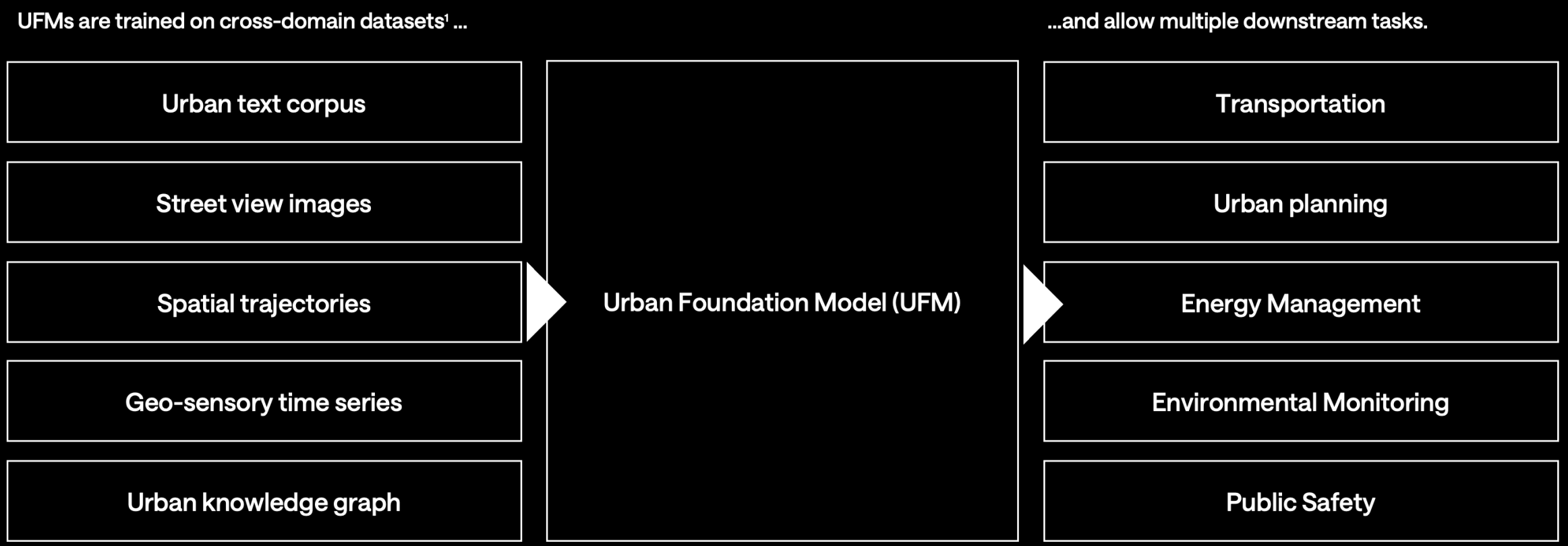
Foundation models are multi-purpose models...



Source: University of Amsterdam (2024): Foundation models are platform models.

LUNAR

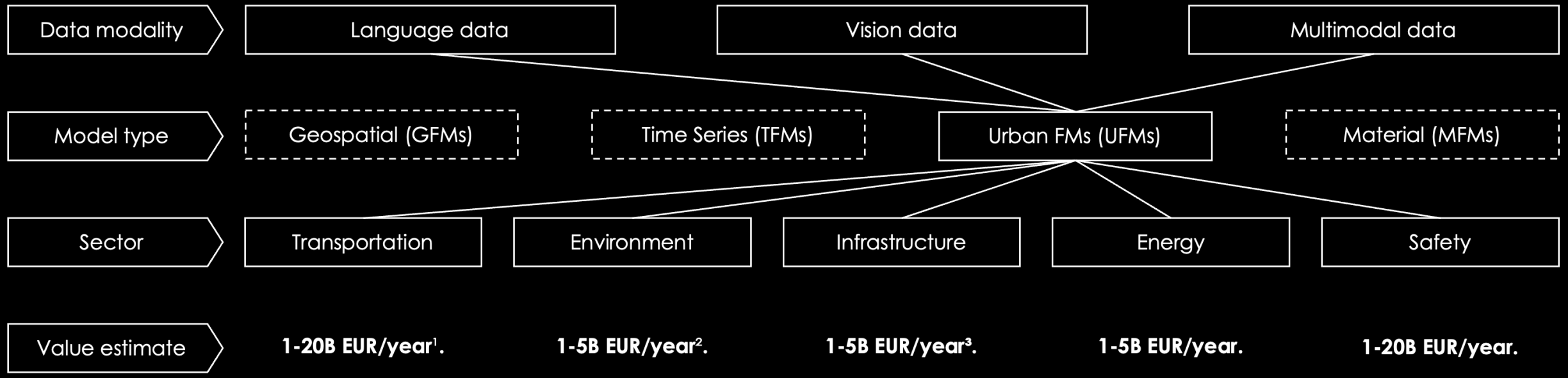
...where UFMs are multifunctional models to aid urban management



Source: Towards Urban General Intelligence: A Review and Outlook of Urban Foundation Models (2025)

LUNAR

UFMs may become a significant industry in the coming years

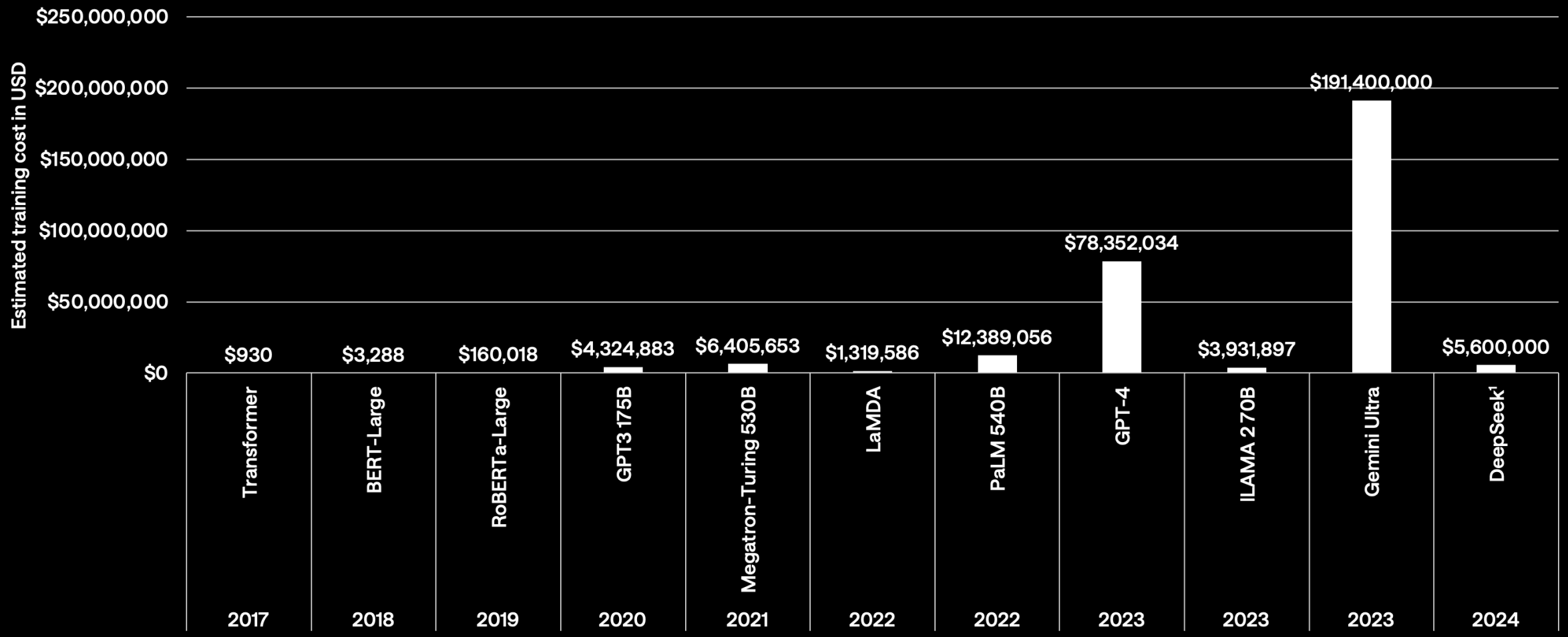


Value estimate	**1-20B EUR/year[1].**	**1-5B EUR/year[2].**	**1-5B EUR/year[3].**	**1-5B EUR/year.**	**1-20B EUR/year.**
	Predicting peak traffic hotspots, public transport demand, accident risk, traffic light optimisation, ride-sharing demand, parking space availability etc.	Urban heat island predictions, flood risk forecasting, air pollution hotspots, green space impact forecasting, peak water/energy usage, noise pollution predictions, waste collection optimisation etc.	Real estate planning, real estate price appreciation, disaster resilience planning (heat, floods, etc.), water resource management, optimal locations for charging stations, bike lane utilization etc.	Energy demand forecasting, grid optimisation, renewable energy locations, EV charging sites, district heating/cooling optimisation, etc.	Crime patterns, social unrest prediction, health management, epidemic management, income inequality, localized mental health etc.

[1] Global costs of traffic congestion is ~1.4T EUR/year, a 1% improvement could save 14B EUR; [2] Heat- and pollution-related excess deaths per year number in the millions, particularly from respiratory and heart diseases; [3] Smart urban planning software is a 15-20B EUR market growing rapidly to ~35B EUR in 2030, a 1-10% improvement in quality could be worth 1-5B EUR.

LUNAR

While training costs for foundation models is generally increasing...

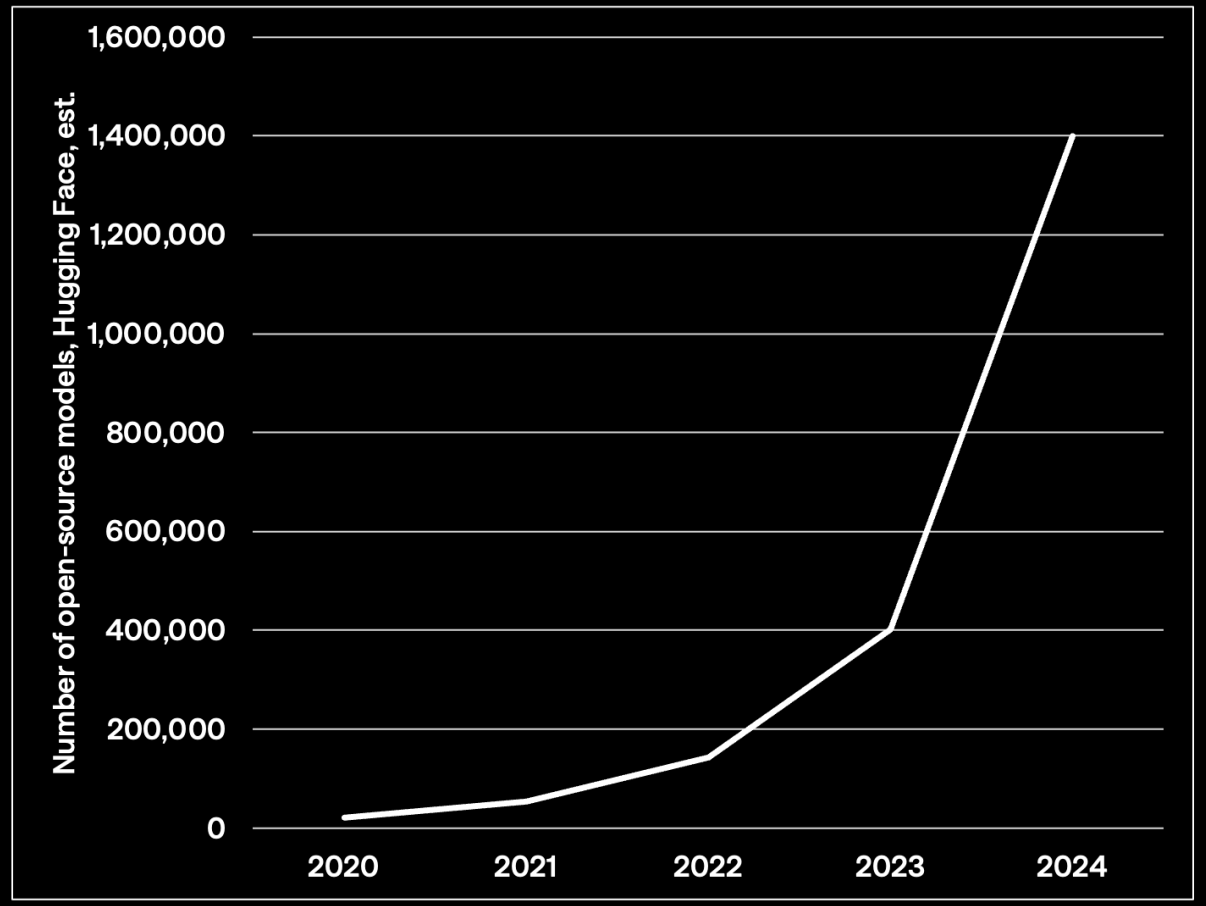


Source: epoch.ai; [1] Note the discussion around DeepSeek's true training costs, with estimates from 5,6mln USD to 1,6bln USD.

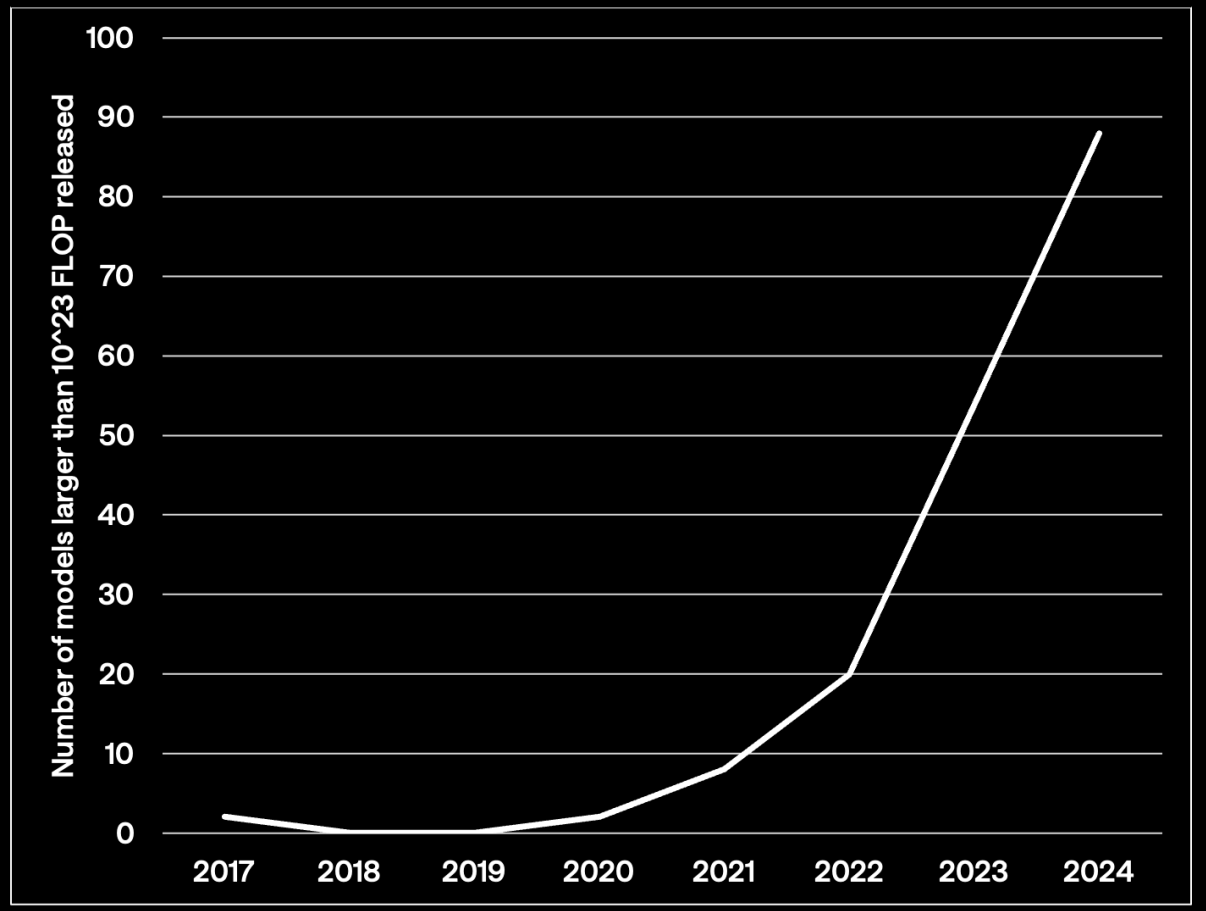
LUNAR

...the competition between models is fierce...

Open-source models grew ~70X in the last four years...



...and more players are releasing large (over 10^23 FLOP) models.

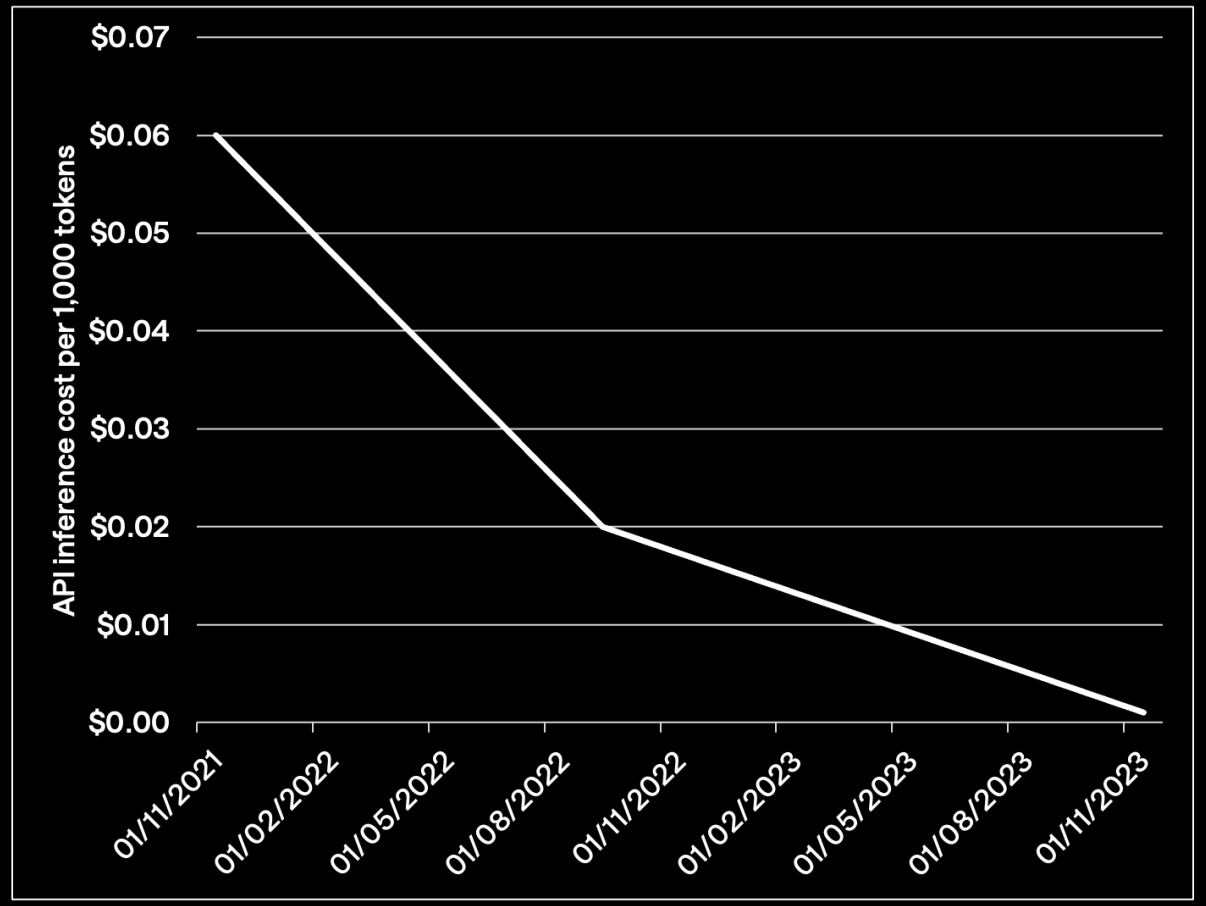


Source: Hugging Face, Epoch.ai.

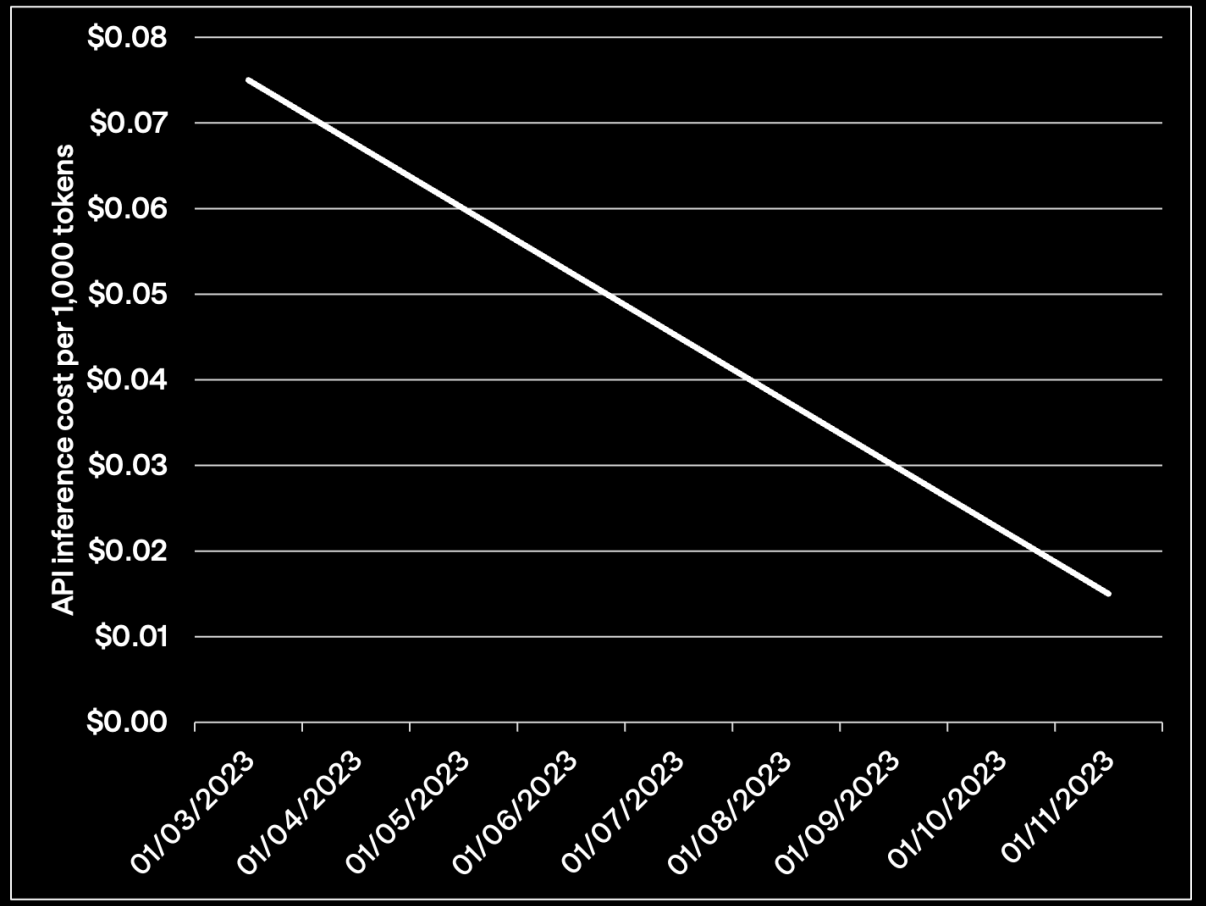
LUNAR

...and falling token costs will make more use cases economical

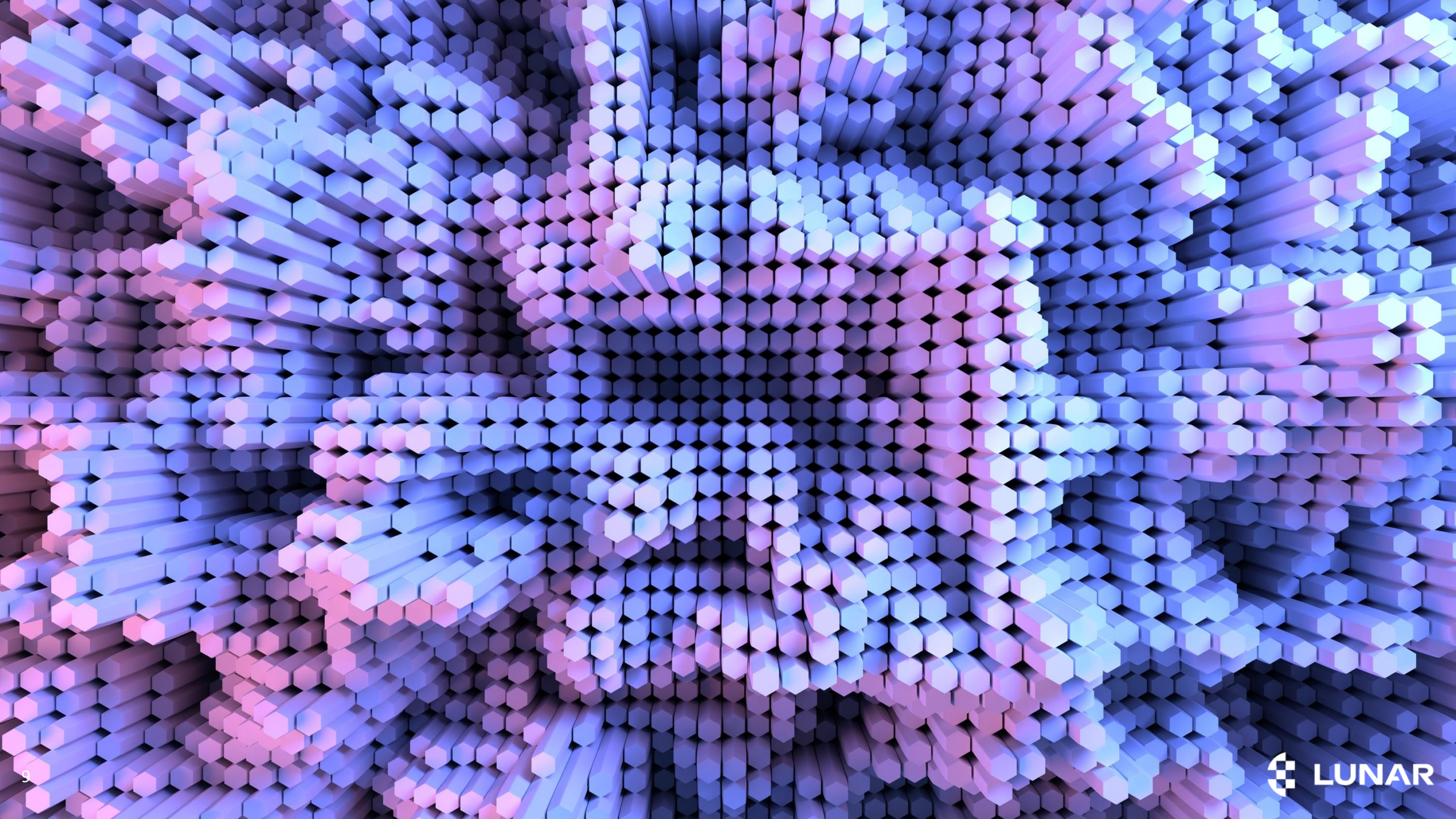
GPT-3 token cost fell ~86% in cost per year...



...and GPT-4 tokens showed a similar trend of falling 92% per year.



Source: Ark Invest analysis (2024); The Batch (2024).



LUNAR