



GREENDAYS 2025 @RENNES



UNIVERSITÉ  
DE LORRAINE



*Inria*



# UNRAVELING THE ENERGY FOOTPRINT OF DEEP LEARNING MODELS DEVELOPMENT



Constance Douwes

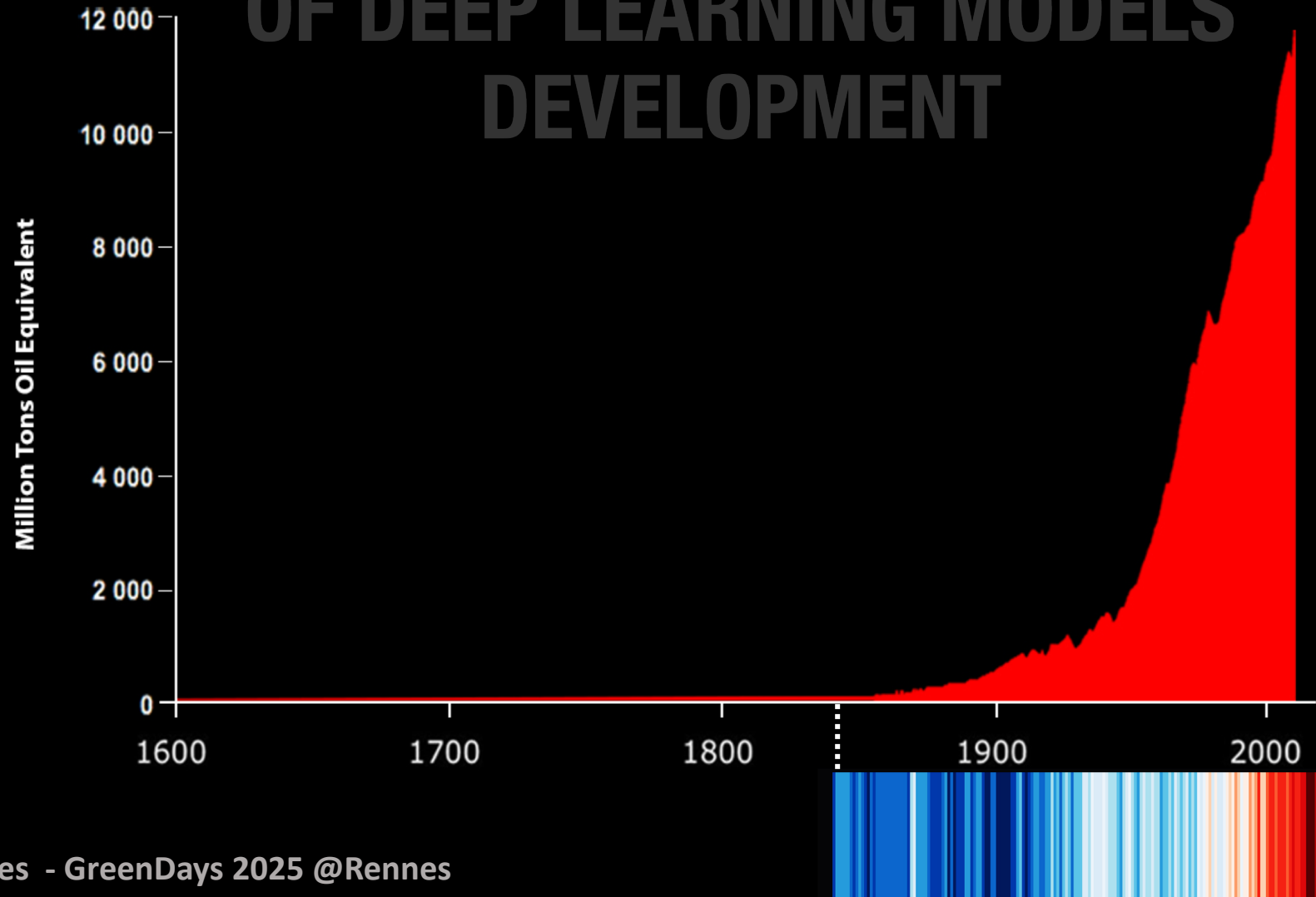
Jean-Eudes Ayilo, Can Cui, Paul Magron, Mayank Mishra, Romain Serizel

*Inria (Nancy), LORIA, University of Lorraine, CNRS, LORIA (FRANCE)*

**& MULTISPEECH**

# **UNRAVELING THE ENERGY FOOTPRINT OF DEEP LEARNING MODELS DEVELOPMENT**

# UNRAVELING THE ENERGY FOOTPRINT OF DEEP LEARNING MODELS DEVELOPMENT



[Janvocici2007]

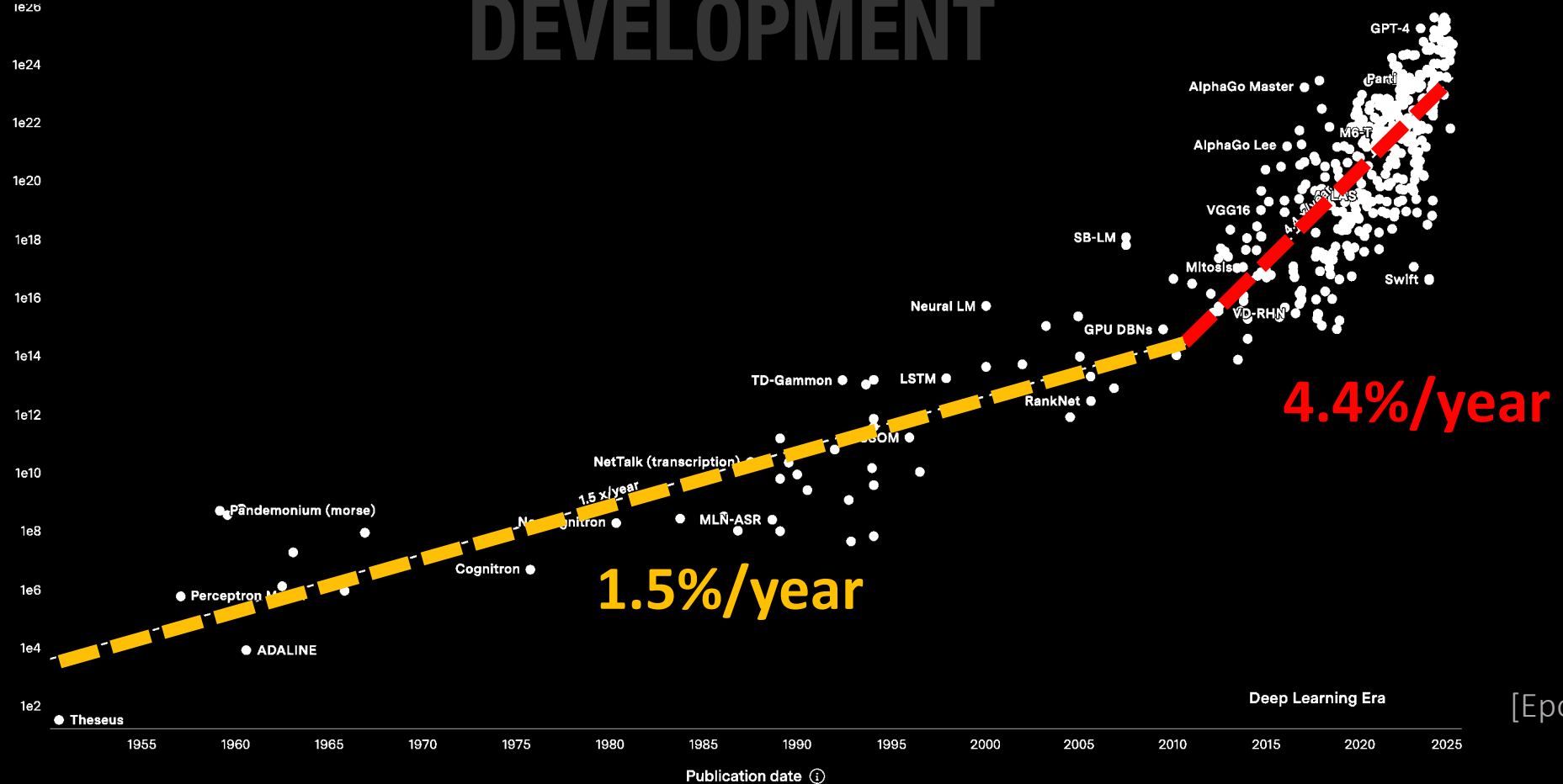
**1.5°?**

[Hawkins2023]

# UNRAVELING THE ENERGY FOOTPRINT OF DEEP LEARNING MODELS DEVELOPMENT

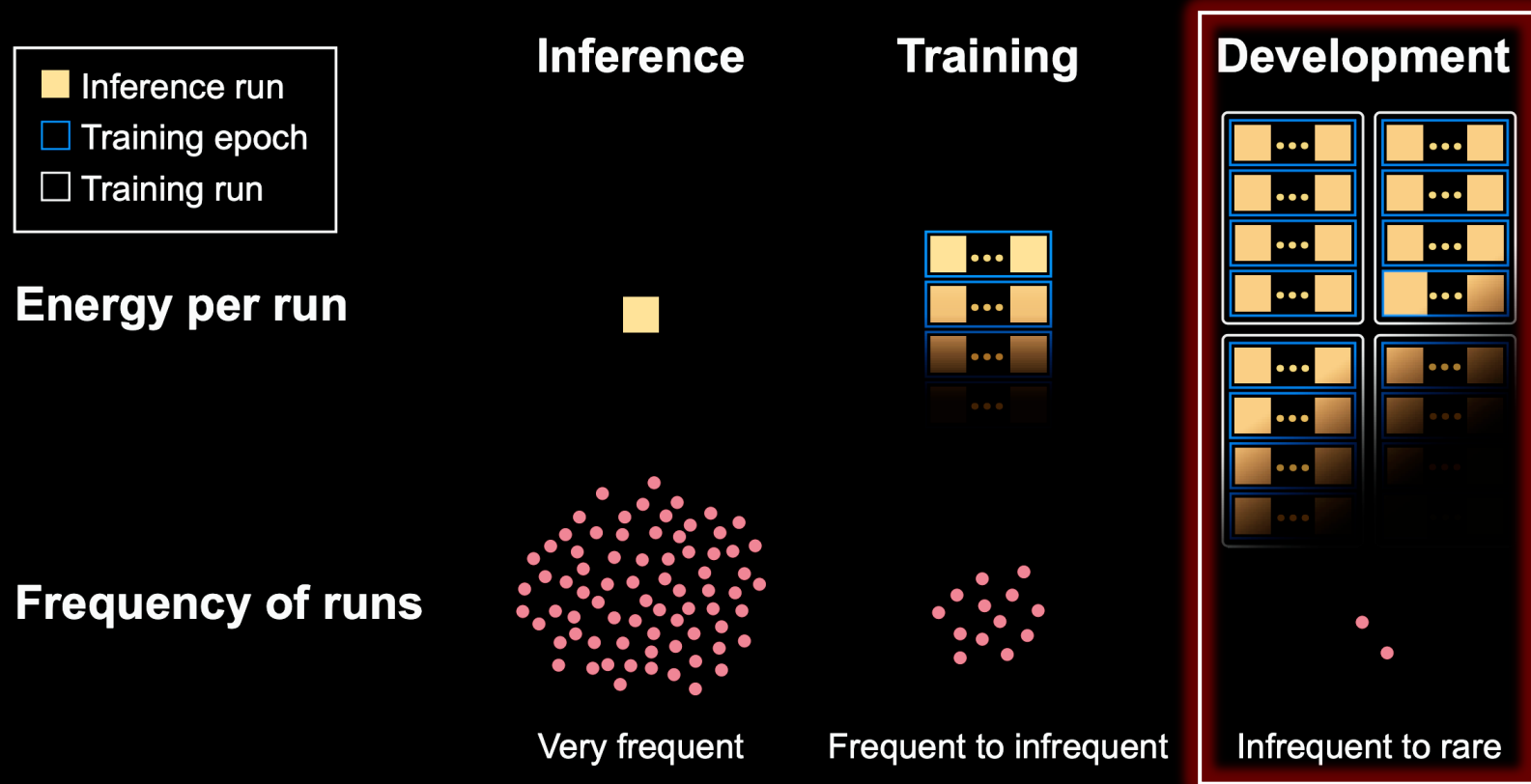
Notable AI Models

Training compute (FLOP) ①



# UNRAVELING THE ENERGY FOOTPRINT OF DEEP LEARNING MODELS

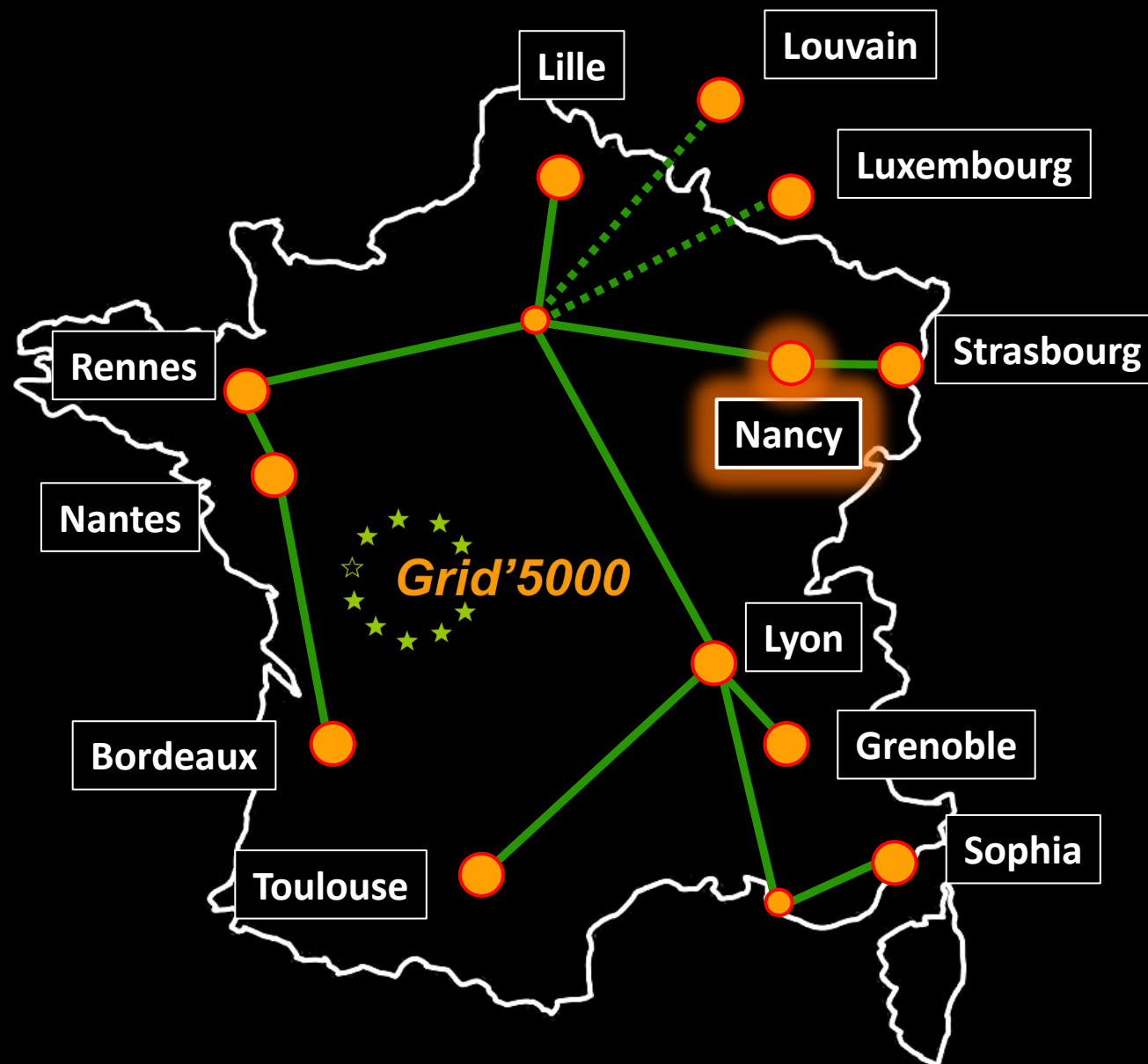
## DEVELOPMENT



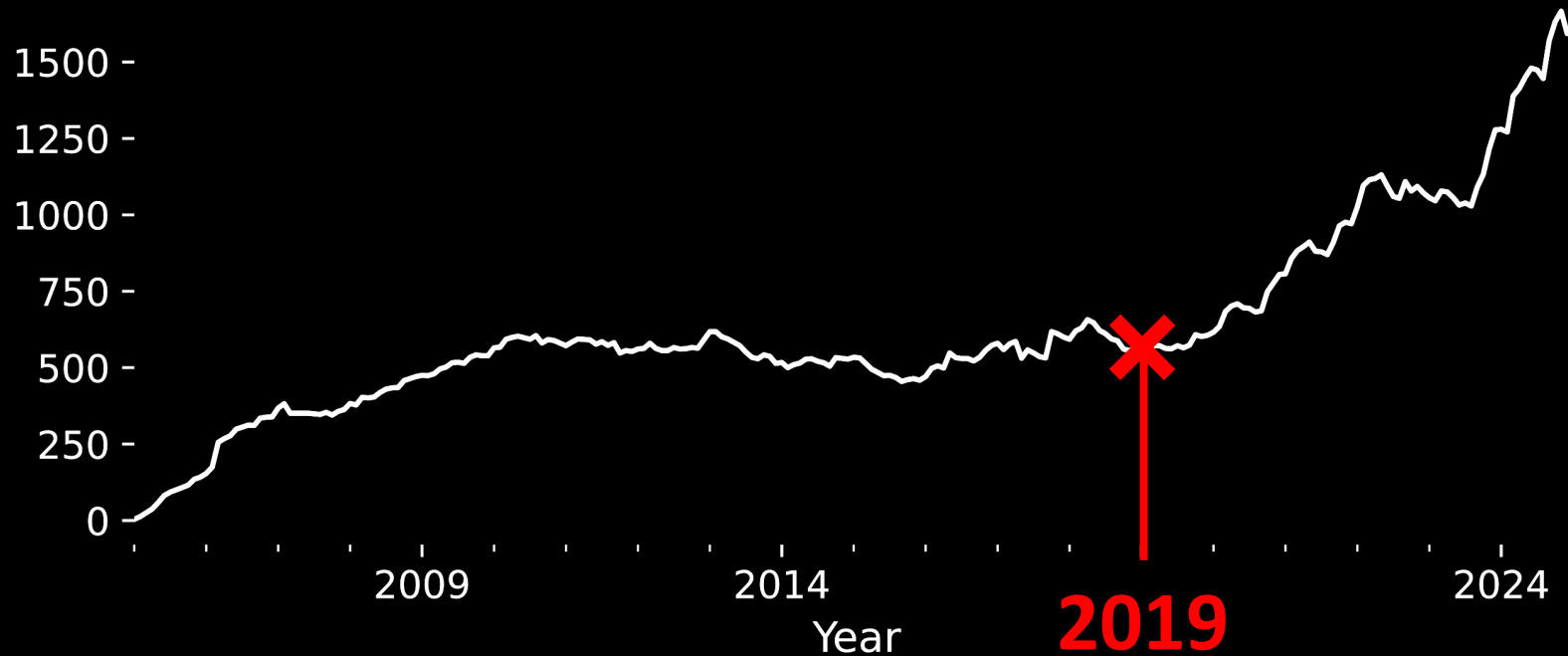
[Haack21]

# EXPERIMENTS



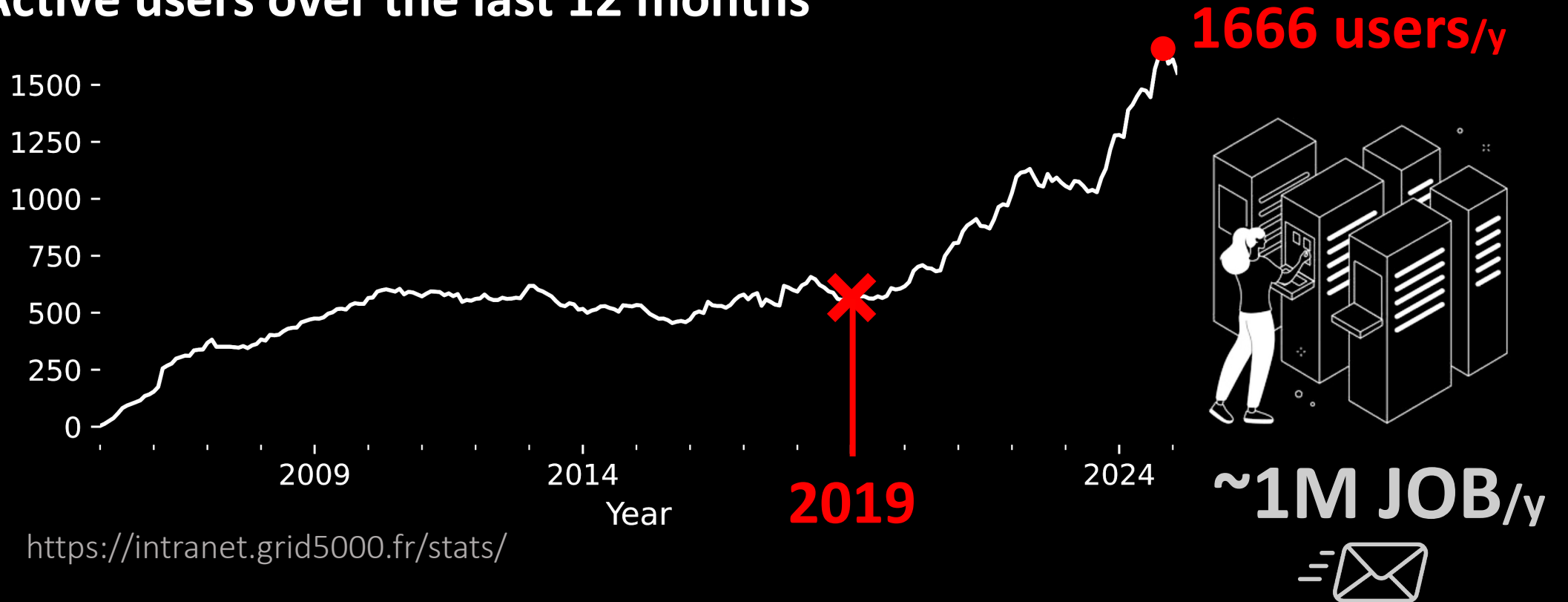


## Active users over the last 12 months



<https://intranet.grid5000.fr/stats/>

## Active users over the last 12 months



# GA.

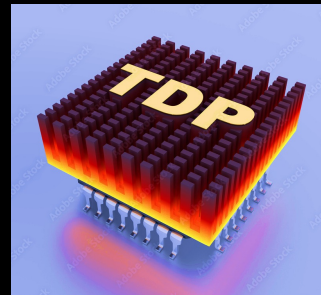
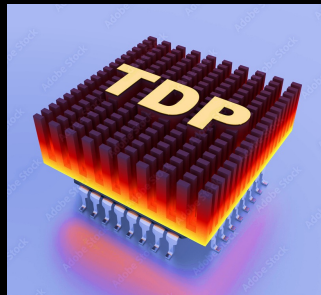
Green Algorithm

[Lannelongue21]

# BMC.

Baseboard Management Controller

$$\text{Energy} = (P_{\text{GPU}} + P_{\text{CPU}} + P_{\text{MEM}}) \times \text{Hours}$$



3W /  
8Gb

# GA.

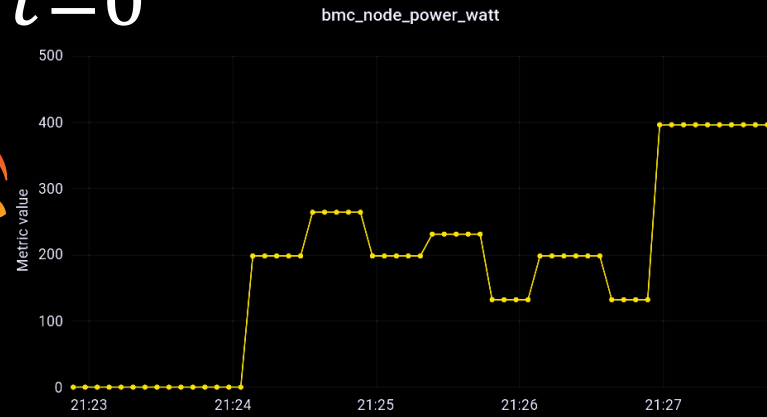
Green Algorithm

# BMC.

Baseboard Management Controller

[Kwollect]

$$\text{Energy} = \sum_{t=0}^T P_{\text{BMC}}(t) \times t$$



# GA.

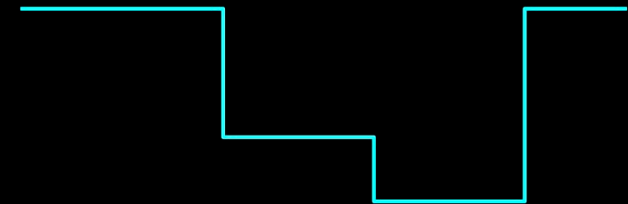
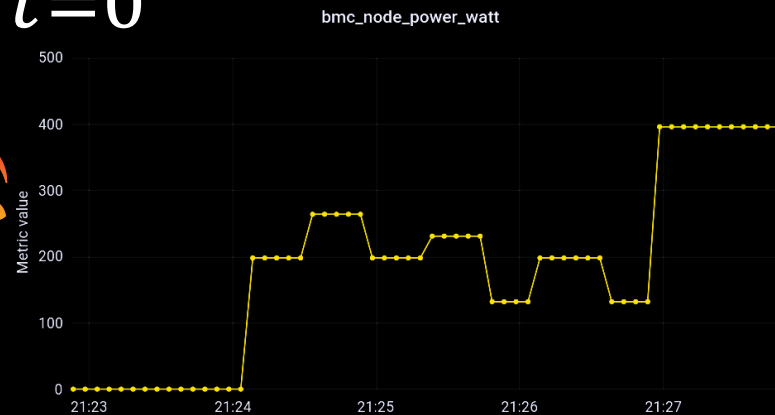
Green Algorithm

# BMC.

Baseboard Management Controller

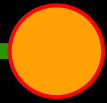
[Kwollect]

$$\text{Energy} = \sum_{t=0}^T P_{\text{BMC}}(t) \times t \times \text{Gate}(t)$$

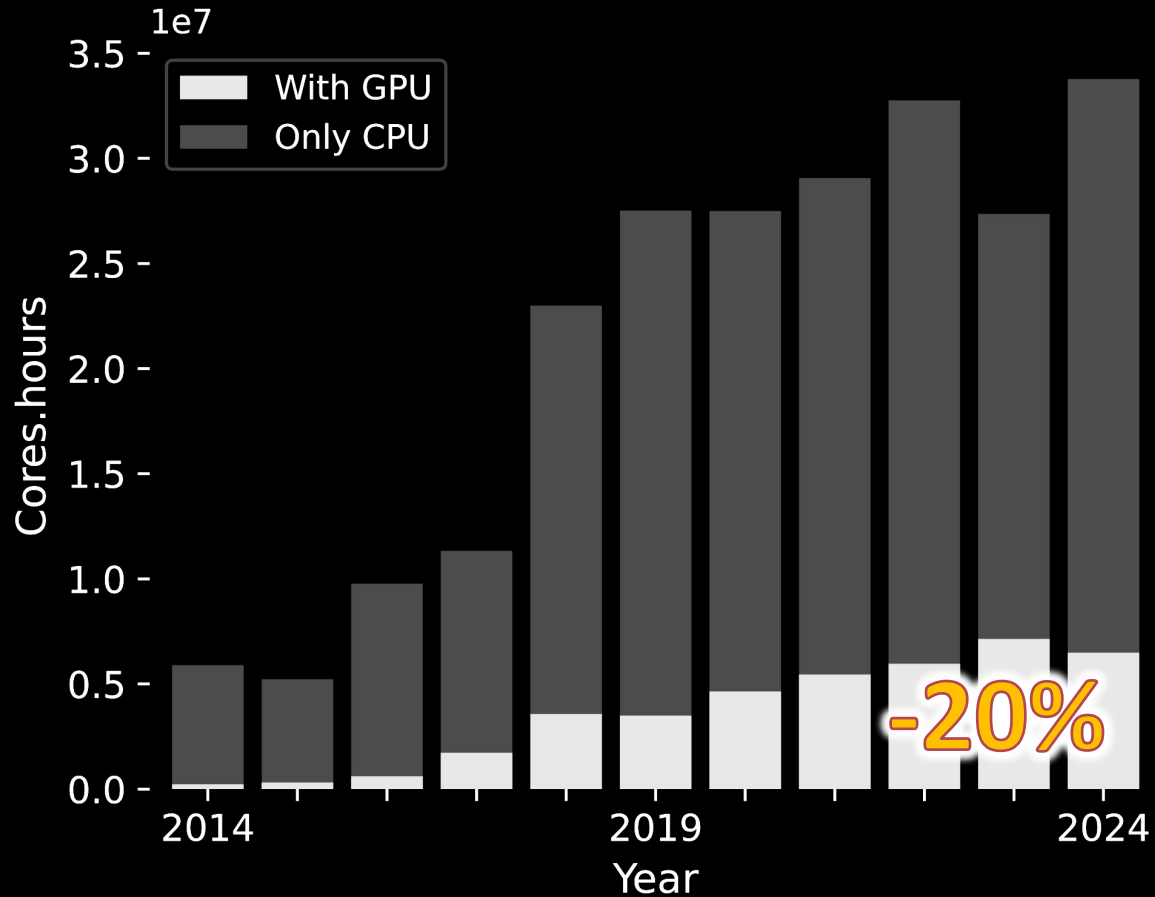


# RESULTS

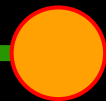




# Cores × Hours

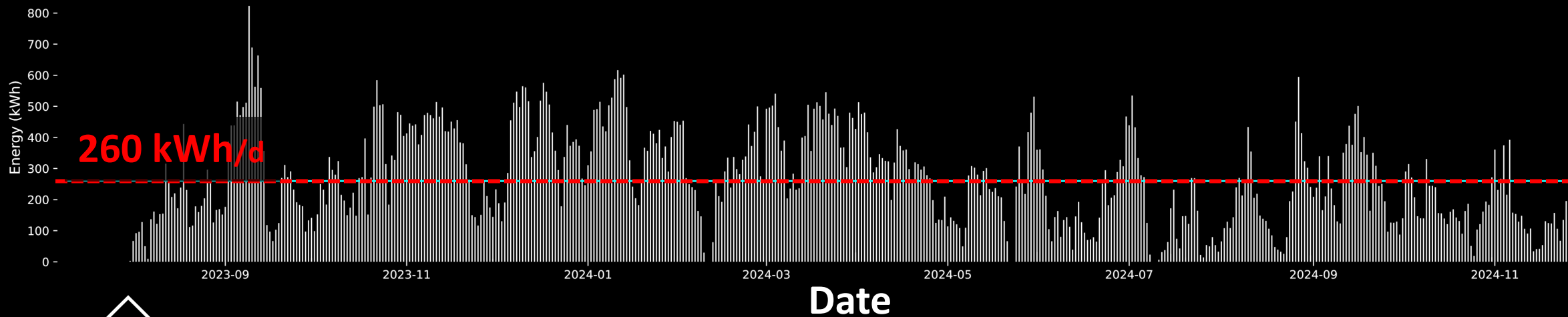




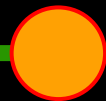


Nancy

Multispeech project



~50 households



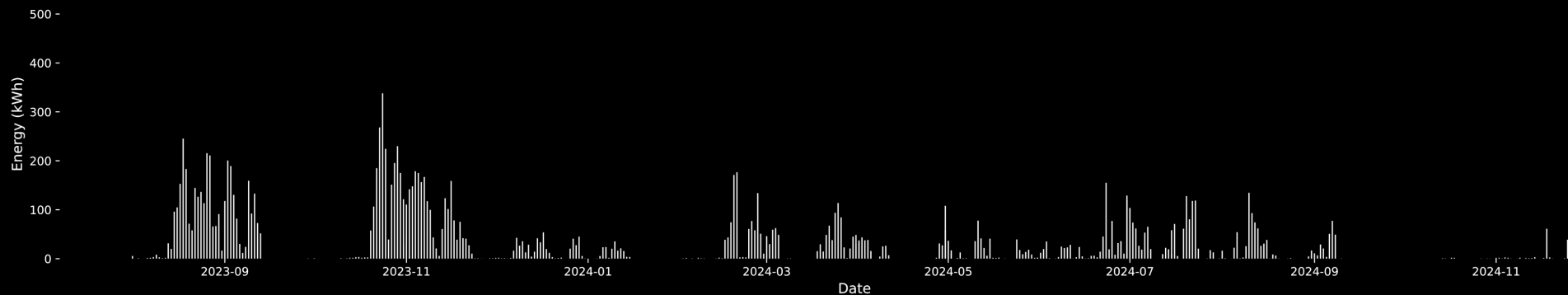
Nancy

Multispeech project

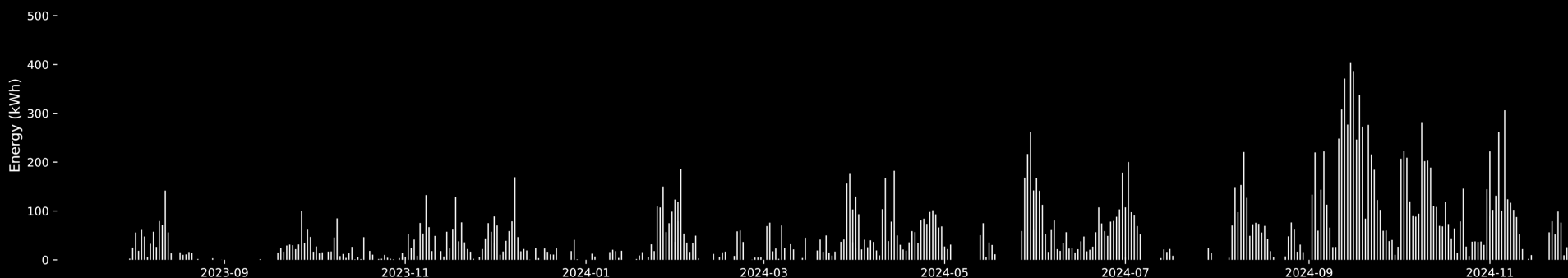
User



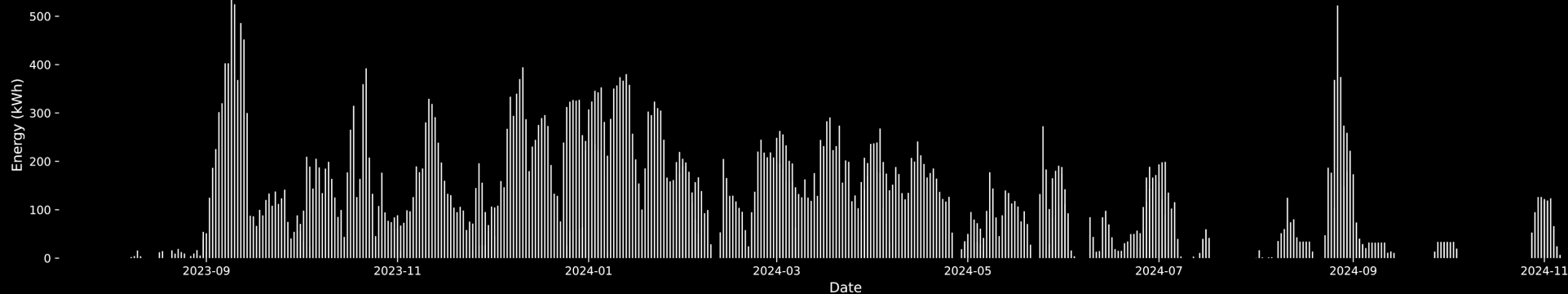
User 1

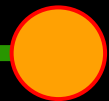


User 2

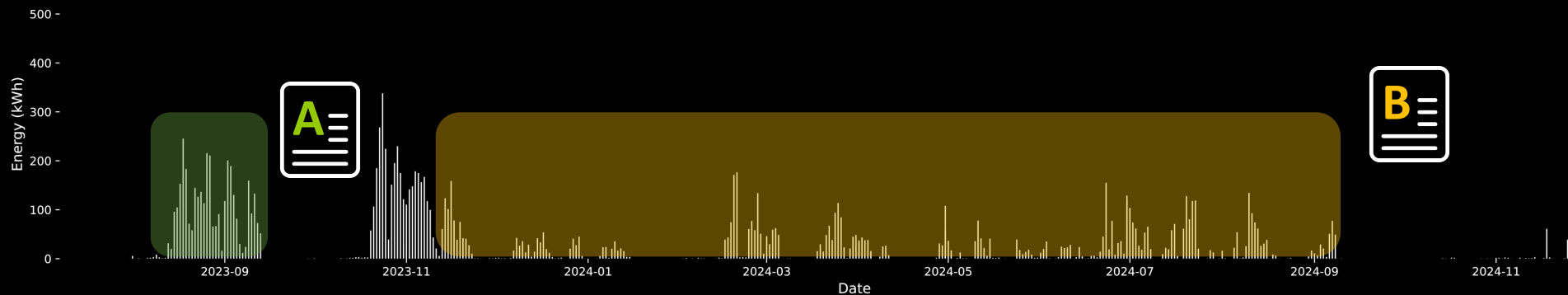


User 3

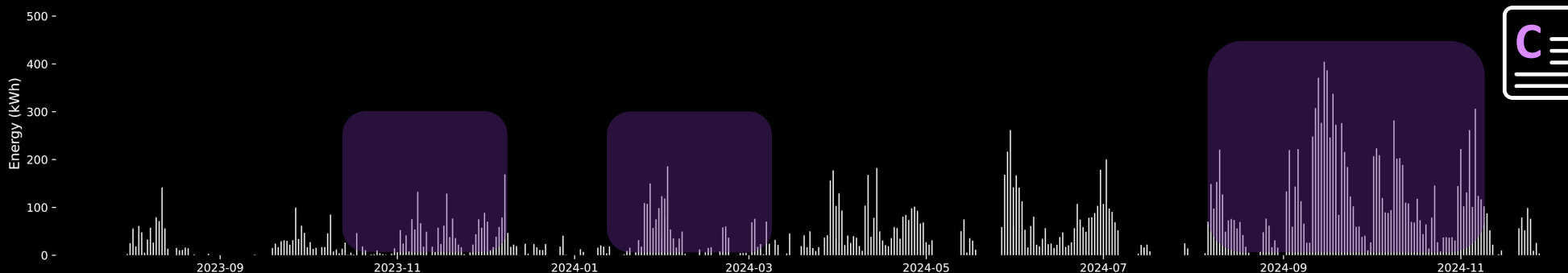




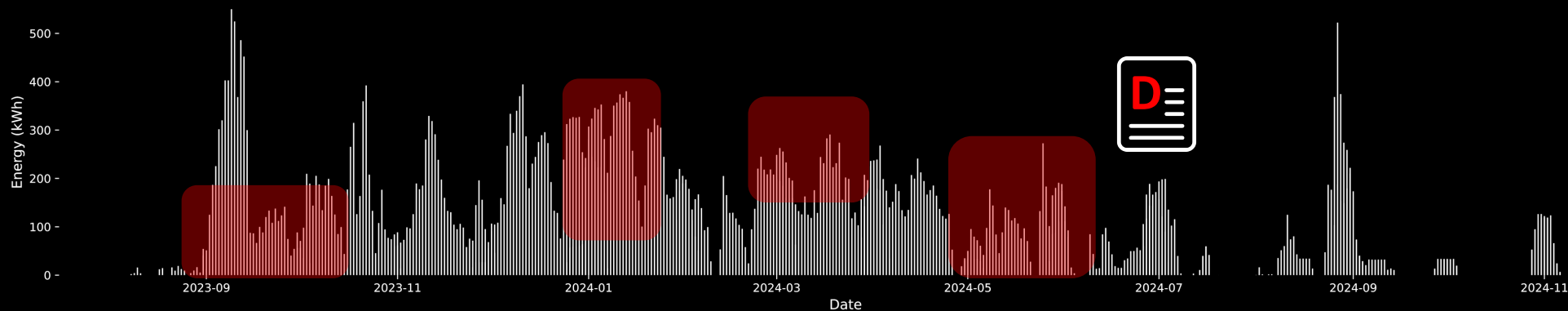
User 1

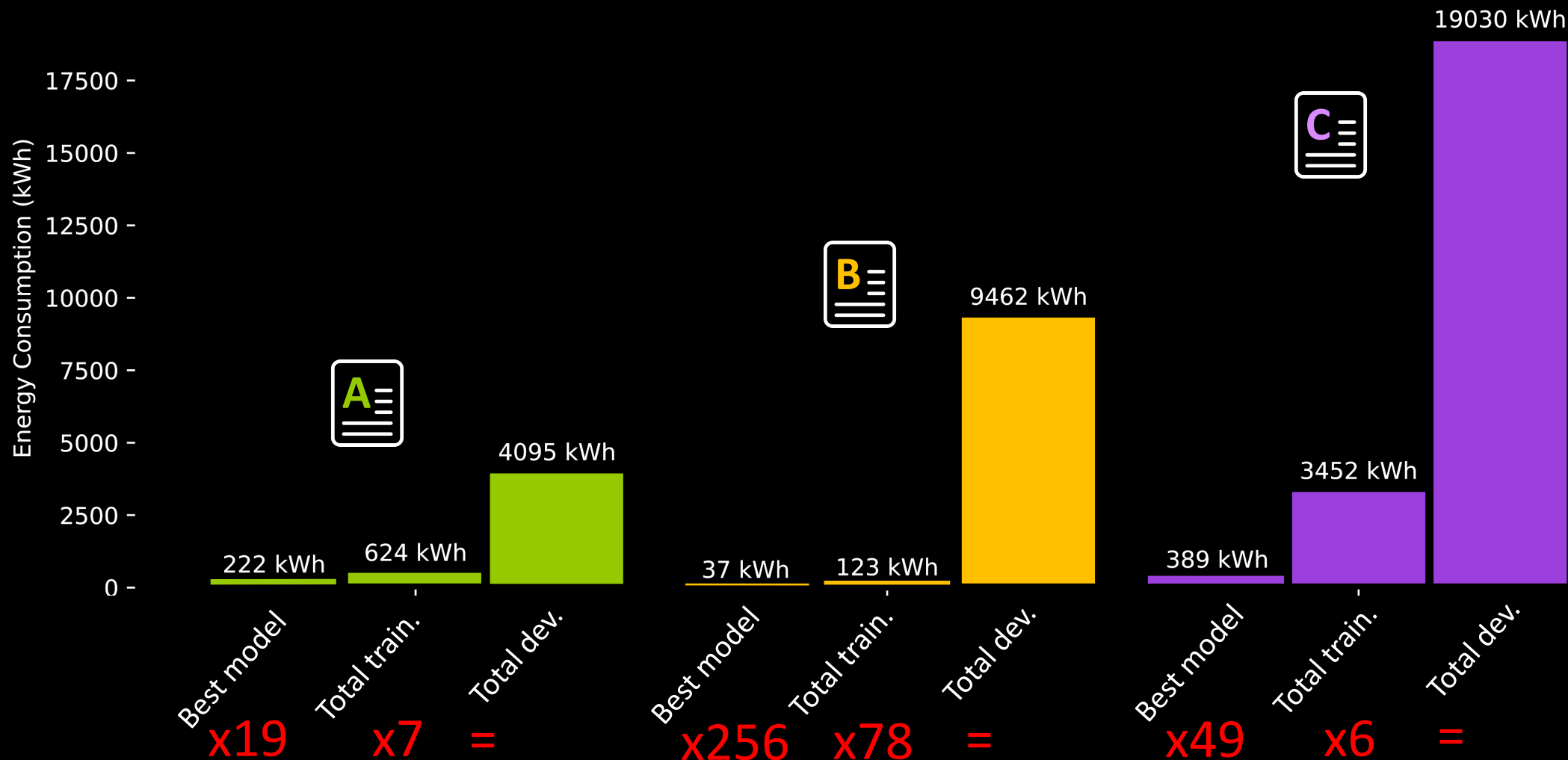
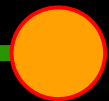


User 2



User 3





# CONCLUSION & FUTURE WORK



1. Grid5000 Nancy consumes **600 MWh/y**, with GPUs using half.  
→ Include offset energy from idle unused hardware.
2. Multispeech project consumes **260 kWh/d** on GPU.  
→ Apply to other (DL-intensive)-team project
3. Development phase equals **49x–256x** training best model  
→ Develop a tracker to facilitate data collection and reporting

**& publication & code online soon 😊**

# Some guidelines...

1. Use more **energy-efficient** hardware ?  
→ Manufacturing cost & rebound effect
2. Run experiments on **lighter** models & **small** dataset size ?  
→ Multiplication of experiments & rebound effect
3. **Publish it !!**

# .bib

- [Janvocici2007] <https://jancovici.com/transition-energetique/l-energie-et-nous/a-quoi-ressemble-notre-consommation-energetique-actuellement/>
- [Hawkins2023] <https://showyourstripes.info/>
- [EpochAI24] <https://epoch.ai/data/notable-ai-models>
- [Haack21] Kaack, L.H., Donti, P.L., Strubell, E. et al. Aligning artificial intelligence with climate change mitigation. Nat. Clim. Chang. **12**, 518–527 (2022). <https://doi.org/10.1038/s41558-022-01377-7>
- [Lacoste19] Lacoste, Alexandre, Alexandra Luccioni, Victor Schmidt, and Thomas Dandre (2019). “Quantifying the Carbon Emissions of Machine Learning.” In: (cit. on p. 45).
- [Schmidt21] Victor Schmidt et al. “CodeCarbon : estimate and track carbon emissions from machine learning computing (2021)”. <https://doi.org/10.5281/zenodo.4658424> (2021). L
- [Lannelongue21] Lannelongue, L., Grealey, J., Inouye, M., Green Algorithms: Quantifying the Carbon Footprint of Computation. Adv. Sci. 2021, 8, 2100707. <https://doi.org/10.1002/advs.202100707>

# Thanks !



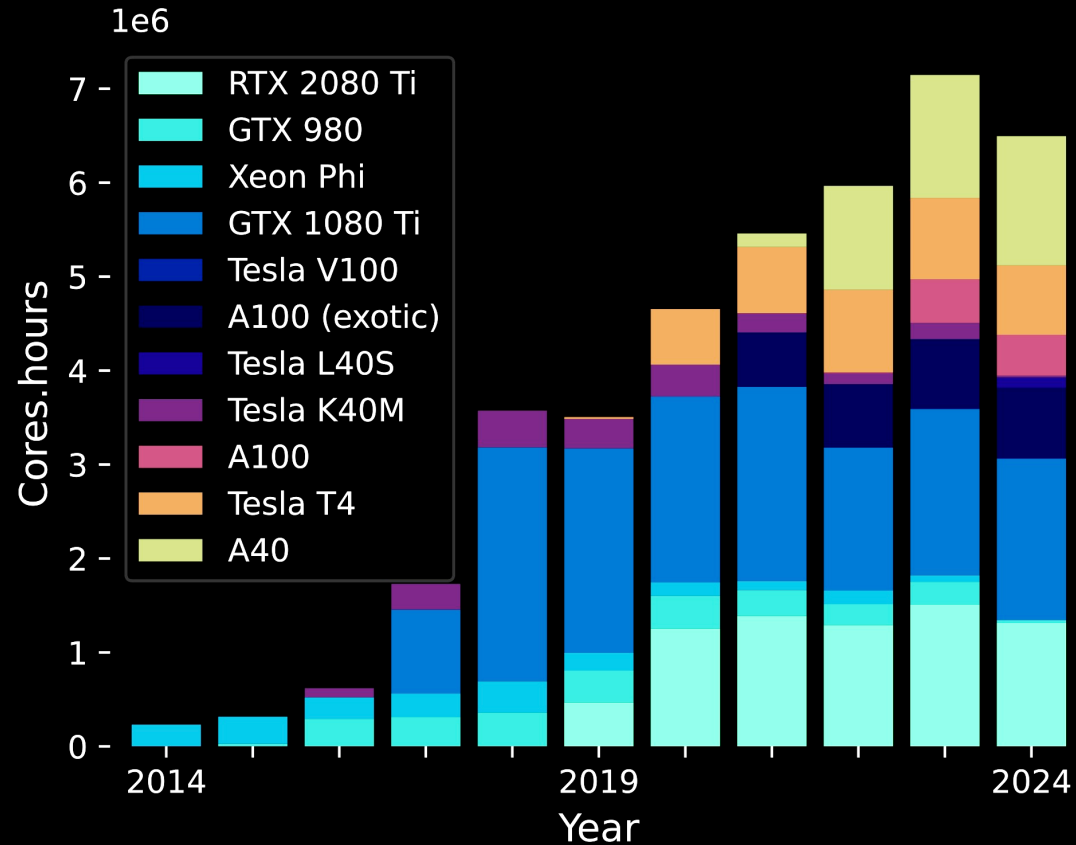
[constance.douwes@inria.fr](mailto:constance.douwes@inria.fr)

(... soon to be [constance.douwes@lis-lab.fr](mailto:constance.douwes@lis-lab.fr))

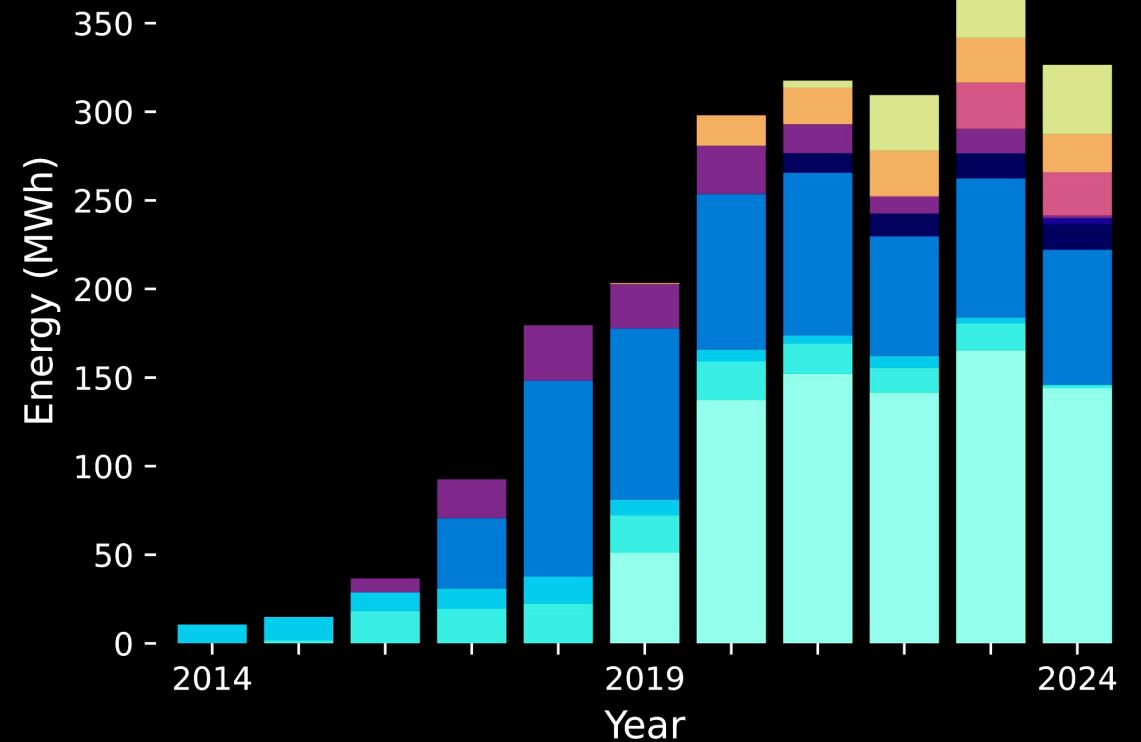
# BONUS



# Cores × Hours



# Energy GA.

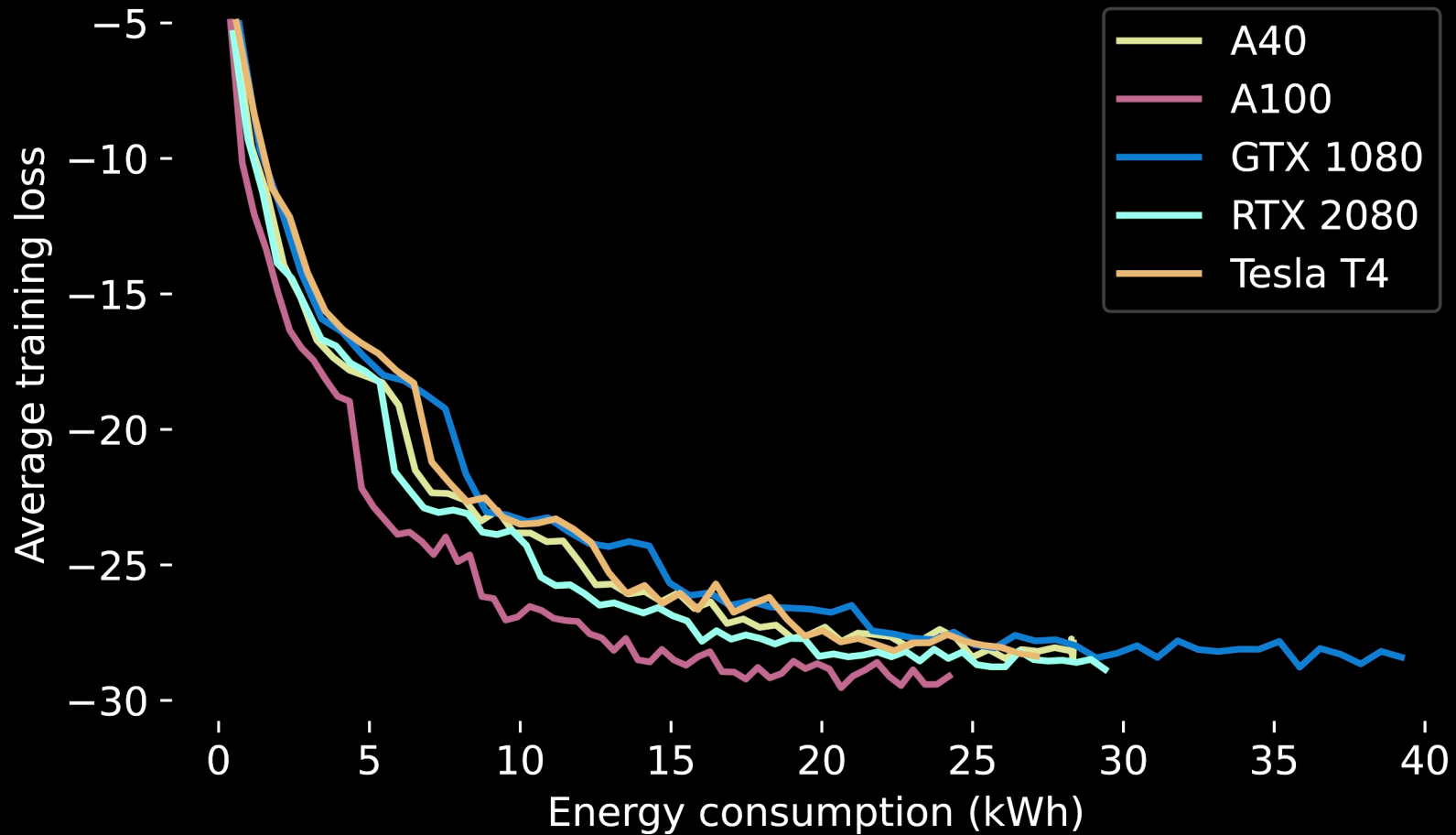


# CUTTING THE COSTS ?



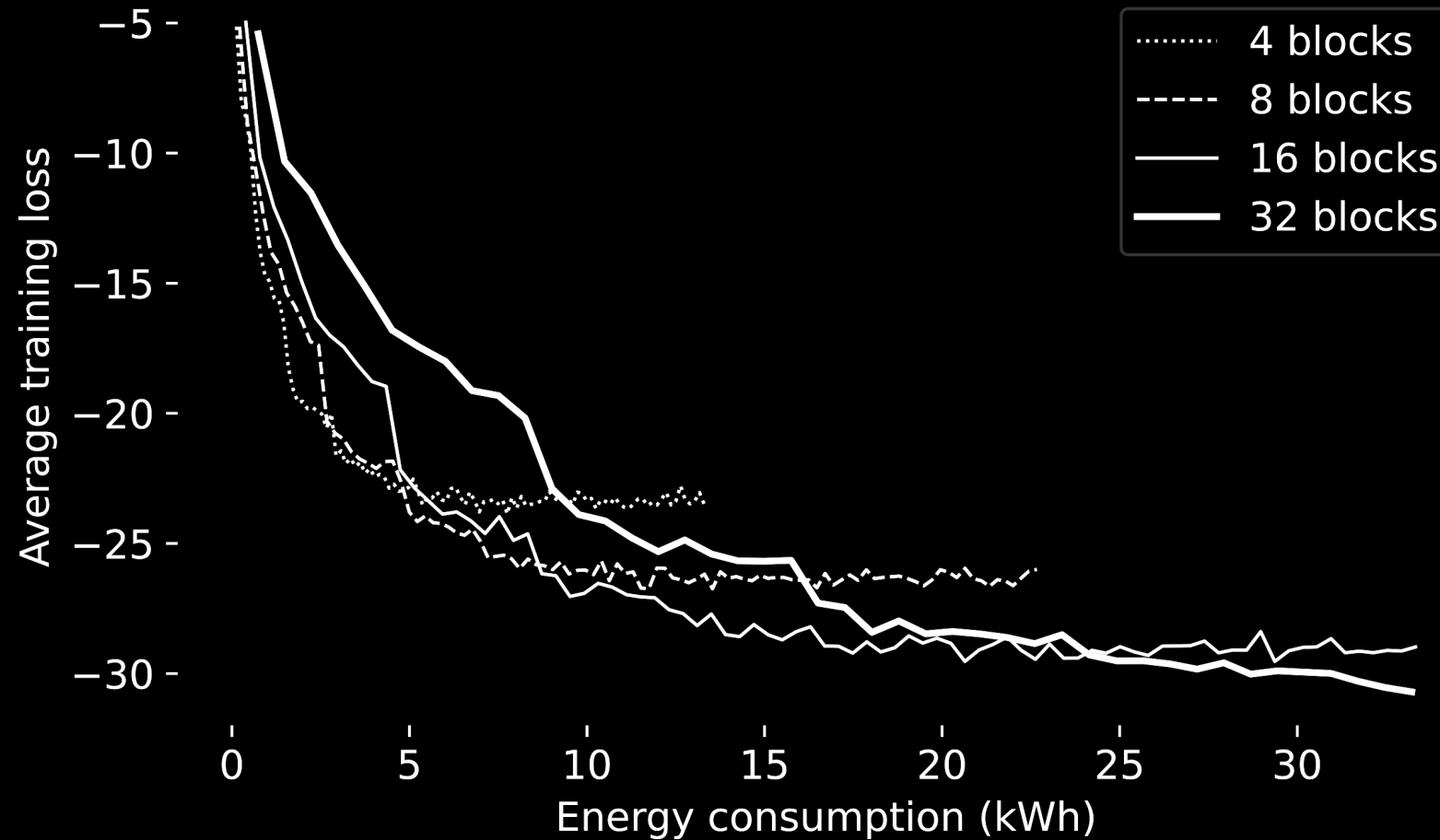
# HARDWARE

# SOFTWARE



# HARDWARE

# SOFTWARE



# MLCO2.

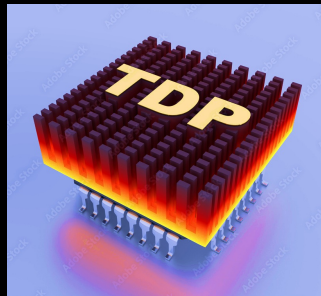
Machine Learning Impact Calculator  
[Lacoste19]

# GA.

# CC.

# BMC.

$$\text{Energy} = P_{\text{GPU}} \times \text{Hours}$$



MLCO2.

Nancy

GA.

Multispeech project

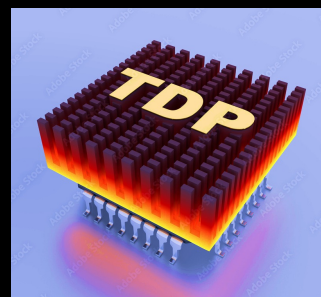
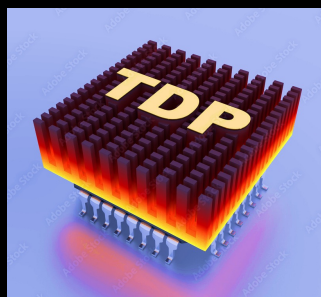
User

CC.

BMC.

Green Algorithm  
[Lannelongue21]

$$\text{Energy} = (P_{\text{GPU}} + P_{\text{CPU}} + P_{\text{MEM}}) \times \text{Hours}$$



3W /  
8Gb

MLCO2.

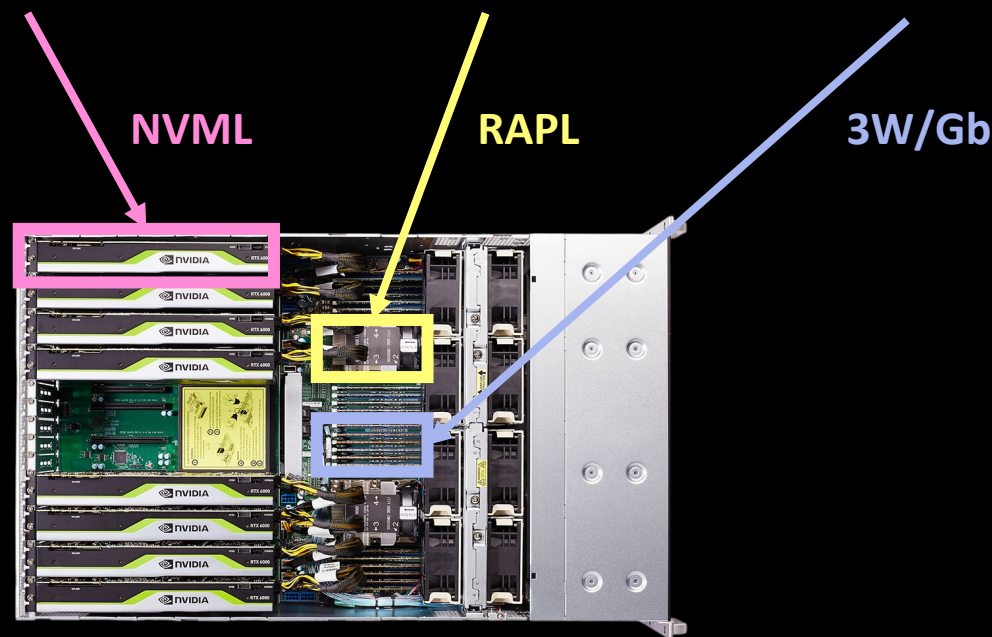
GA.

CC.

CodeCarbon  
[Schmidt21]

BMC.

$$\text{Energy} = \sum_{t=0}^T (P_{\text{GPU}}(t) + P_{\text{CPU}}(t) + P_{\text{MEM}}(t)) \times t$$



MLCO2.

GA.

CC.

**BMC.**

Baseboard Management Controller

$$\text{Energy} = \sum_{t=0}^T P_{\text{BMC}}(t) \times t \times \text{Gate}(t)$$

