Lecture Notes 3

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Séminaire Suivi ENS L3 SIF
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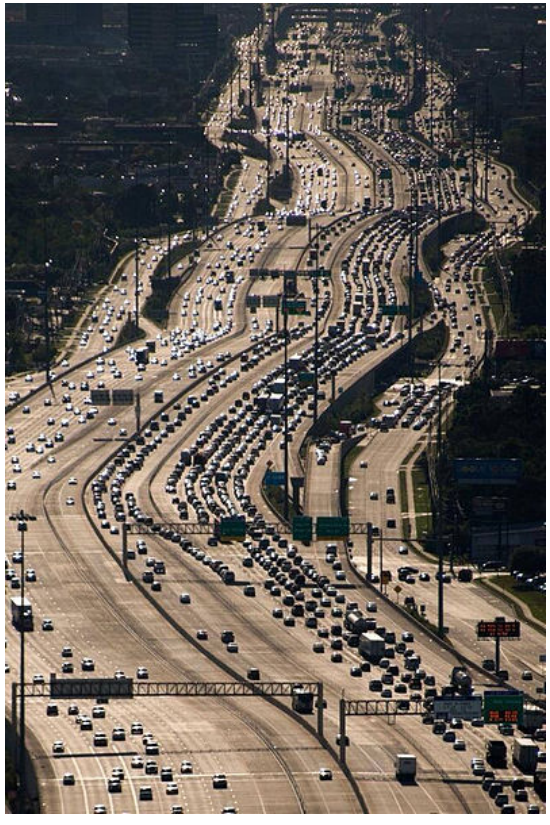
What is the rebound effect?



Katy Freeway, Houston (Wikipedia)

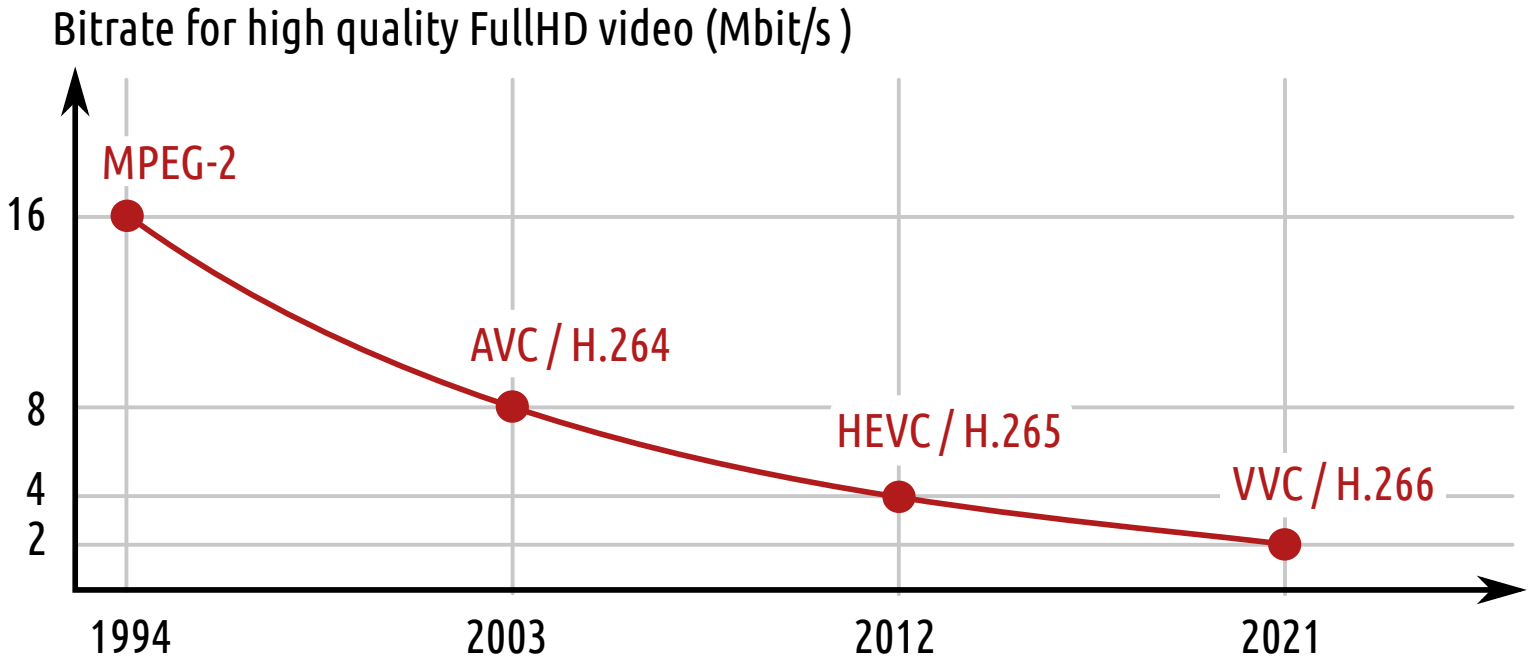
Jevon's paradox (or rebound effect):

As technological improvements increase the efficiency with which a resource is employed, the total consumption of that resource may increase rather than decrease. (Wikipedia)

- Direct *vs* indirect
- comes when the usage of the technology is not questioned
- limited by sensitization and by thinking the problem globally

Examples:
Cars consumption $\searrow$ $\longrightarrow$ fuel expense $\searrow$ $\longrightarrow$ global usage of the car $\nearrow$

Video coding gain over the years



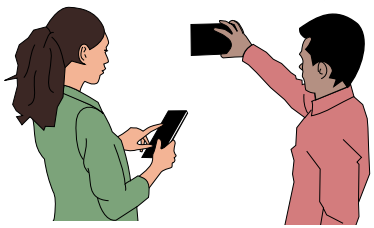
≈ 50% of gain every decade

Karwowski, D., *et al.*. "20 years of progress in video compression, from MPEG-1 to MPEG-h HEVC. General view on the path of video coding development". In IPCC, Poland, September 2016

Carbon footprint of video streaming (Kaya model)

$$\eta = N \cdot A \cdot E \cdot C$$

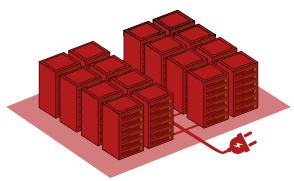
A : amount of videos streamed / user (in GB)



C : carbon intensity

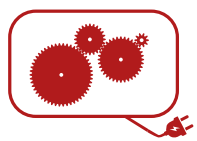
N : number of equipped users

E : Energy cost per GB of streamed videos including:



storage

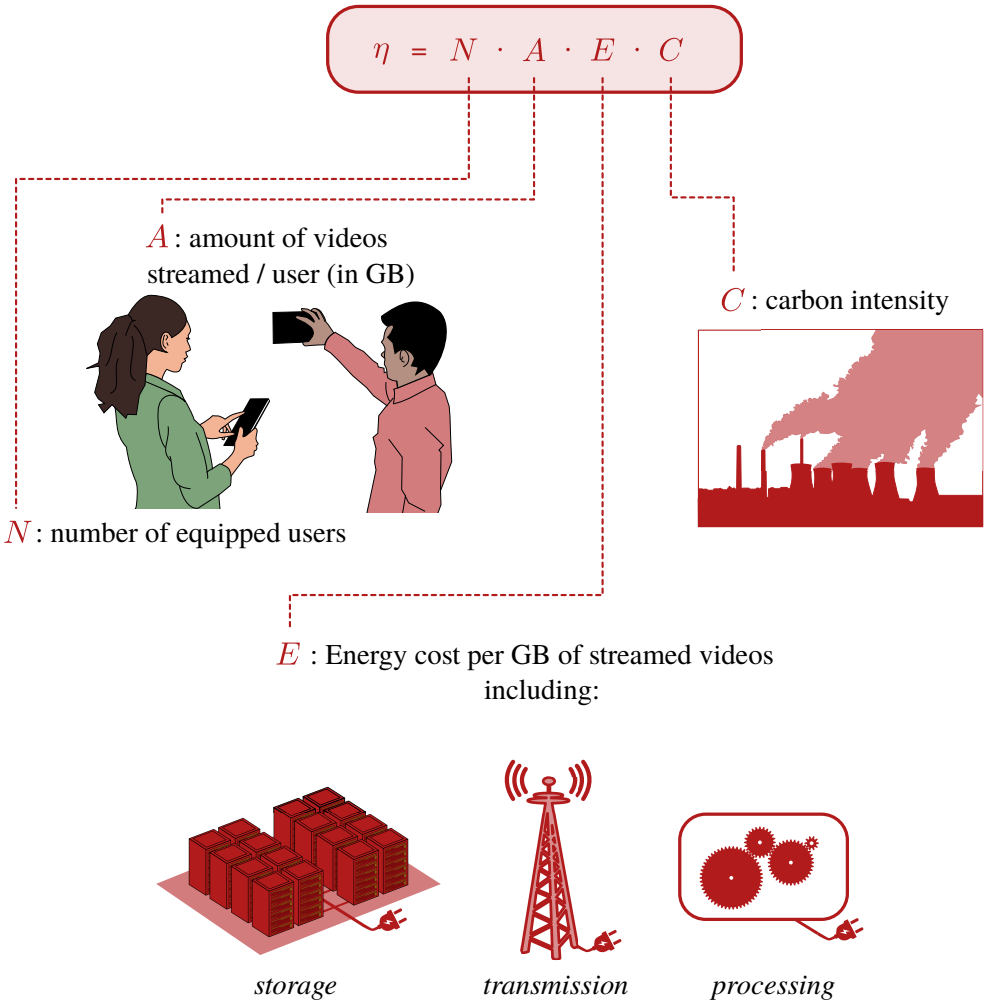
transmission



processing

T. Maugey, *Towards digital sobriety: why improving the energy efficiency of video streaming is not enough,* IEEE MMSP, Poitiers, France, Sept. 2023.

Carbon footprint of video streaming (Kaya model)



A **exponential** behavior:

$$\begin{aligned} N(t) &= \alpha_N N(t-1) \\ A(t) &= \alpha_A A(t-1) \\ E(t) &= \alpha_E E(t-1) \\ C(t) &= \alpha_C C(t-1). \end{aligned}$$

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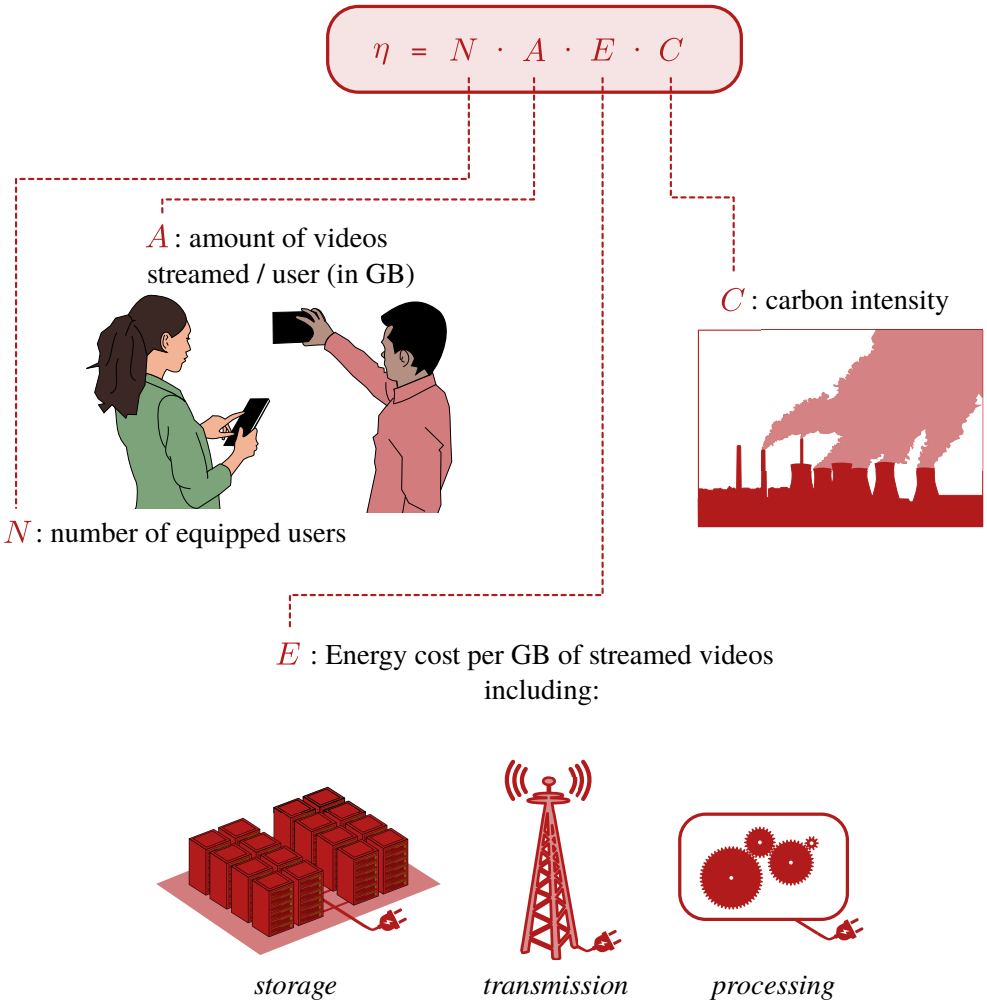
Carbon footprint of video streaming (Kaya model)



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Aiming at **efficiency** $\leftrightarrow \alpha_E \searrow$

Is it sufficient ?

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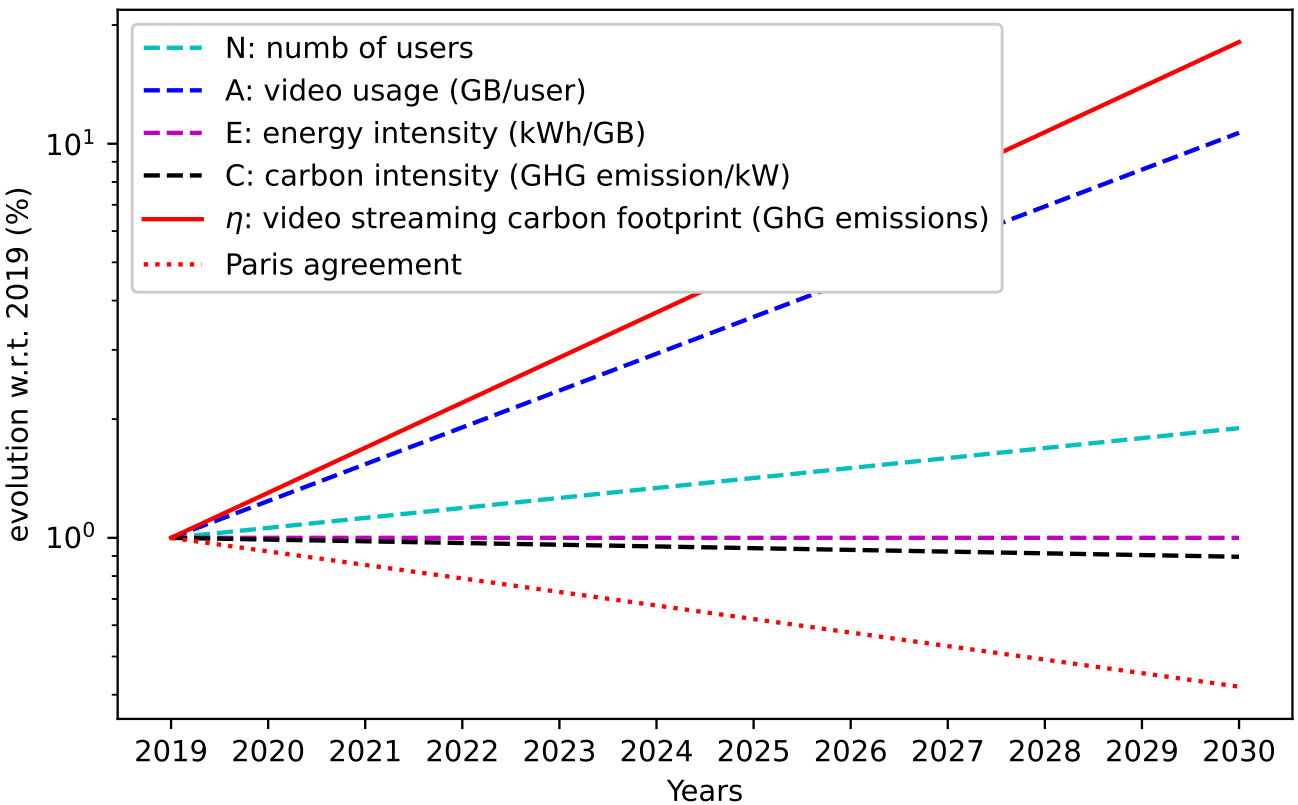
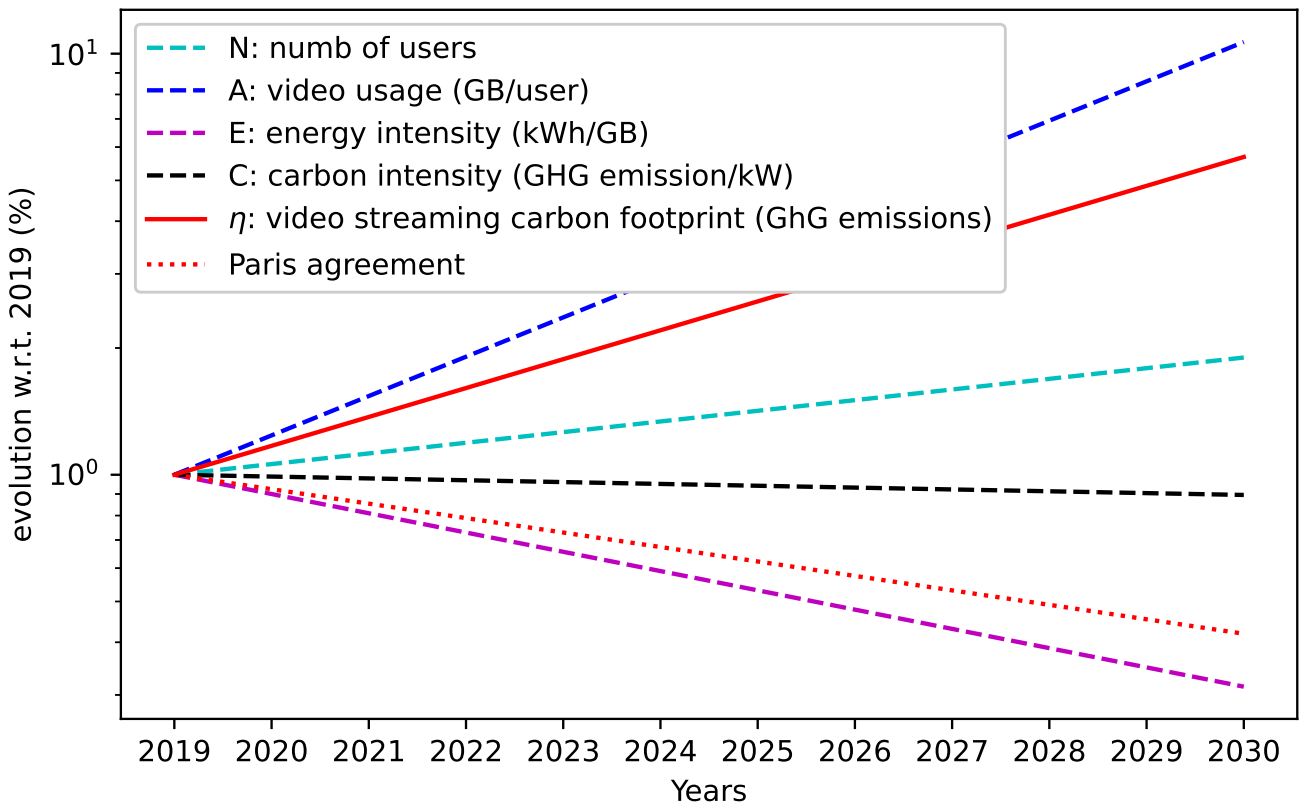
Energy efficiency is important... but not enough



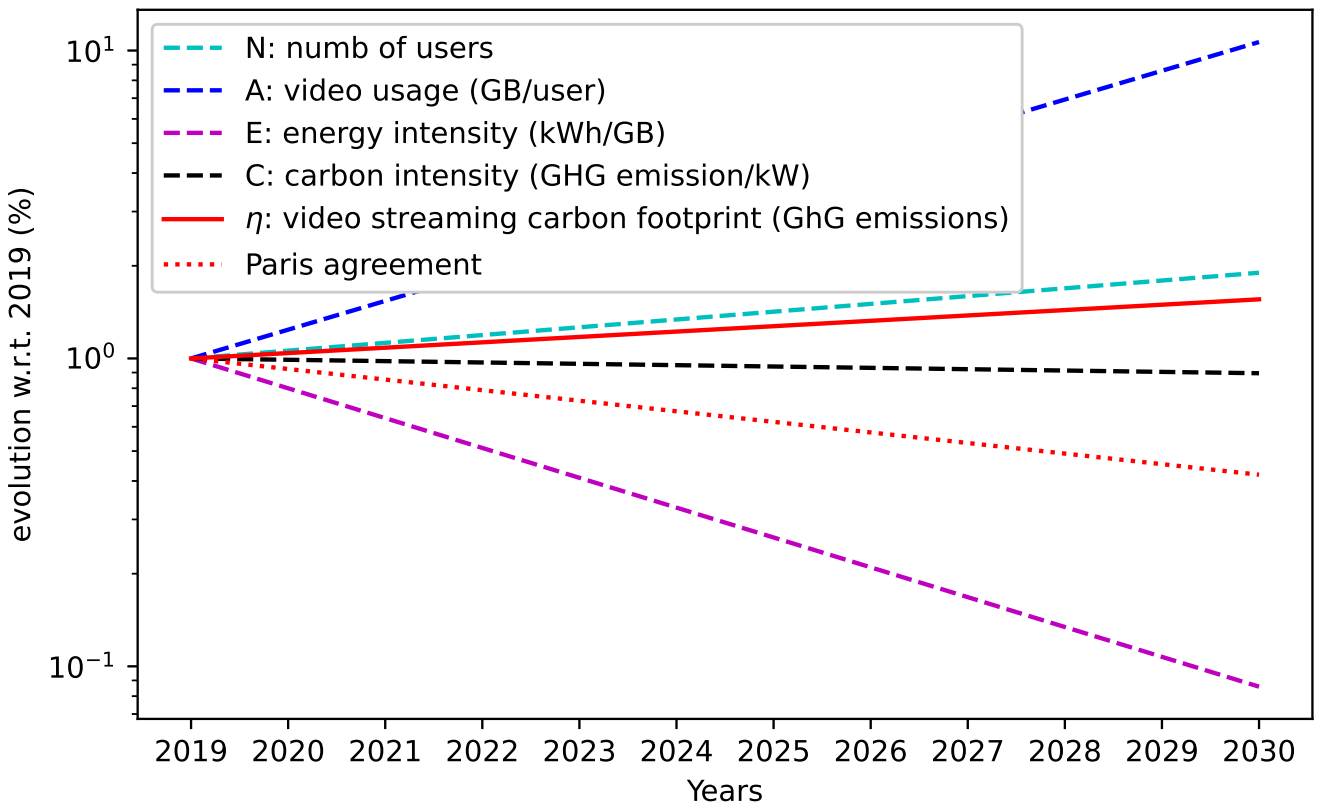
no energy saving: $\alpha_E = 1$

Energy efficiency is important... but not enough



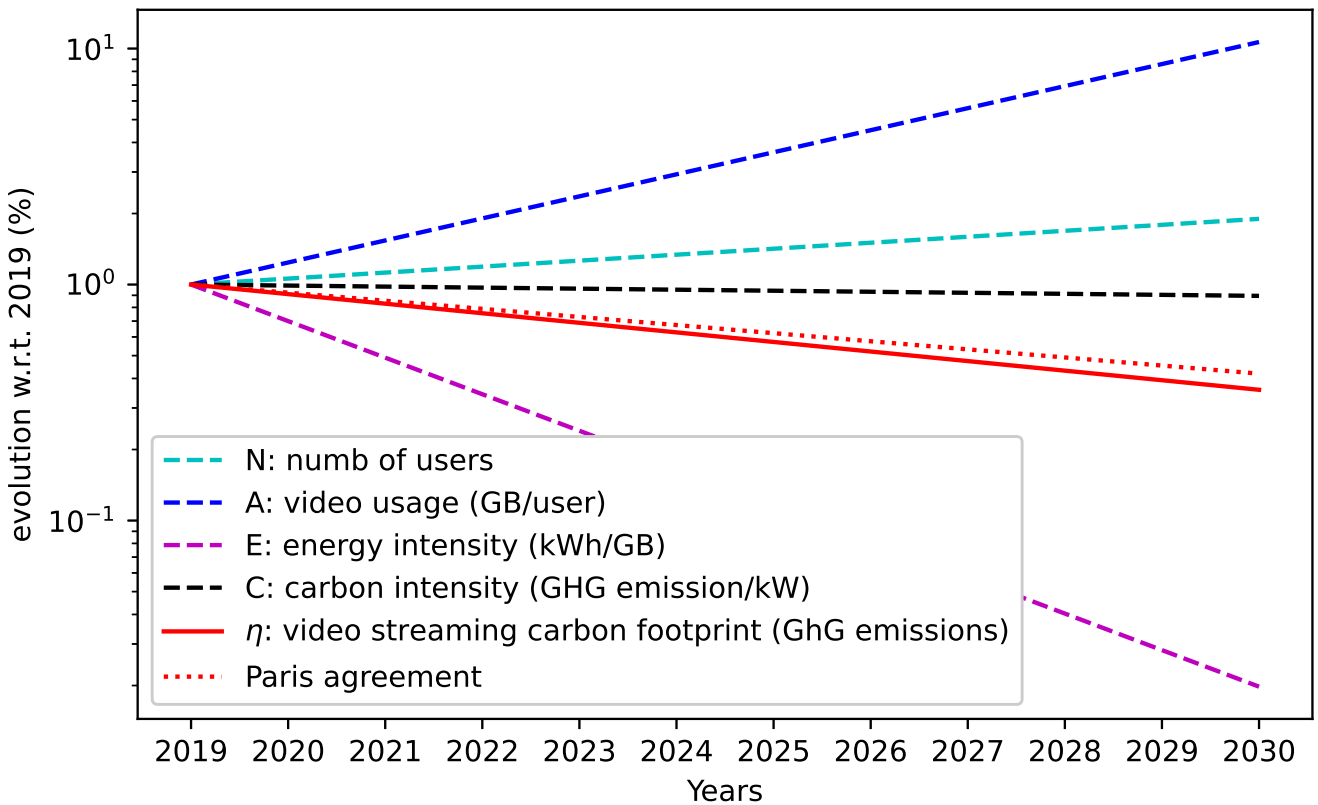
Realistic energy saving: $\alpha_E = 0.9$

Energy efficiency is important... but not enough



Optimistic energy saving: $\alpha_E = 0.8$

Energy efficiency is important... but not enough



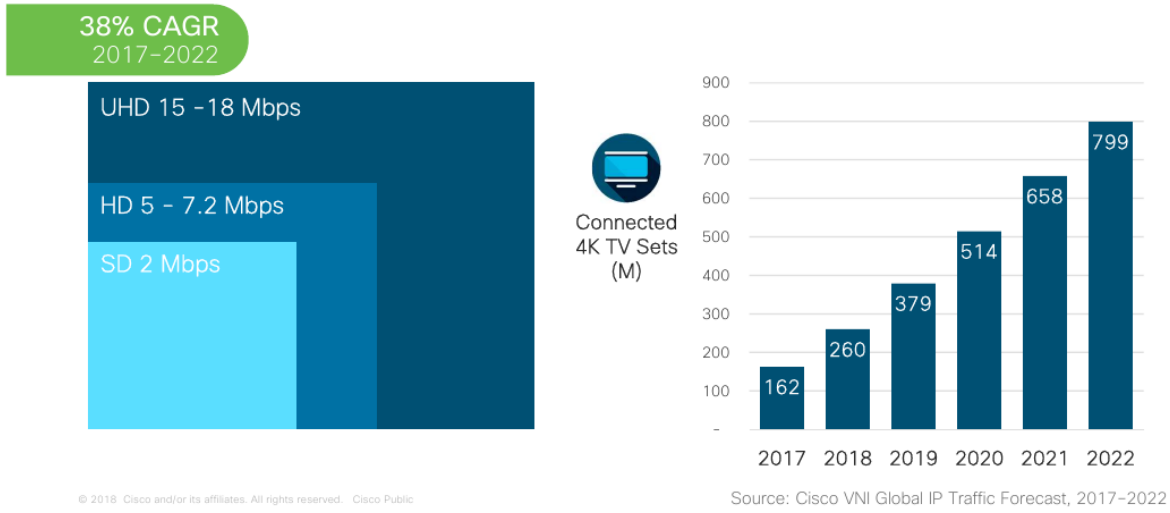
Unrealistic energy saving: $\alpha_E = 0.7$

Rebound effect in video streaming

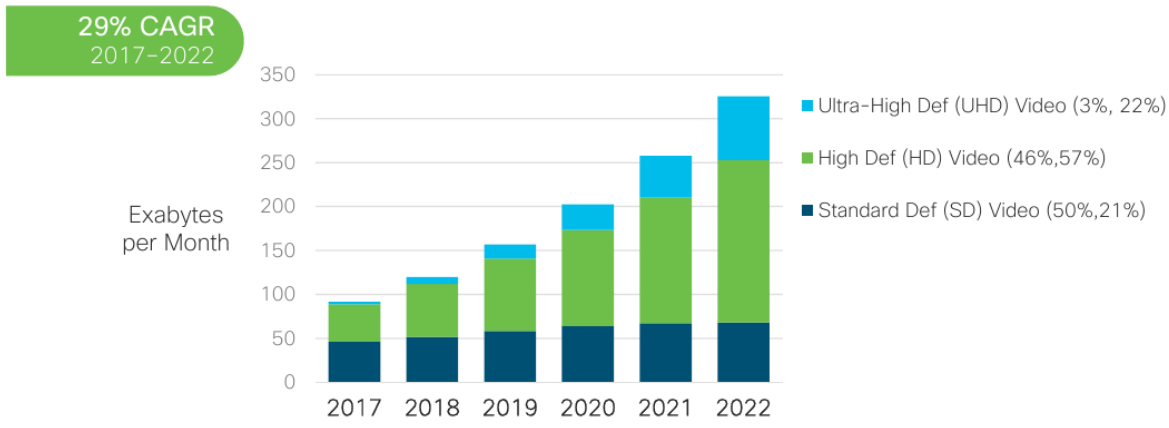
Video size $\searrow$ $\longrightarrow$ one video streaming cost $\searrow$ $\longrightarrow$ number of videos $\nearrow$

Rebound effect in video streaming

Video size ↘ ⟶ one video streaming cost ↘ ⟶ video resolution ↗



Source: Cisco VNI Global IP Traffic Forecast, 2017–2022



* Figures (n) refer to 2017, 2022 traffic share

Source: Cisco VNI Global IP Traffic Forecast, 2017–2022