

U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

Microelectronics' Energy Efficiency Scaling for 2 Decades (EES2) Pledge and WG WELCOME

Tina Kaarsberg, PhD

EES2 Workshop Co-Chair

Advanced Materials and Manufacturing Technology Office (AMMTO)

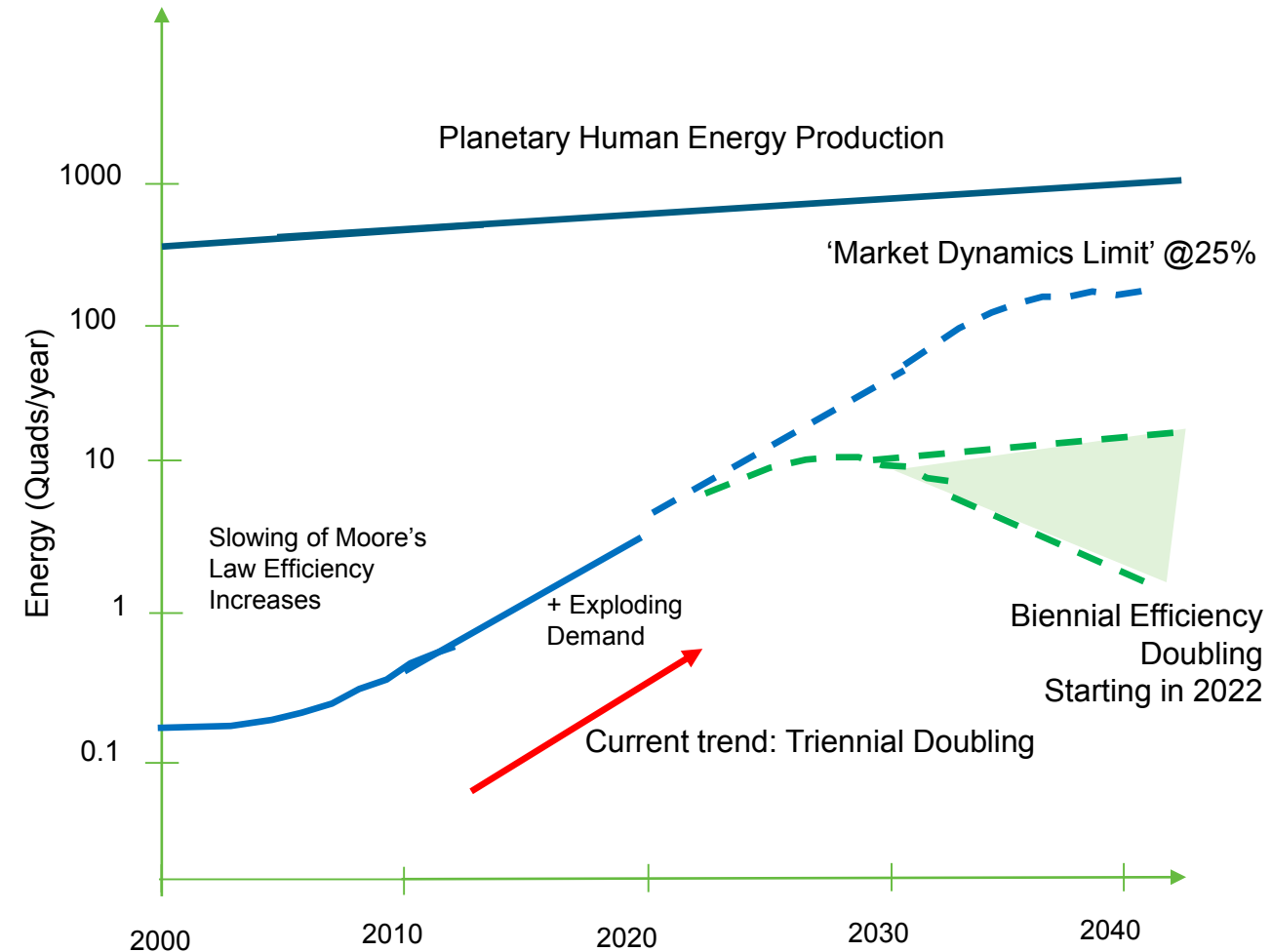
February 15, 2023

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



Economics of Energy Efficiency Scaling—increasing returns!

- Against **Un-sustainable** Growth –that reaches market dynamics limit.
- Upper EES2 scenario not necessarily “worst case” shows growth PARALLEL to planetary human energy production
- Neither is lower EES2 scenario “worst case” could show an earlier transition to a more distributed nature inspired manufacturing and energy use
- Energy Efficiency leads to “increasing returns” which is a win for all companies and like-minded countries



Source: Based on SRC Decadal Report (2021)

Action Needed NOW Against Unsustainable Energy Use

Urgent Need for Electric Energy Efficiency —climate-driven extreme weather plus decarbonization stresses electricity supply and yet...

- Exascale Supercomputer energy use—how did it get to be the same scale as Accelerator energy Use!!
- Almost none of the “Tech Talk” about Artificial Intelligence (chatGPT etc) mentions its enormous energy use.

Help us spread the word—help with the other parts of the Pledge

Next Steps: Expanded Pledge as our Guide

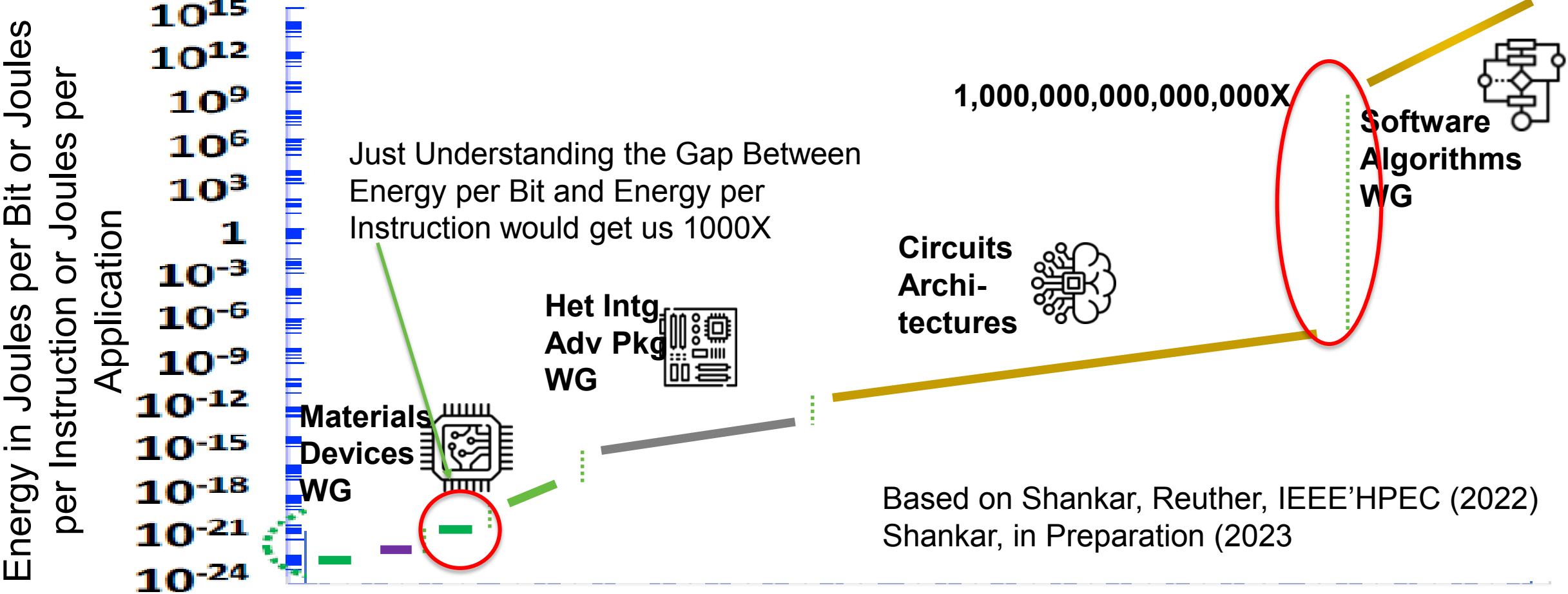
We the undersigned agree to cooperate

- 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.

HELP EXPLAIN THIS for Layers of Computing and its Implications



Dynamic Energy at 300K
Single ATP to ADP
Energy per bit switching
Energy per bit switching
per Instruction (INT4)
per Instruction (INT4)
per Instruction (INT8)
per Instruction (INT8)
per Instruction (FP16)
per Instruction (FP16)
per Instruction (FP32)
per Instruction (FP32)
per Instruction (FP64)
per Instruction (FP64)
per Instruction (Rmax)
per Instruction (Rmax)
Spike Protein (HPCG)
per Instruction (HPCG)
per Application (NLP)
per Application (NLP)

EES2 Working Group Homework: Assign March Leads by 2/16

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 March 2023							
Working Group Highlight Month	March	April	May	Observe all, February Highlight group-led August I	June	July	August II

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





Thank you

Tina.Kaarsberg@ee.doe.gov

For office information and to subscribe for updates:

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