

# Can Federated Learning Save the Planet?

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# Why carbon footprint matters?

- Energy by DL grew **300, 000 x** from 2012 to 2018.<sup>[1]</sup>
- Data centers account for **0.3%** of global carbon emissions. <sup>[2]</sup>

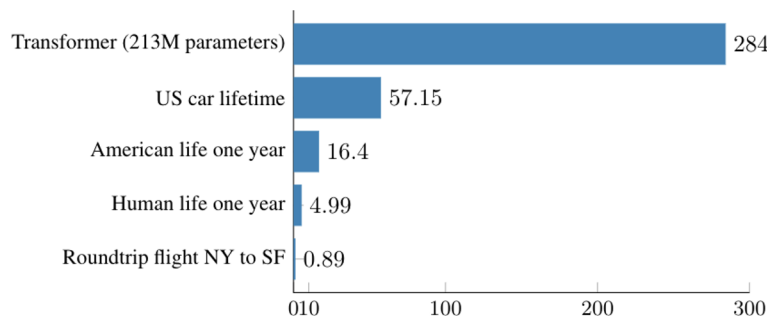


Fig: Estimated CO<sub>2</sub> emission in (tonnes) in different scenarios

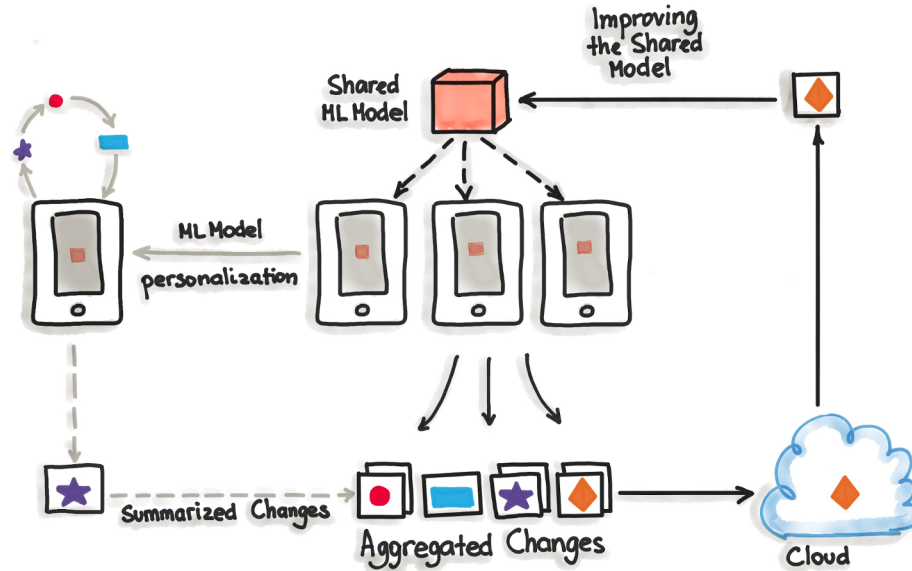
[1] <https://openai.com/blog/ai-and-compute/>

[2] <https://www.nature.com/articles/d41586-018-06610-y>

[3] figure number source: Strubell, Emma, Ananya Ganesh, and Andrew McCallum. "Energy and policy considerations for deep learning in NLP." *arXiv preprint arXiv:1906.02243* (2019).



# Federated Learning



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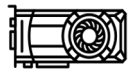


**Decentralized**



# How to quantify the carbon footprint?

## Data Center Specifications



GPU



Cooling



Data transfer & storage

## FL Specifications



CPU

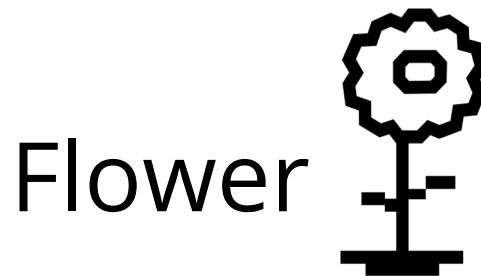


Cooling



Data transfer & storage

Country	CO2 (kg) / kWh
France	0.079
UK	0.509
US	0.547
China	0.975



# Experiments: Cifar10 on Resnet18

Country/CO2 (g)	V100	K80	V100	K80	FL (IID)		FL (non-IID)	
CIFAR 10	PUE = 1.67		PUE = 1.11		1 local epoch	5 local epoch	1 local epoch	5 local epoch
USA	3.1	6.5	2.1	4.3	2.3	6.5	10.9	8.0
France	0.4	0.9	0.3	0.6	0.3	0.9	1.6	1.1



## Data Center Specifications

- Nvidia V100: 250W
- K80: 300W
- 1 GPU, 48 sec total (V100)
- 1 GPU, 84 sec total (K80)



## FL Specifications

- Nvidia Tegra X2: 5W
- 38.2 sec/round, 1 local epoch
- 5 clients/round
- 16 rounds to 60%



# Discussion & Conclusion

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- FL IID: data centres  $\cong$  FL

FL non-IID: data centres  $\leq$  FL

- Homogeneous setup is not practical in real case
- FL has more potential as it does not need cooling
- Also depends on tunable hyper-parameters



# Thank you!

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