



Energy and Carbon Efficiency in FLUIDOS

FLUIDOS @AIOTI Days

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Energy efficiency in FLUIDOS continuum



- In traditional setups devices often run at high power even for small tasks, leading to wasted energy
- Edge-to-Cloud continuum enables dynamic workload assignment



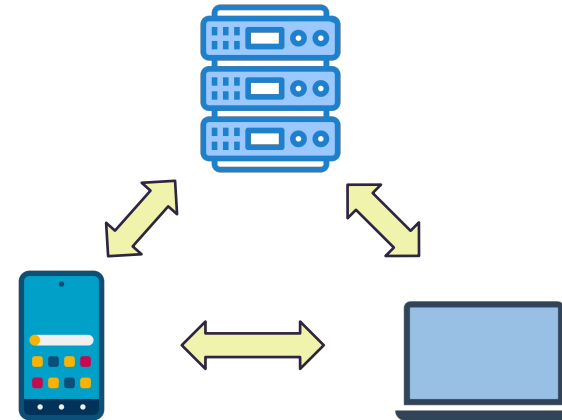
Source: *spec.org* [Intel Xeon Gold 6226R]



Energy efficiency in FLUIDOS continuum



- Lighter tasks offloaded to edge devices
- ☐ No need to power up energy-hungry servers
- Up to 25% energy savings through dynamic assignment to the most energy-efficient device



Energy efficiency = Carbon efficiency?



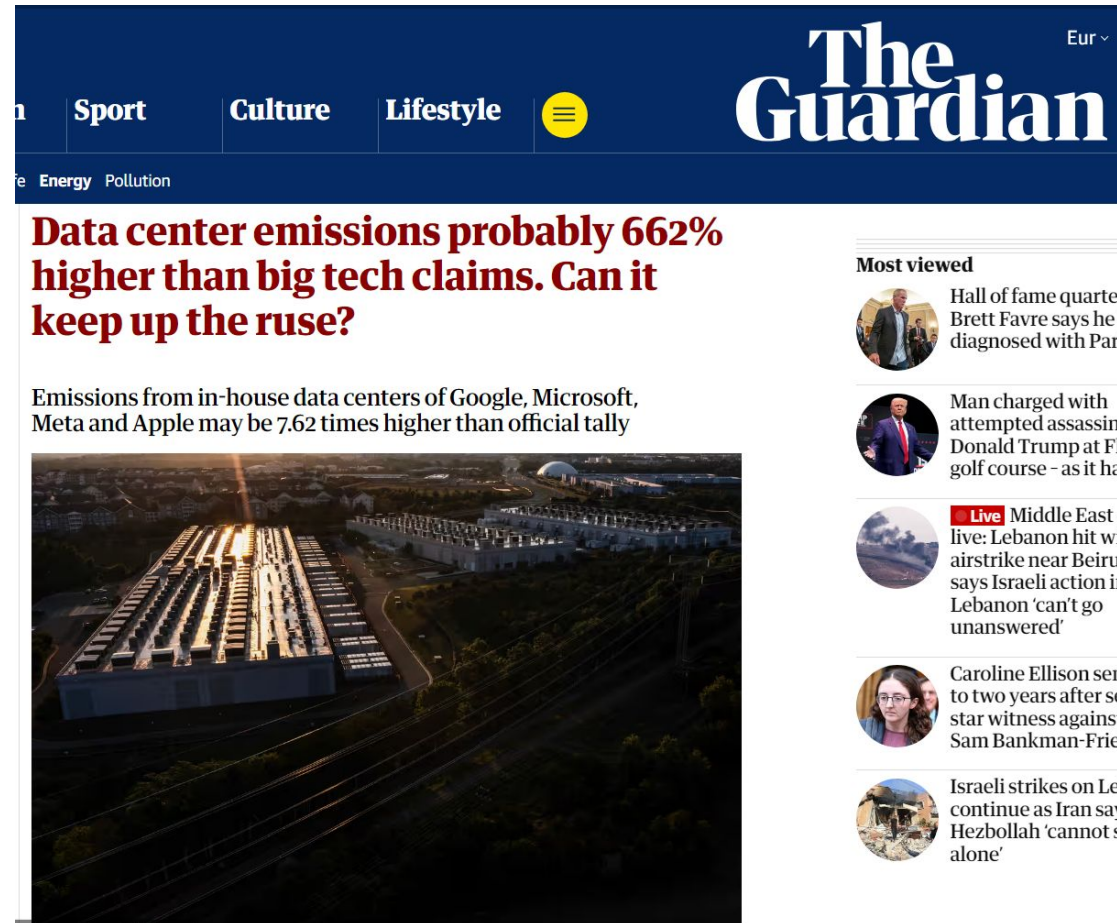
- Improving energy efficiency does passively improve carbon efficiency
- Moore's law is ~~dead~~ slowing down
- PUEs of hyperscalers are already close to 1
- Carbon efficiency must be tackled additionally!



Carbon efficiency on paper vs in reality



- Renewable Energy Match
- aka Market-based
- Cons:
 - Lack of additionality
 - Double-counting
- ☐ Benefits are questionable and being questioned



Source: [theguardian.com](https://www.theguardian.com)



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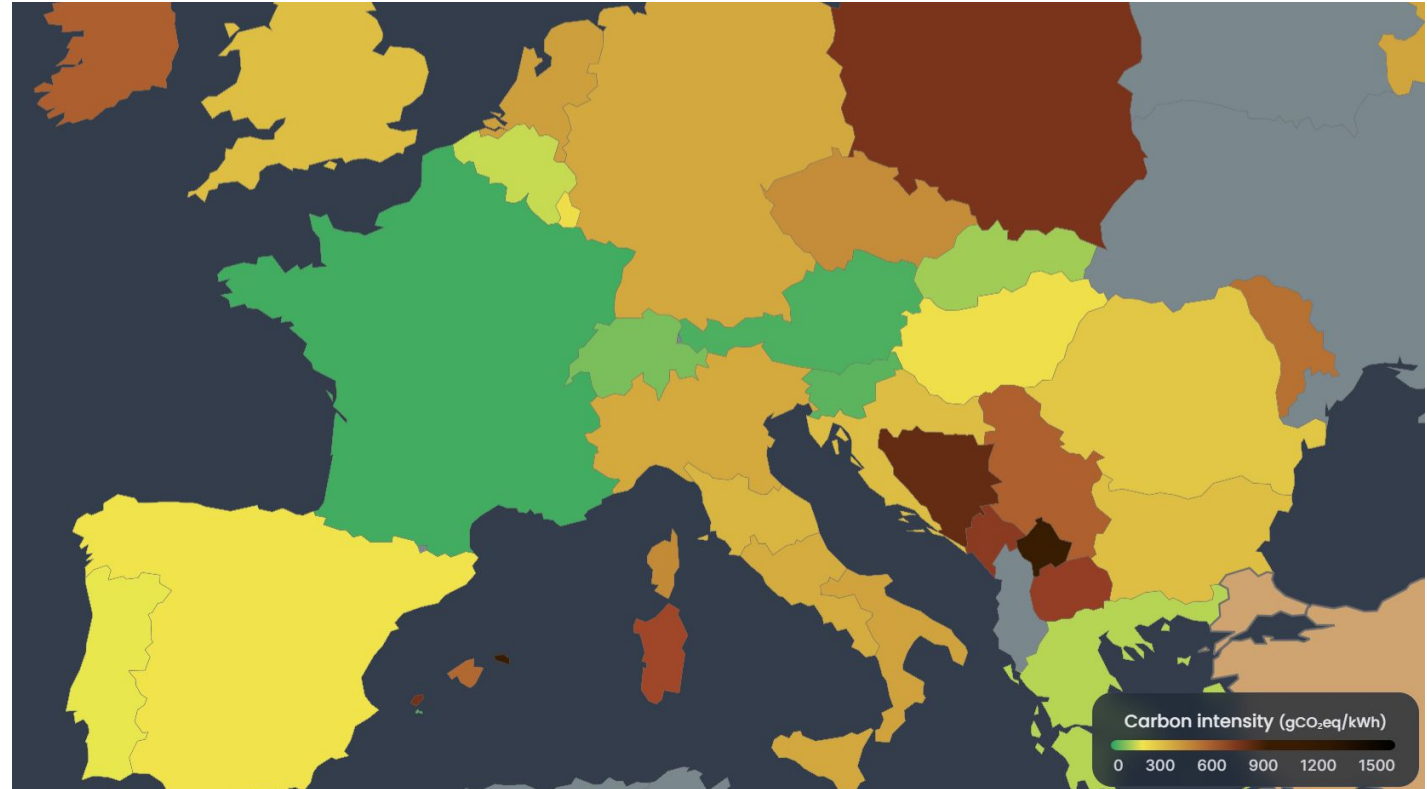
- 24/7 Carbon-Free Energy
 - aka Location-based
 - True Carbon-neutrality!



What enables 24/7 carbon-free energy?



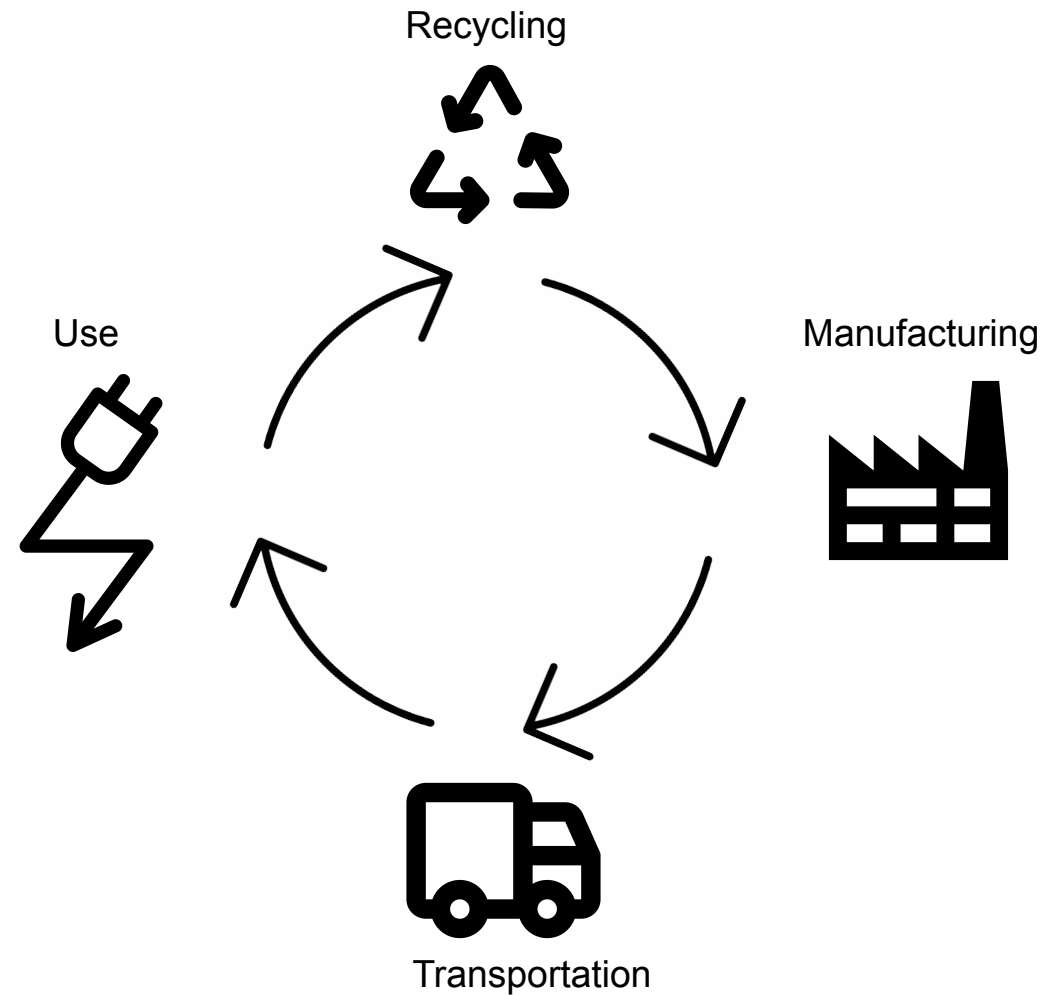
- Data from various grids
- ☐ spatial shifting
- Their production forecasts
- ☐ temporal shifting
- But!
- Electric energy is not the only contributor to the carbon footprint



Source: electricitymaps.com



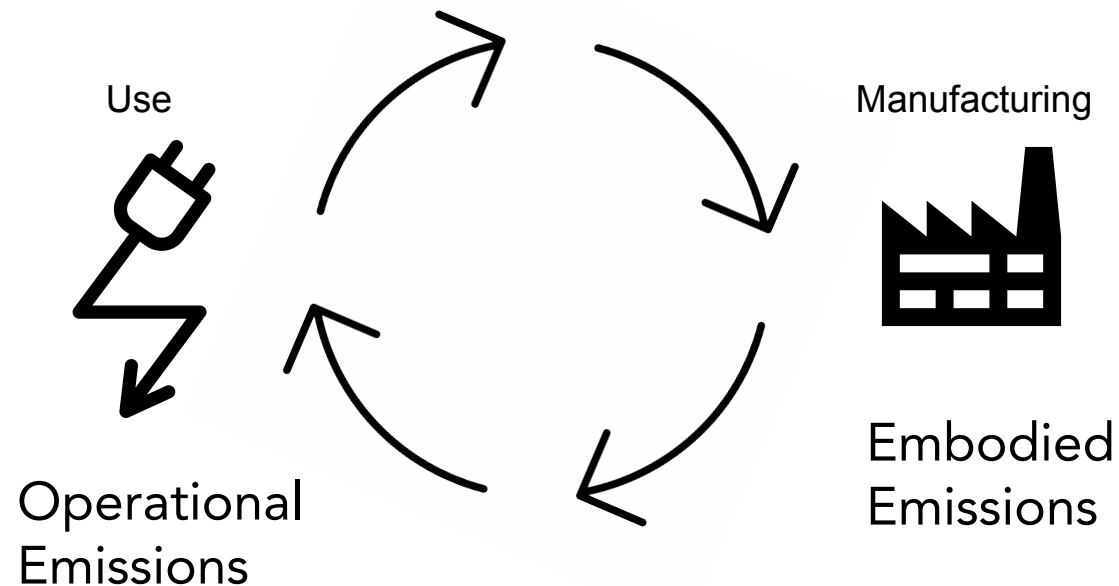
Life Cycle of Hardware



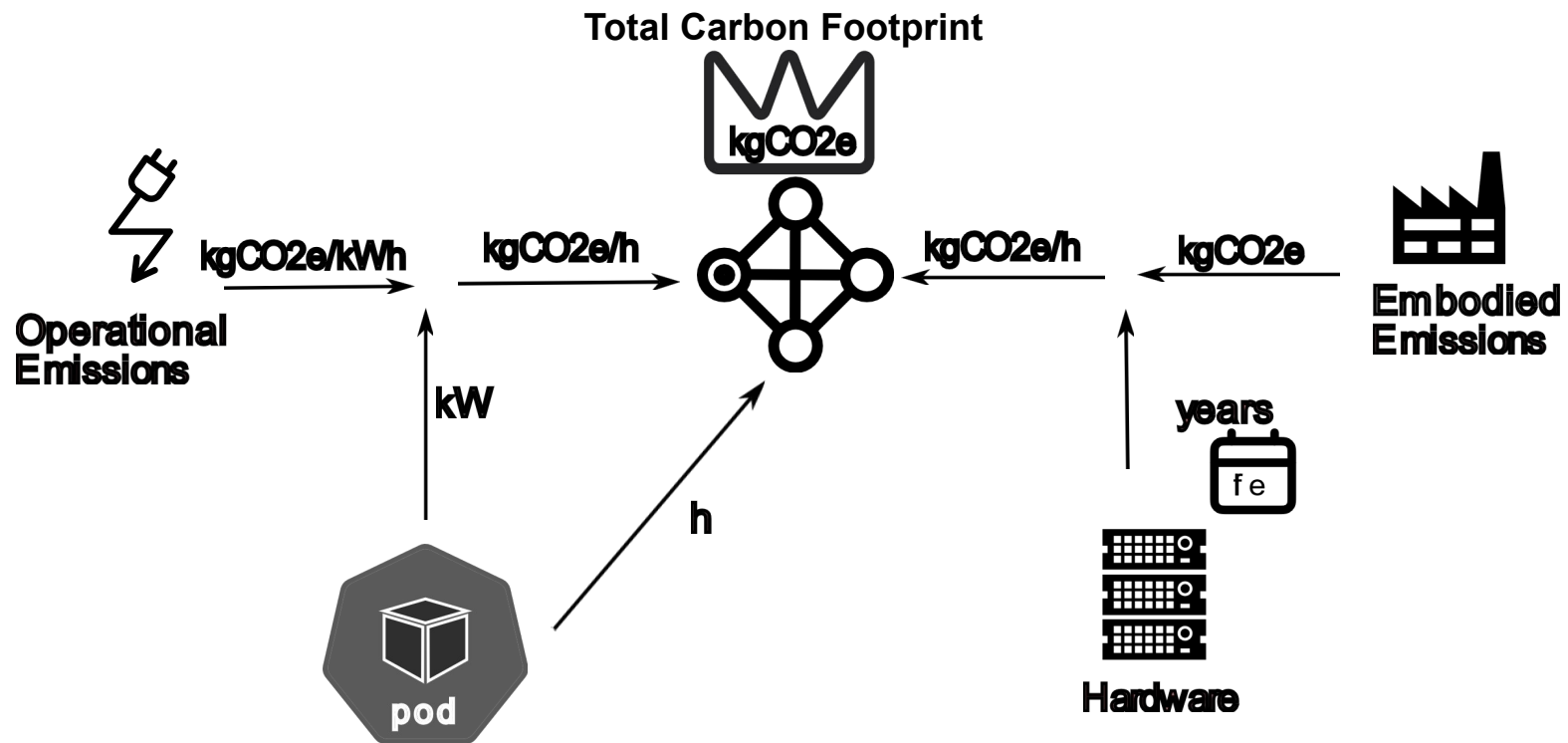
Embodied emissions missing from the picture!



- Transportation and Recycling are negligible for carbon
- Focus on Manufacturing and Use phase:



Total Carbon Footprint



Spatiotemporal orchestration



We pack the pods into a grid of

- locations (rows)
- time slots (columns)

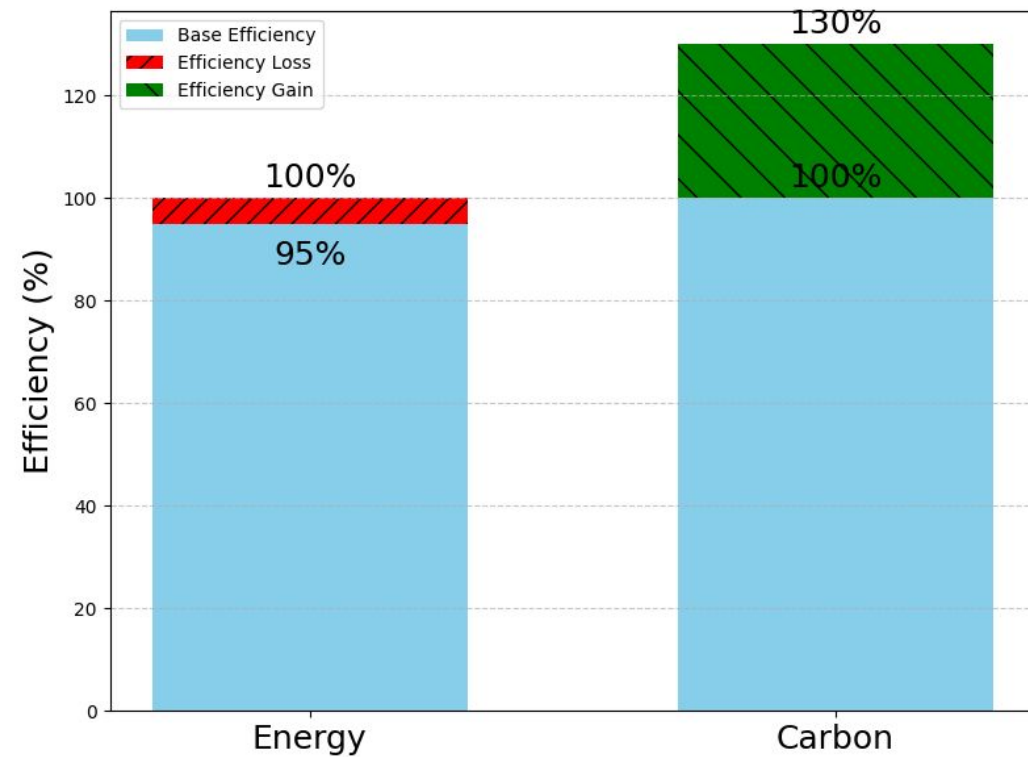
	TS 0	TS 1	TS 2	TS 3	TS 4	TS 5	TS 6	TS 7
Node 0 embodied: 2019335 gCo2	1293.259		343.259	855.259	963.259	1989.259		271.259
Node 1 embodied: 1842572 gCo2		1273.17	821.17	433.17	315.17	613.17	1313.17	161.17
Node 2 embodied: 697606 gCo2	1783.818	1893.818	1233.818	801.818	361.818	695.818	783.818	1853.818
Node 3 embodied: 594020 gCo2	1131.905	183.905	1371.905	157.905		245.905	763.905	2025.905
Node 4 embodied: 1702348 gCo2		253.166	1245.166	2057.166	1339.166	1815.166	1753.166	
Node 5 embodied: 2294236 gCo2	1734.95	886.95	460.95	1958.95	1238.95		566.95	1868.95
Node 6 embodied: 2203975 gCo2	239.798	1819.798	1191.798	1869.798	659.798		1217.798	
Node 7 embodied: 2414797 gCo2		1967.831	1111.831	275.831	1437.831	1373.831	2055.831	
Node 8 embodied: 1051560 gCo2		1960.021	1992.021	1976.021	1452.021	268.021	236.021	1498.021
Node 9 embodied: 1214034 gCo2	1381.294	1867.294	143.294	1745.294		1835.294	1461.294	1693.294



Finally: Looking through the prism of costs



- Flexible scheduling uses more energy
- However, the benefits stand out when considering both efficiencies jointly
 - e.g. a 5% reduction in energy efficiency can result in 30% improvement of carbon efficiency [Wait Awhile]





<https://www.fluidos.eu/>



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