

Prof Douglas Paul

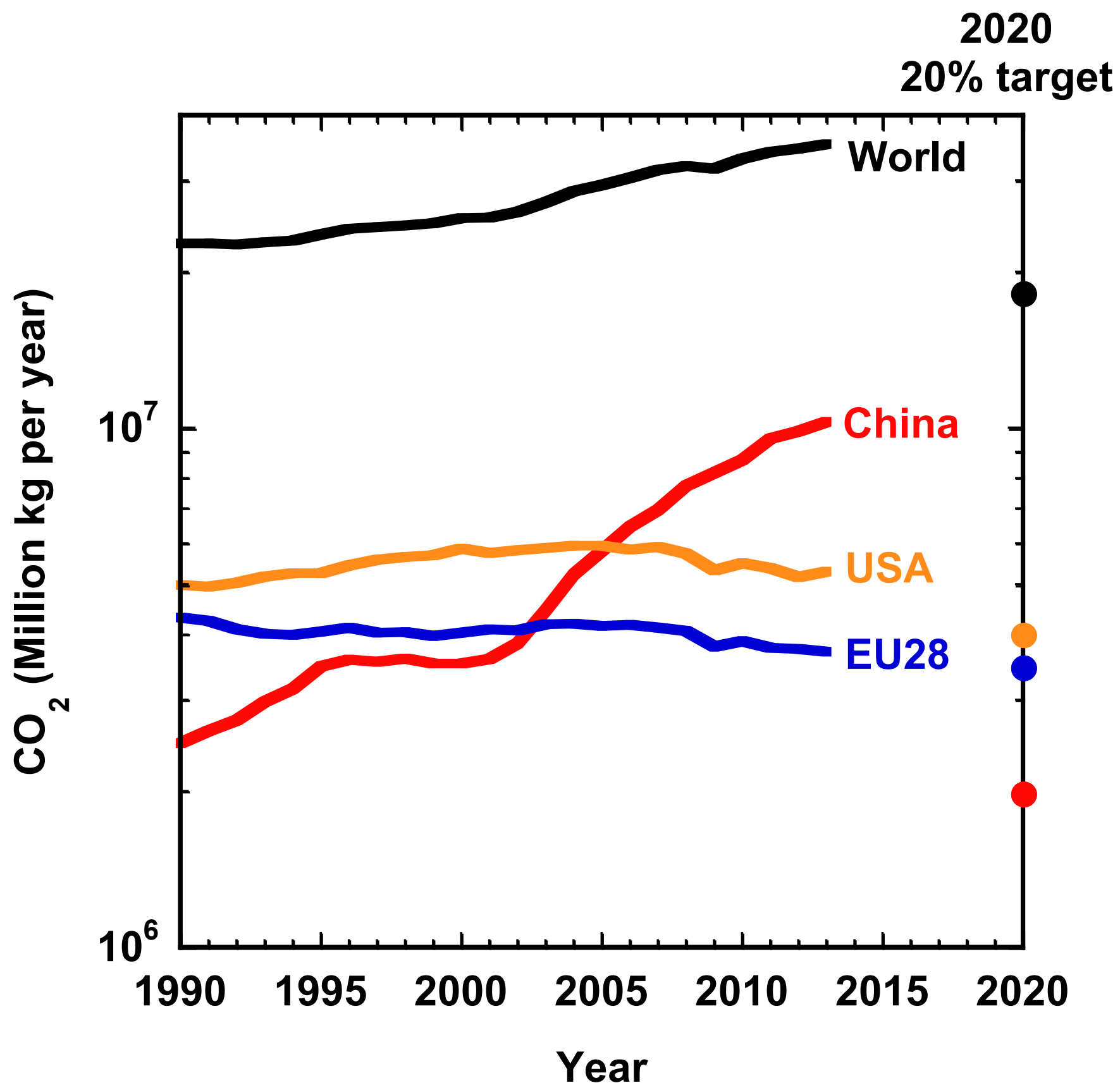
**Director: James Watt Nanofabrication Centre
University of Glasgow, U.K.**

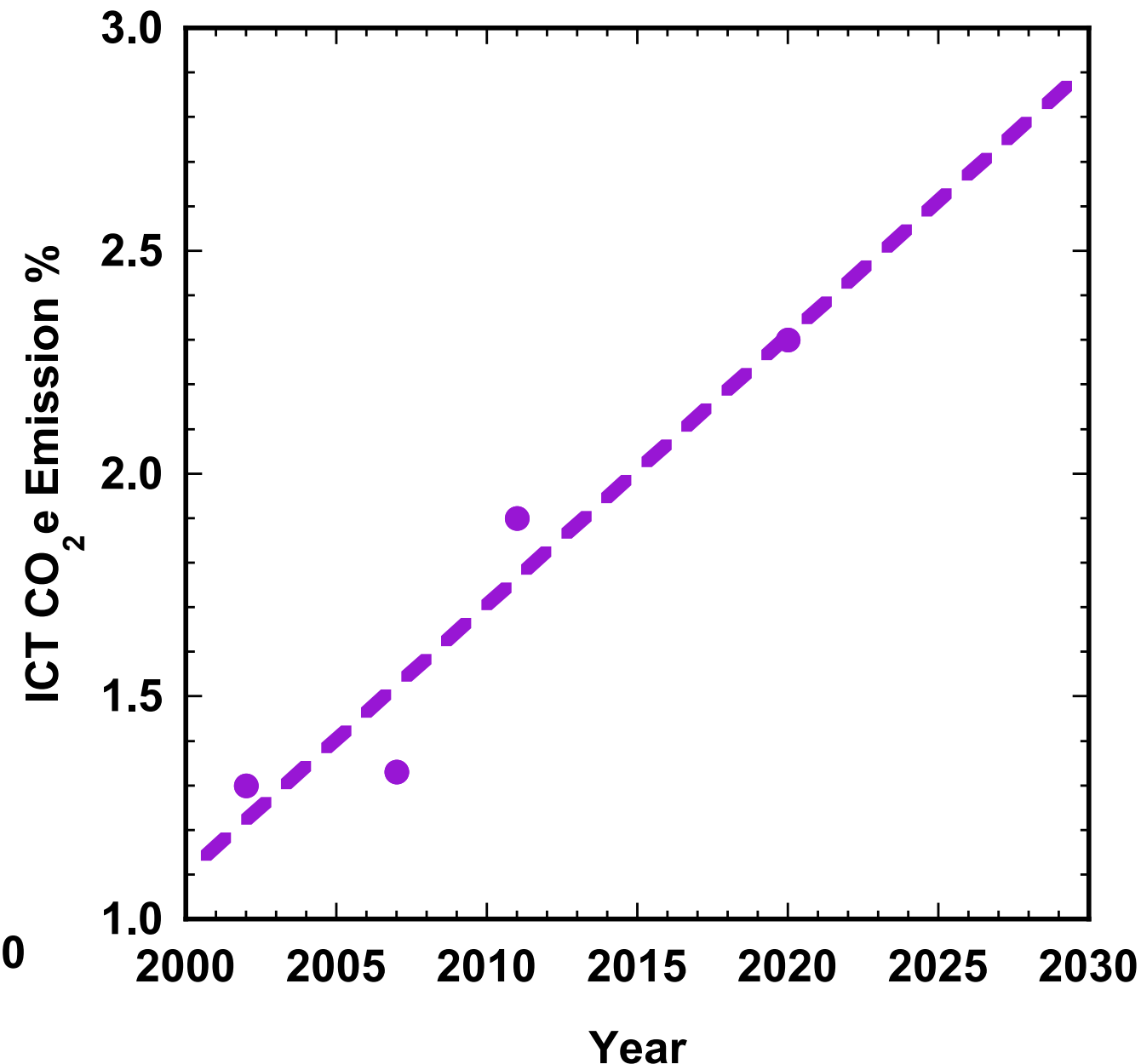
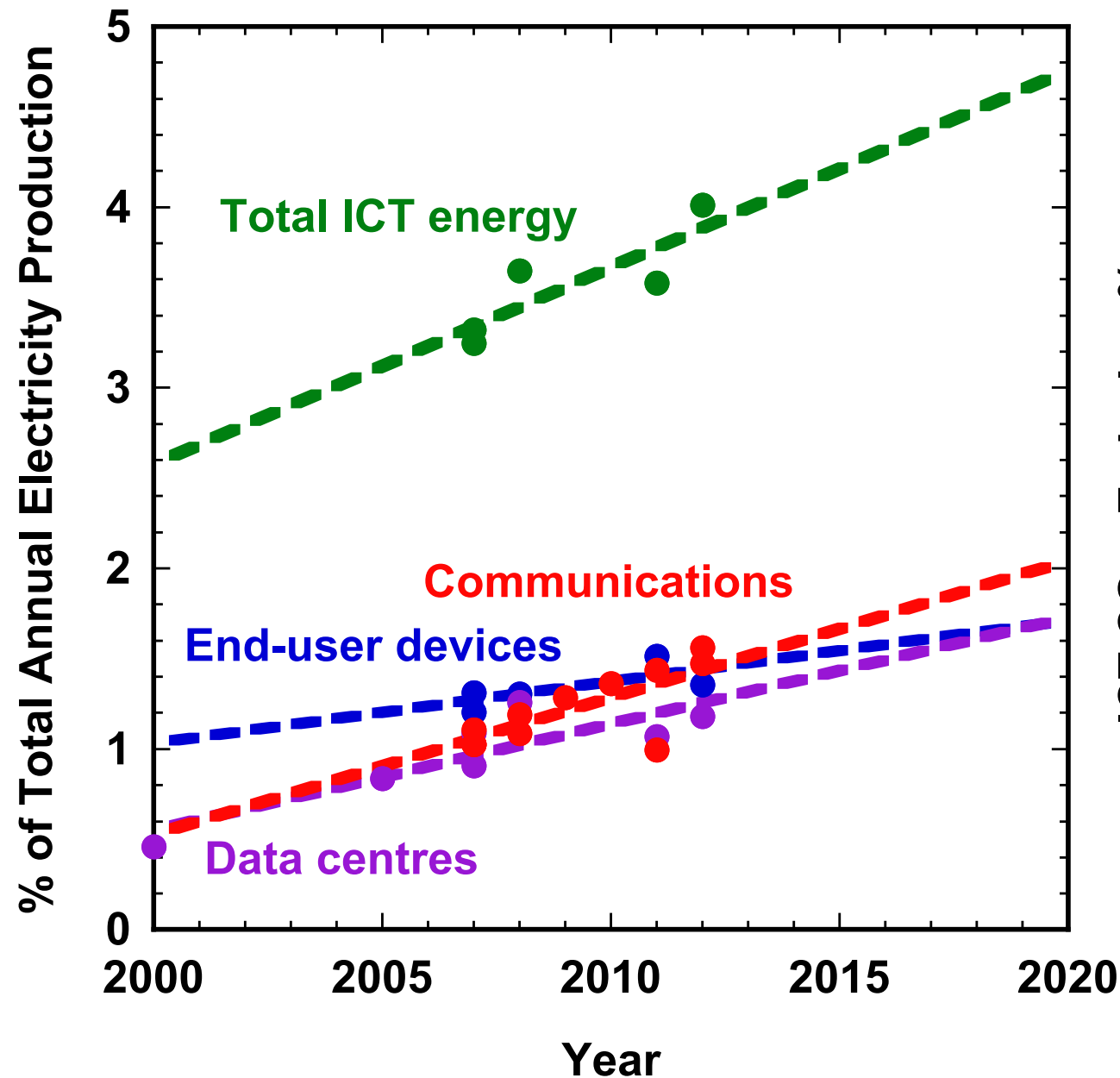
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- **> 30 page document with executive summary**
- **Overview / brief introduction of field (laymans version - everyone can understand)**
- **Comparison of different approaches**
- **Strategic objectives / recommendations to drive **common** research objectives**
- **Roadmap and links to other appropriate roadmaps**
- **Ultimately used by Brussels to aid what should / could be funded in the future**

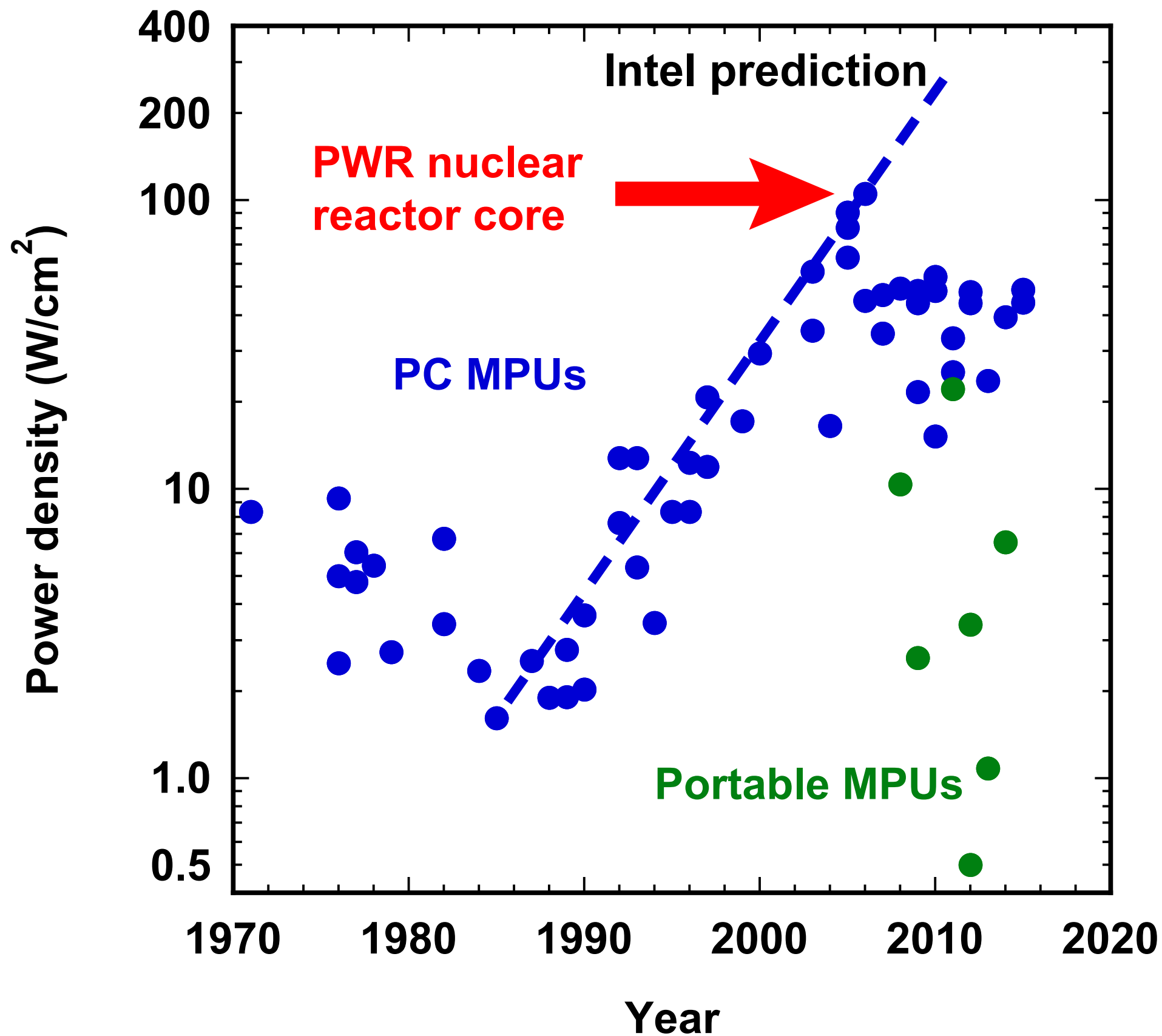
EC 2020 CO₂ Emission Target



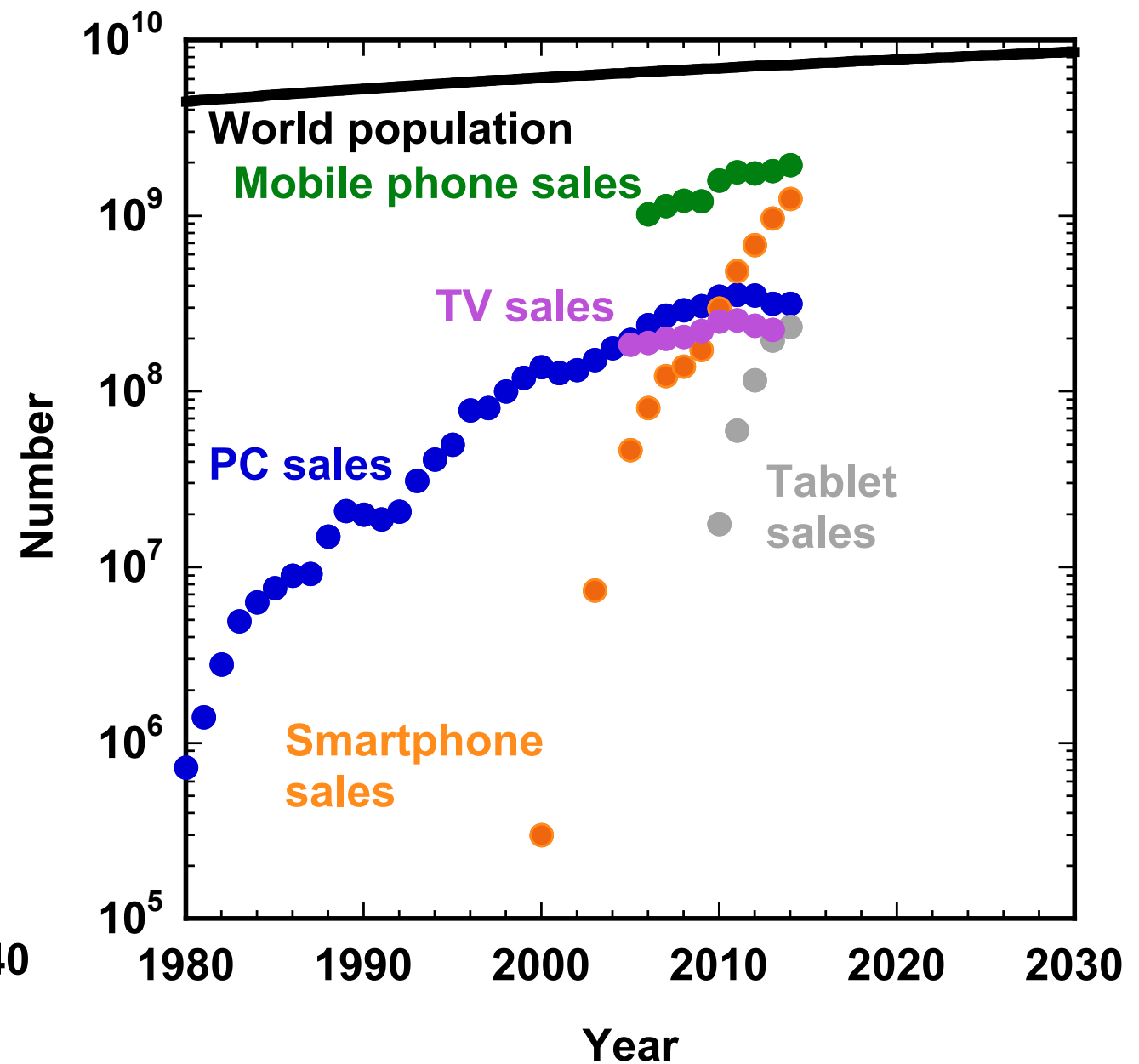
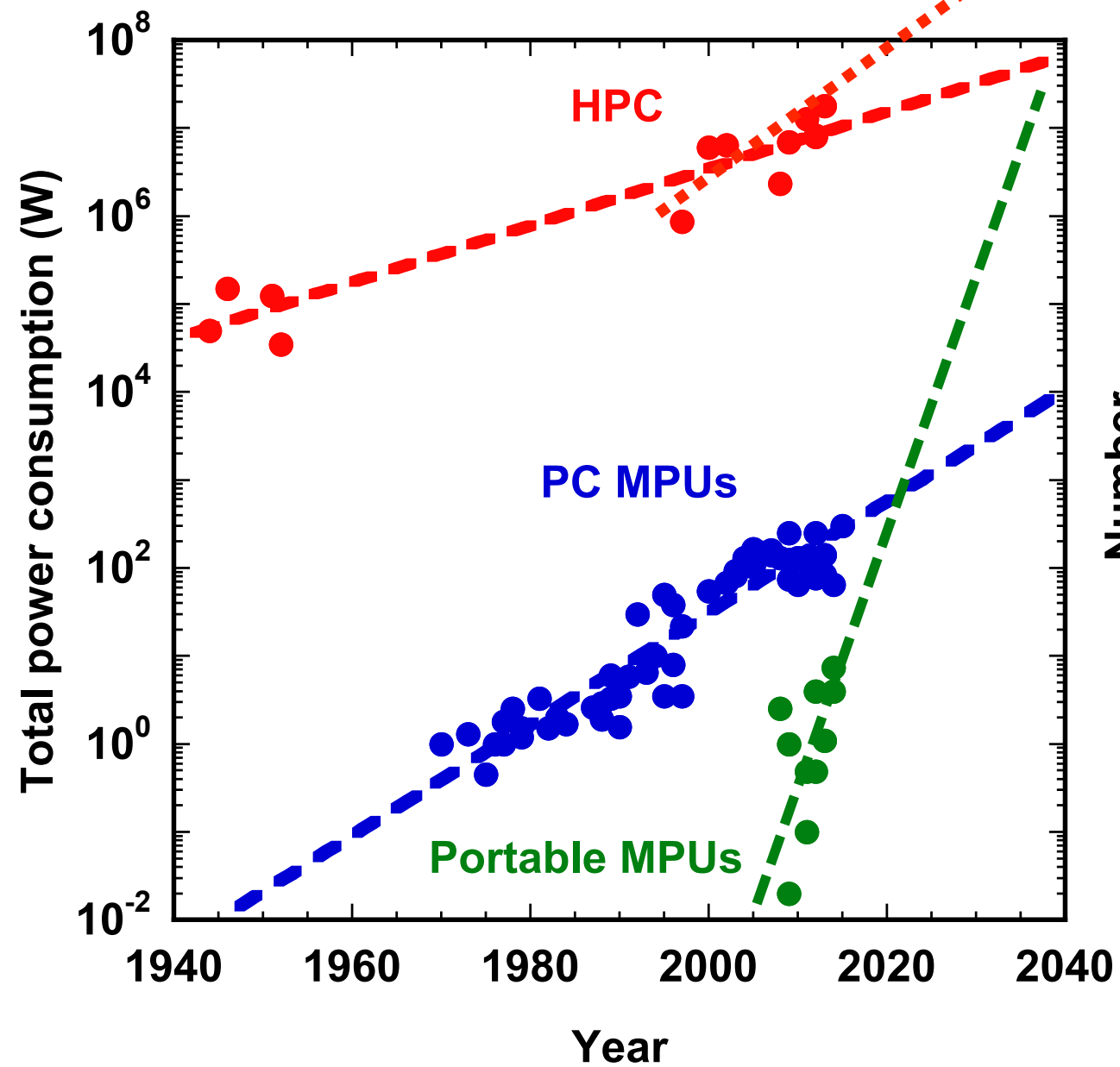


This excludes TV, media, publishing, games, power switches, domestic & industrial ICT devices

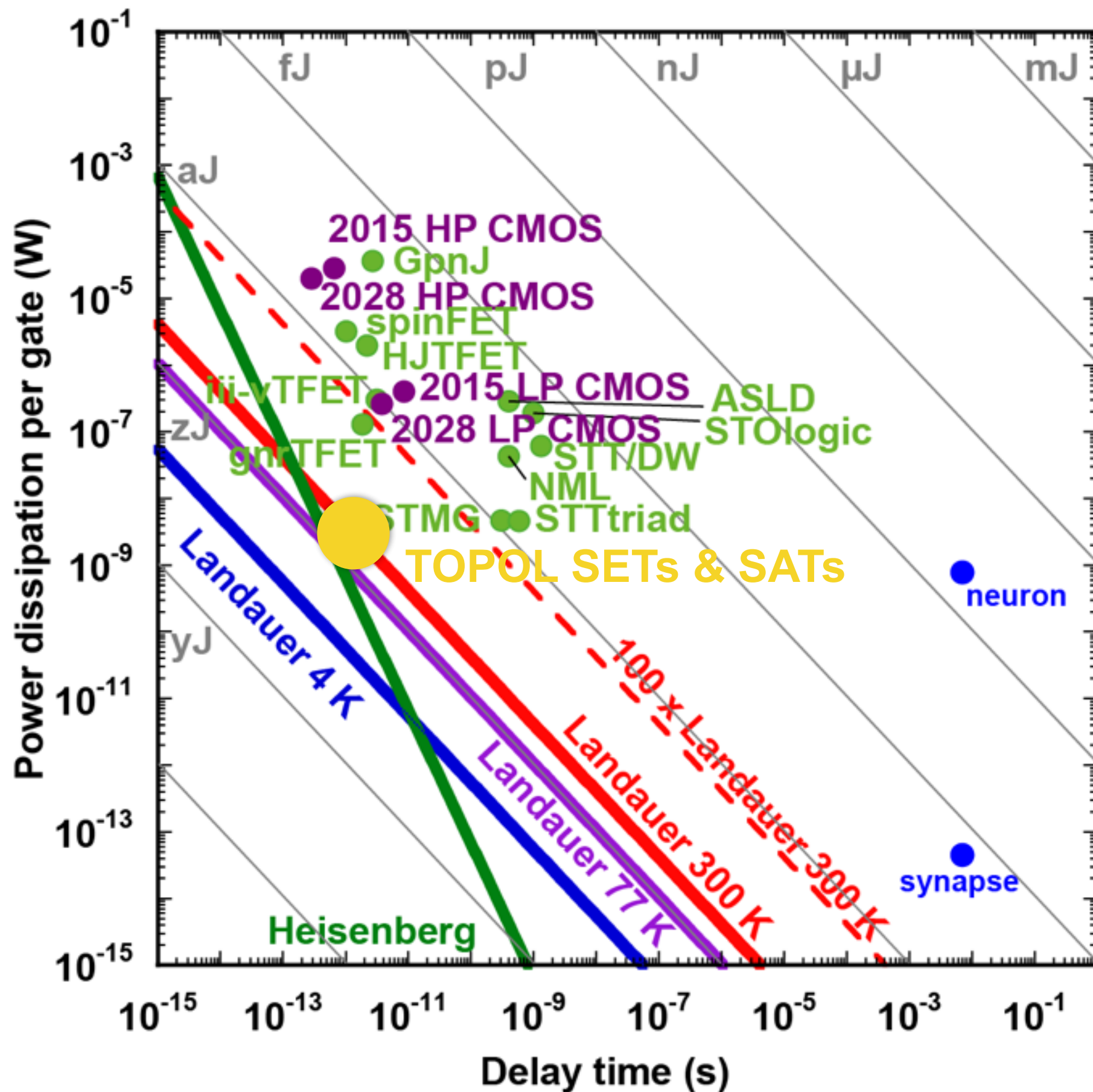
=> 10% to 15% of electricity & ~ 5 % CO₂ emissions

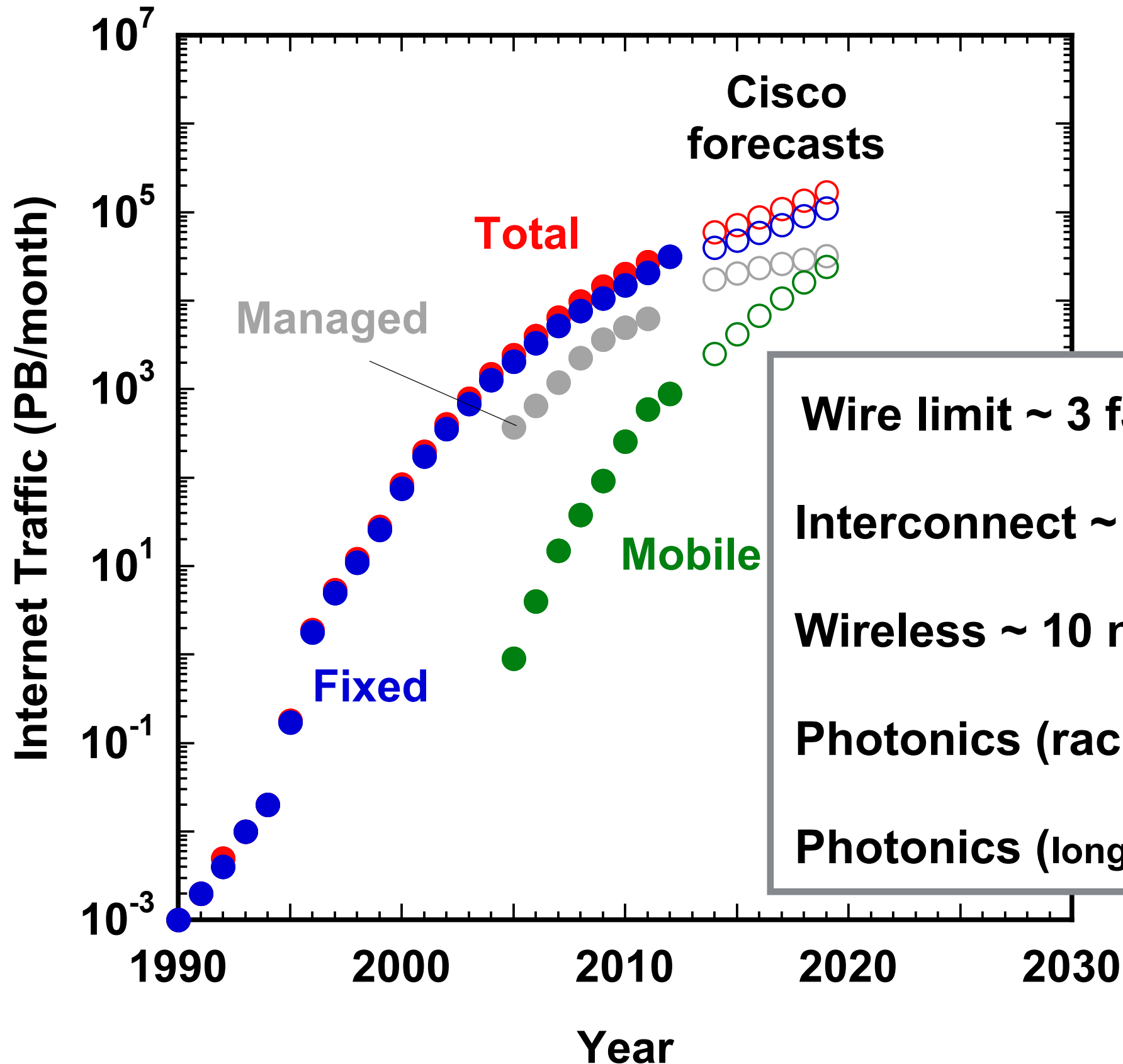


without history



Devices Energy Consumption





Wire limit ~ 3 fJ / bit.m

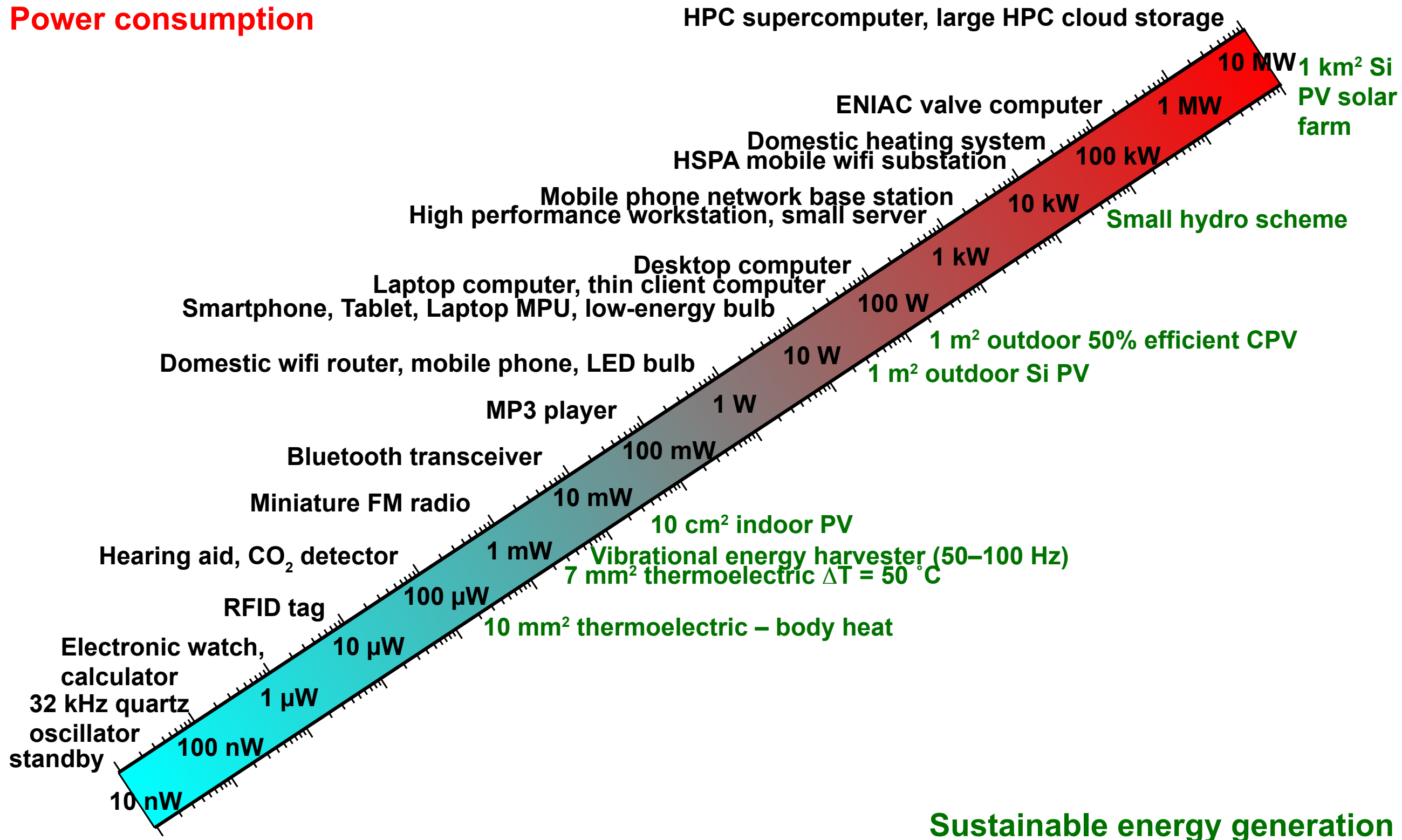
Interconnect ~ 0.1 fJ to 100 pJ / bit

Wireless ~ 10 nJ / bit.m

Photonics (rack) ~ 40 pJ / bit

Photonics (long distance) ~ 1 μ J / bit

Power consumption



Sustainable energy generation

Digital Agenda for Europe:

- By 2013, access to all for internet with ≥ 30 Mbps
- By 2020, 50% of people with access to internet with ≥ 100 Mbps

Smart Growth:

- Develop economic growth based on knowledge & innovation
- Increase internet of things (ICT devices) to improve GDP

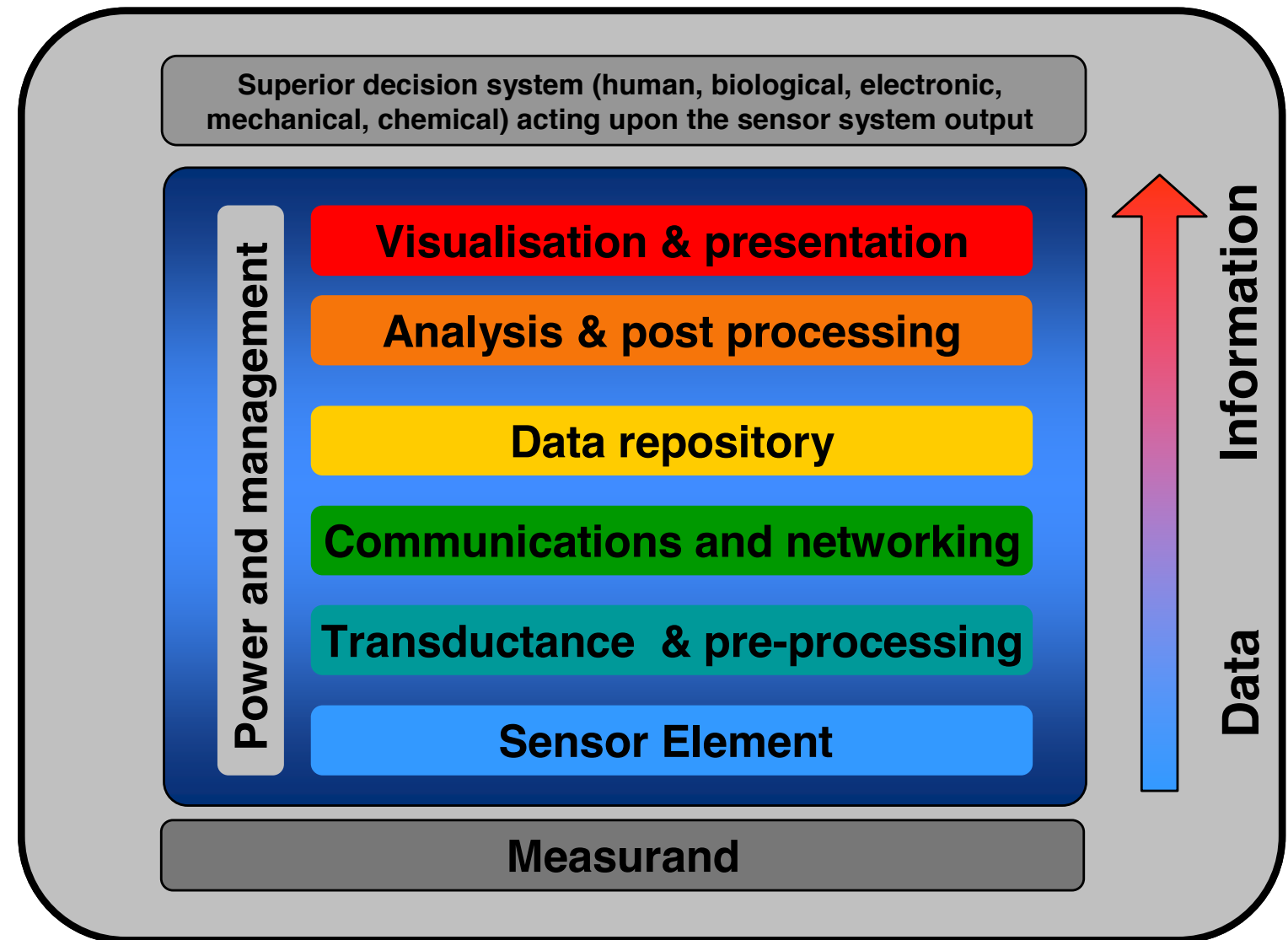
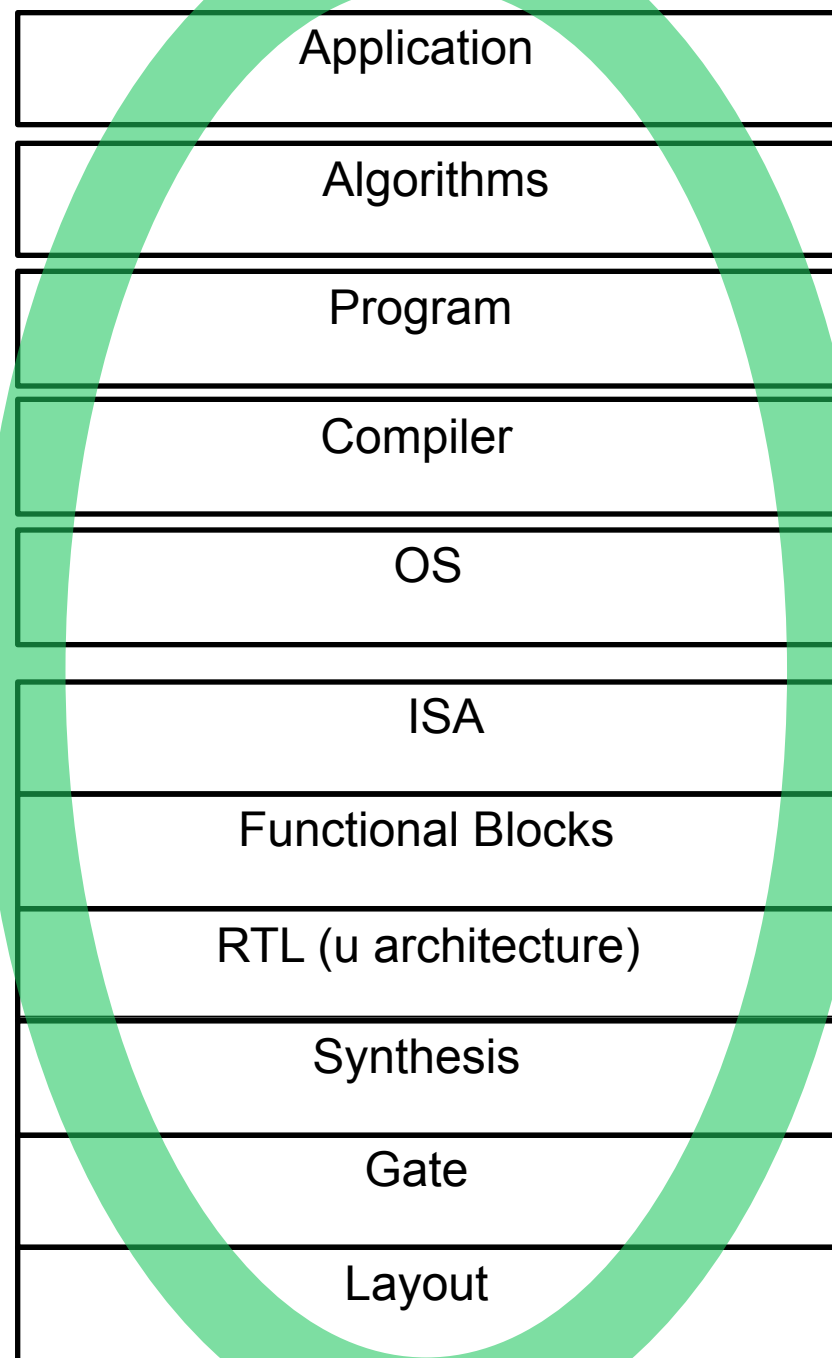
Whilst meeting climate change targets:

- Reduce CO₂ emissions by 20% from 1990 levels !!!!!

- **High performance and low cost are major ICT drivers**
- **Energy is only optimised when it prevents high performance (scaling, multi-core, photonics at rack level, etc....) or the cost is excessive (HPC)**

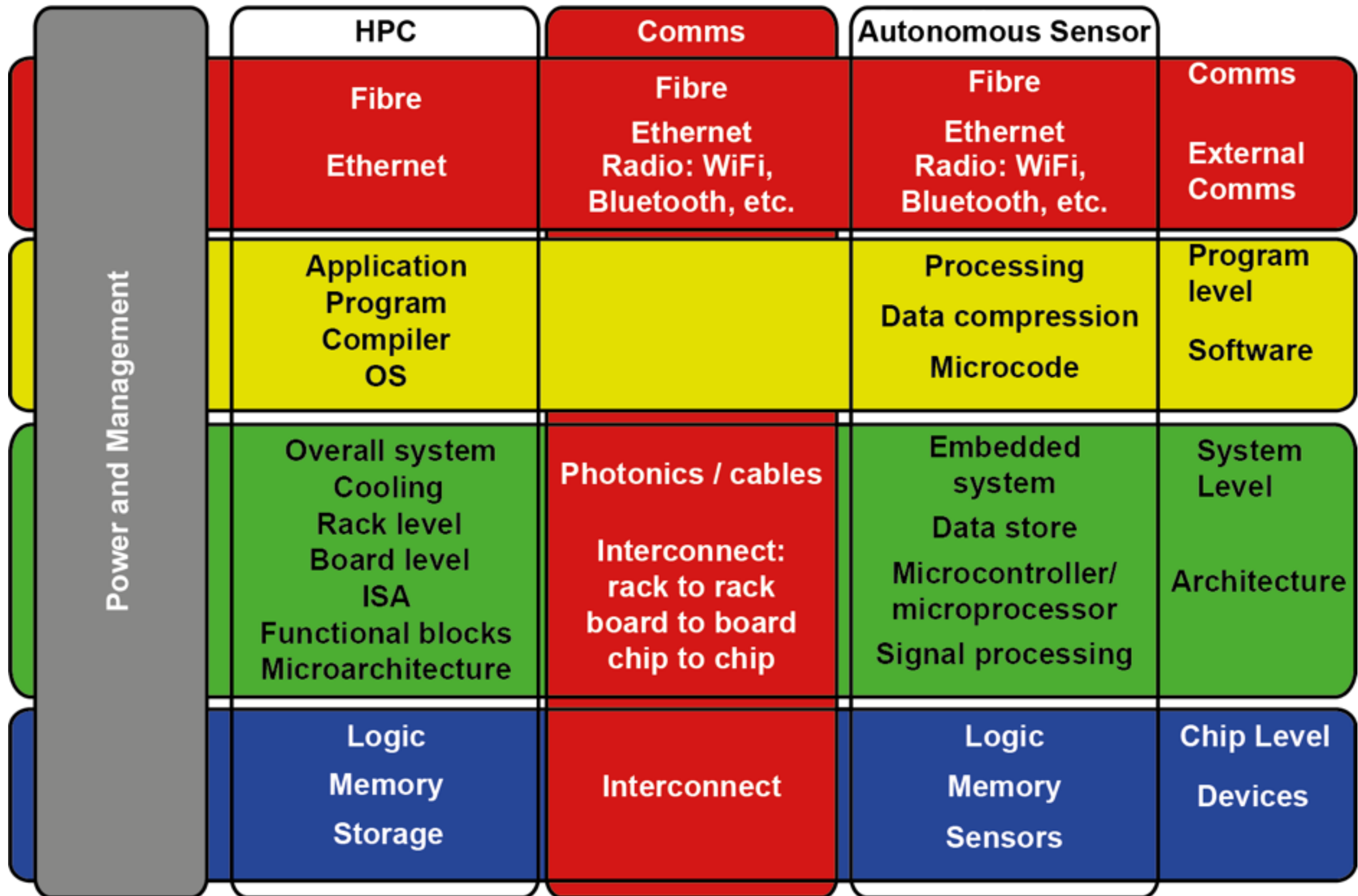
The Vision of the ICT Energy Co-ordinated Action is to direct research towards sustainable energy solutions for ICT devices and systems

- **How to produce energy sustainable ICT systems?**
- **Can a heuristic approach produce larger savings than individual energy improvements at each level of the stack?**

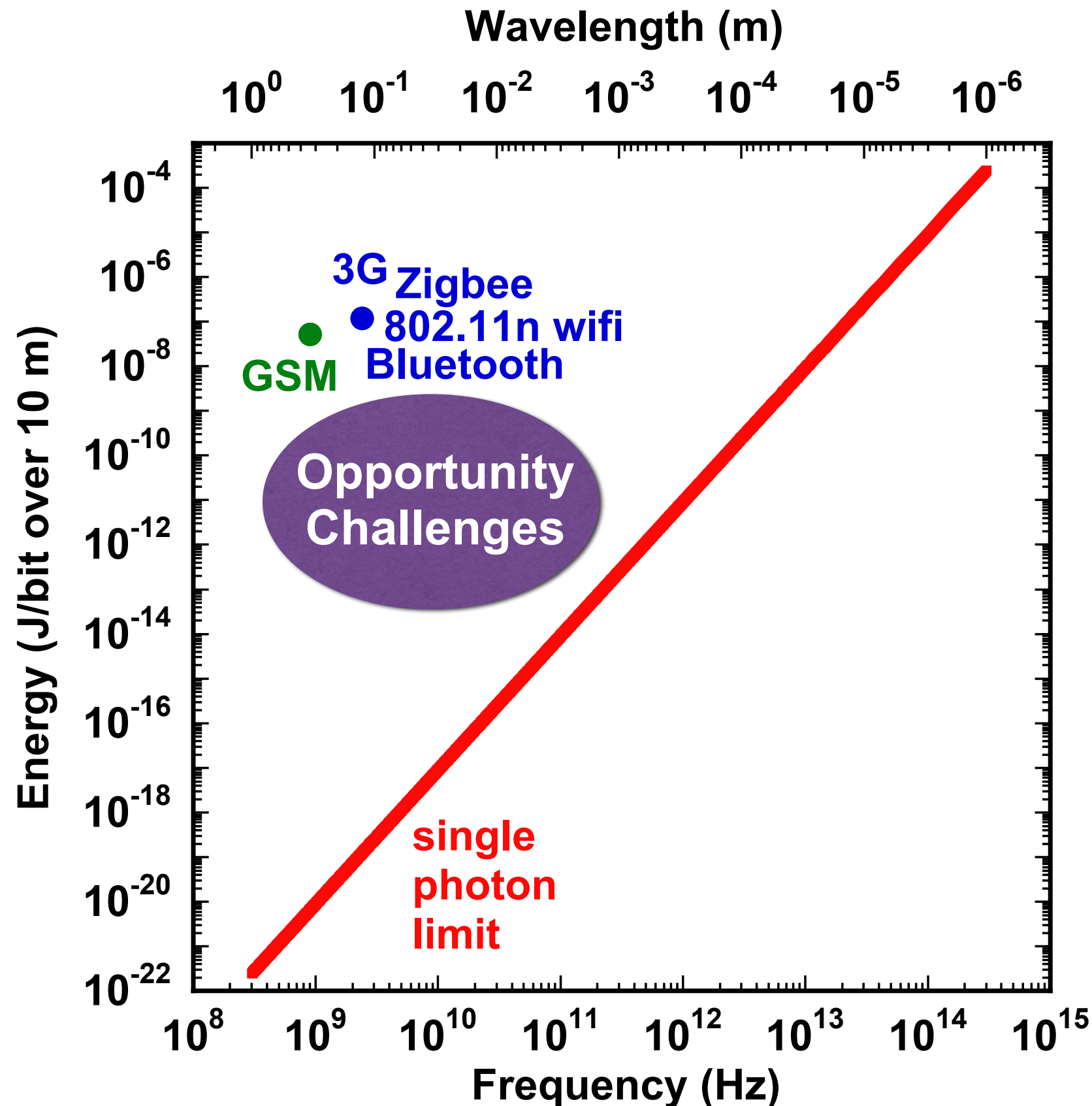


How comparable is a supercomputer system stack?

The ICT System Stack



- Which part of the system stack do you belong to?
- What are the fundamental limits for reducing energy consumption in this level of the stack? (Are they known?)
- What is the biggest challenge to reduce energy consumption in ICT devices?
- What is the most promising opportunity to reduce energy consumption in ICT devices?
- What strengths does Europe have to produce sustainable ICT systems?
- What weaknesses does Europe have to produce sustainable ICT systems?



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Input Deadline: Friday 9th October 2015

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<http://userweb.eng.gla.ac.uk/douglas.paul/index.html>

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