

U.S. DEPARTMENT OF  
**ENERGY**

Office of  
ENERGY EFFICIENCY &  
RENEWABLE ENERGY

# Microelectronics' Energy Efficiency Scaling for 2 Decades (EES2) Pledge and WG Day 2 Closing

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**EES2 Workshop Co-Chair**

Advanced Materials and Manufacturing Technology Office (AMMTO)

March 16, 2023

<https://microelectronics.slac.stanford.edu/amo-microelectronics>



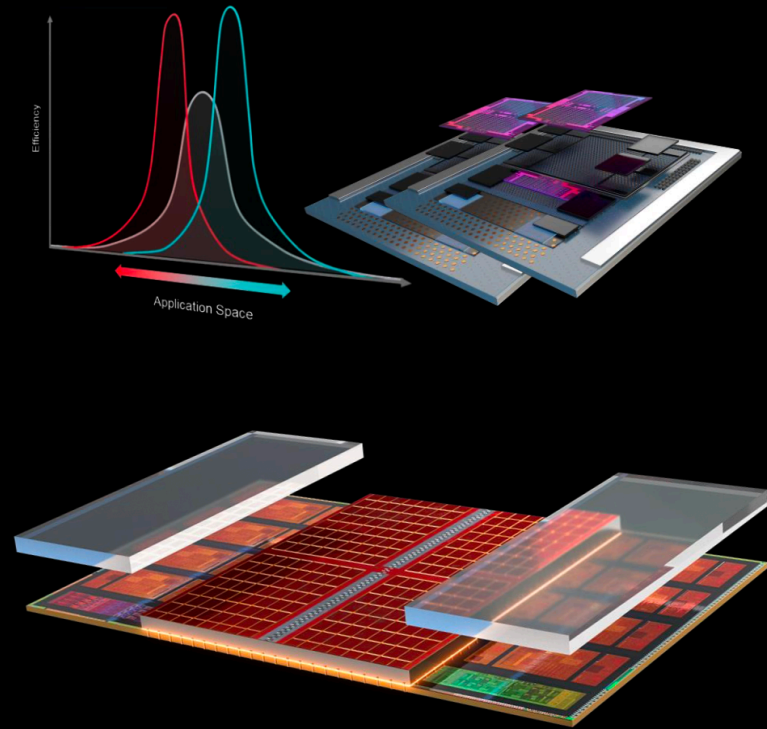
# AMD CEO: The Next Challenge Is Energy Efficiency

A 500-megawatt supercomputer is “probably too much”

21 FEB 2023

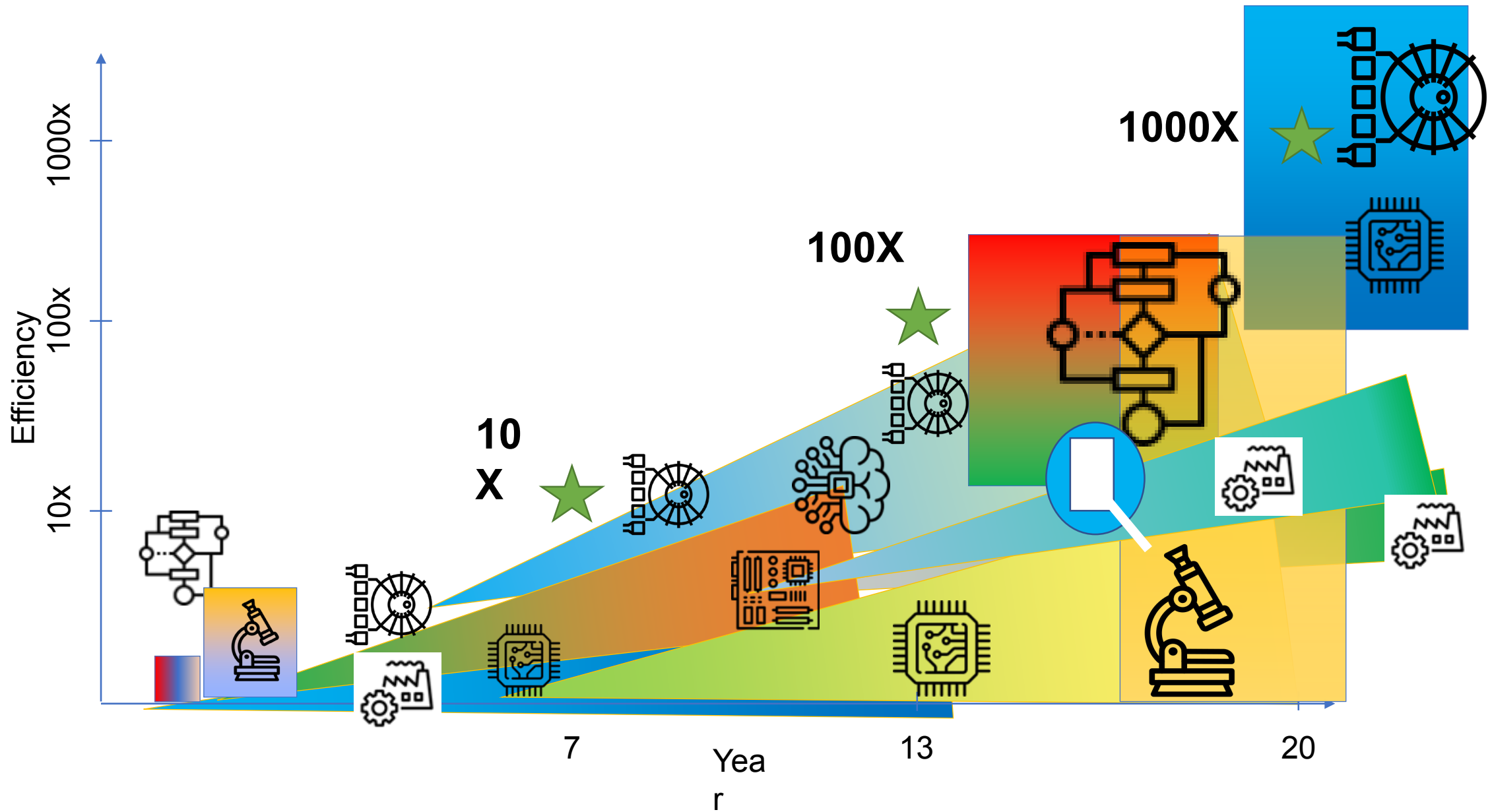
## Driving Performance Gains Over the Next Decade Requires Relentless Focus on Energy Efficiency

- Insatiable demand for more compute
- Energy efficiency is the primary limiter
- We must innovate in new dimensions:
  - System level optimizations
  - Domain specific architectures
  - Tight integration of compute and memory with chiplet architectures, advanced packaging, new interconnects
  - Leveraging AI holistically
- Deep collaboration required across materials, process, circuits, system design, architecture, software, and applications





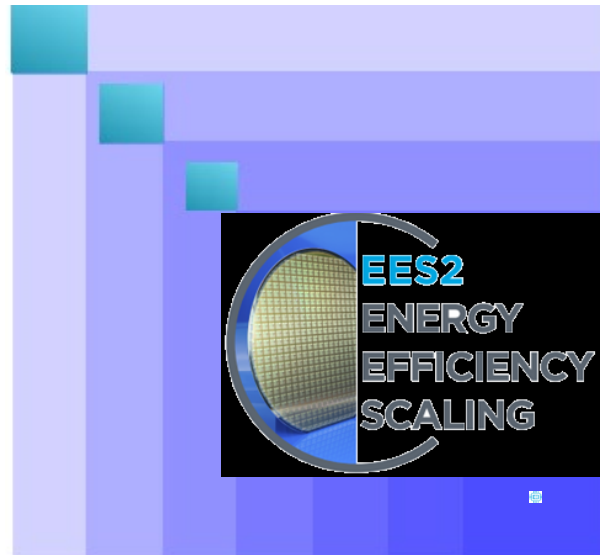
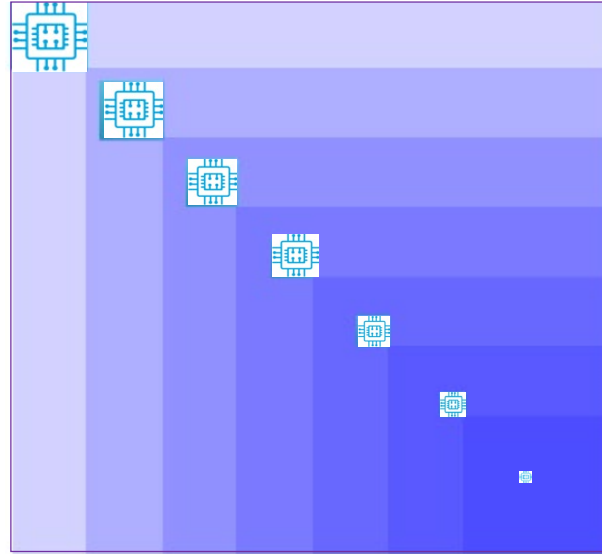
# Tech Deployment Scenario for doubling every 2 years




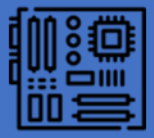




# Next Steps To Do List (esp for Non-R&D Roadmap Pledge)

1. Pick a Logo, Draft Social Media posts for us to use
2. List (and Justify) what we're NOT including in version 1.0 of roadmap—e.g. Communication/Wireless
3. More, Better Data on Microelectronics Energy Use (EIA, DOC). Break out according to AMD's 3 c's (compute, communication,
4. Publicize Sadas' Findings on energy hogs
5. Outreach to Performance Benchmarking Organization on Efficiency for Software and algorithms
6. Write articles
  1. Perspectives article on EES2 Goal for Sr. Pledge Officials to sign
  2. Technical letter on Analysis leading to EES2 Goal for Working Group members to sign
7. Think of Prizes for both promoting R&D and Publicity
8. Summer Event for Pledge Partner Senior Officials?
9. Get Briefings from Sadas' Postdocs, other AMMTO Microelectronics activities (PI meeting)
10. Recruit More Universities and Workforce oriented pledgers

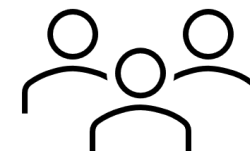
# Logo



# EES2 Working Group Homework for April

Working Group	Materials and Devices 	Circuits and Architectures 	Het Intg Adv Pkg 	Metrology & Benchmark 	Power & Control 	Software Algorithms 	Mfg Energy Efficiency 
Co-chair Point for April 2023	<b>Shashank?</b>	<b>Aziz</b>	<b>Josh Fryman</b>	<b>Jim Booth</b>	<b>Phil Sharps</b>	<b>Brian Hirano?</b>	<b>Josh Ballard?</b> <b>Steve Putna?</b>
Working Group Highlight Month	March	<b>April</b>	May	August I	June	July	August II

....don't stop thinking about the workforce



# Next Steps: Go Back to Pledge as our Guide

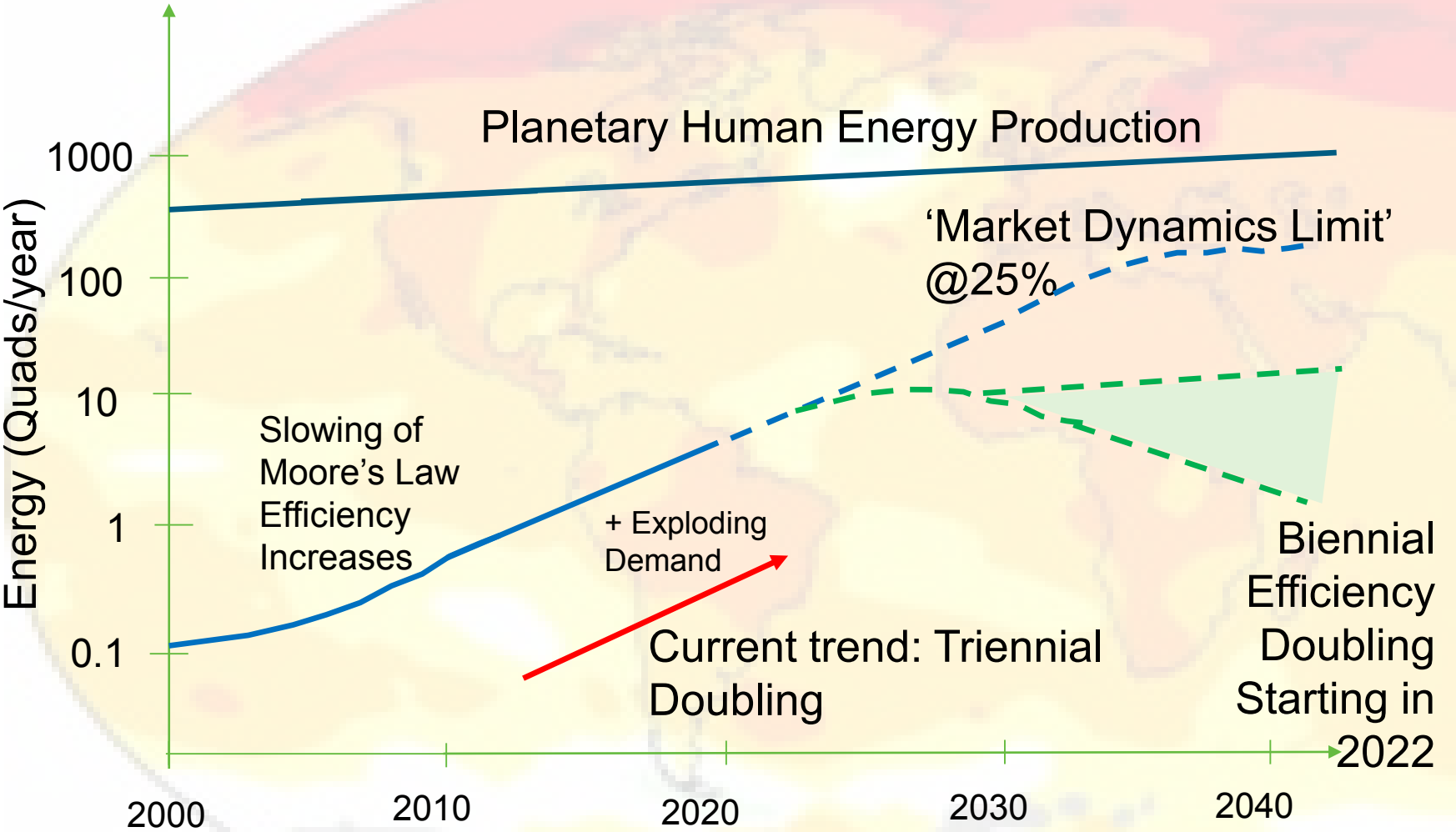
## We the undersigned agree to cooperate

- To document and learn from the extraordinary record of microelectronics', including power electronics', energy efficiency such as increases greater than 1,000,000x in energy efficiency since the invention of the transistor nearly 75 years ago;
- To document and learn from microelectronics' past and forecasted future ability to enable all sectors of the economy to become more energy efficient and sustainable;
- To identify and publicize problems solved and opportunities offered by microelectronics' Energy Efficiency Scaling over 2 Decades (EES2);
- To participate in the AMMTO-led EES2 2022-2023 R&D roadmapping effort; and
- To explore formation of a partnership, an "EES2 Alliance" that enables the EES2 1000X efficiency increase goal by leading EES2 R&D Roadmapping after 2023 and by catalyzing the deployment of cost-effective technologies, including power electronics, needed to stay on the EES2 path of doubling microelectronics' energy efficiency every two years.

## We do this because

- Microelectronics' life-cycle energy use is rapidly becoming unsustainable as microelectronics demand begins to outpace continuing efficiency improvements due to burgeoning computing, communication, and electrification demands
- EES2 is a key organizing principle that aims to help meet new energy demands
- The EES2 is a technology leadership path that provides economic and other public benefits.

# SRC and EES2 Forecast Outreach Needed Now



Source: Based on SRC Decadal Report (2021)

### Document and Learn

- We did biennial efficiency generation for 30 generations
- today's CHIPS investments are for economic and national security
- Future of microelectronics energy efficiency strongly impacts clean energy, decarbonization

### Identify and Publicize

- EES2 challenges
- EES2 opportunities
- potential EES2 Alliance.



# We can DO This!

- In the short- and medium-term
  - We understand the difference between the best and the rest in hardware\*.
  - The best hardware technologies are already on EES2 path\*
  - Benchmark algorithms and software energy efficiency performance
- For the long term –getting from 100X to 1000x
  - Don't Stop Thinking About Software
  - Start thinking about WG implications of Green (nature inspired axis) and Blue (Quantum-inspired computing axis)





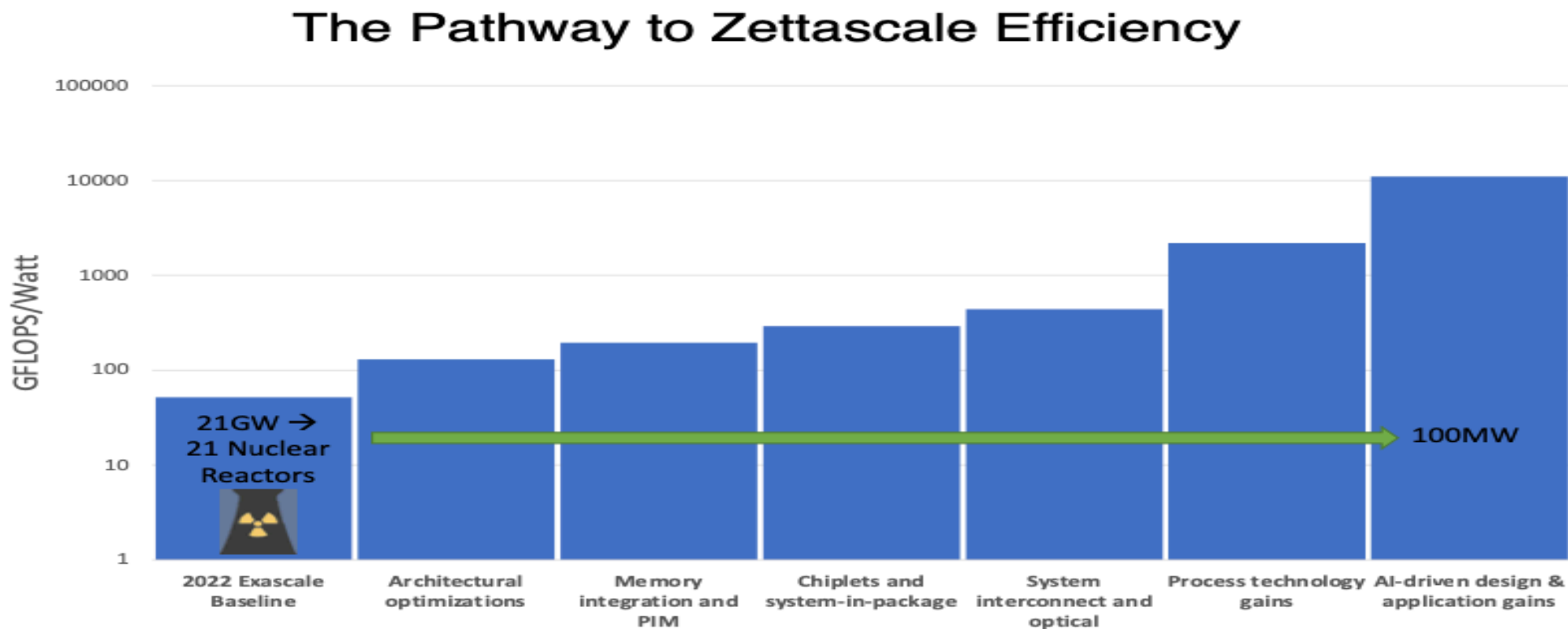
**Thank you**

**[Tina.Kaarsberg@ee.doe.gov](mailto:Tina.Kaarsberg@ee.doe.gov)**

**For office information and to subscribe for updates:**

**[manufacturing.energy.gov](http://manufacturing.energy.gov)**





**Figure 1.1.18: Efficiency gains must outstrip those of the last decade in order for a zettascale-capable system to fit within a reasonable power level.**