

# Amortizing Embodied Carbon Across Generations

The 15th International Green and Sustainable Computing Conference (IGSC '24)

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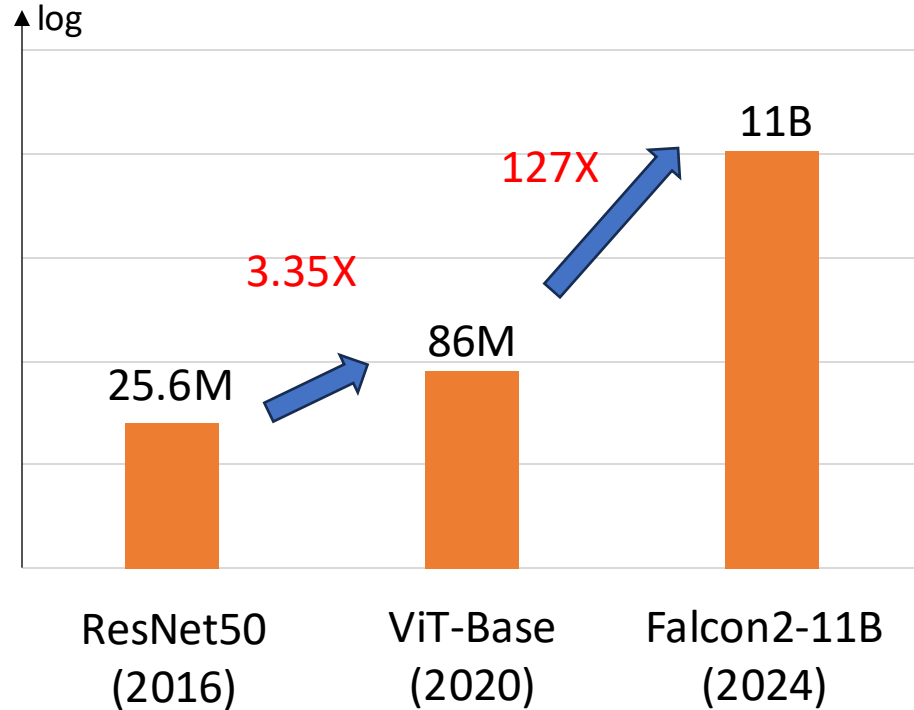
BROWN



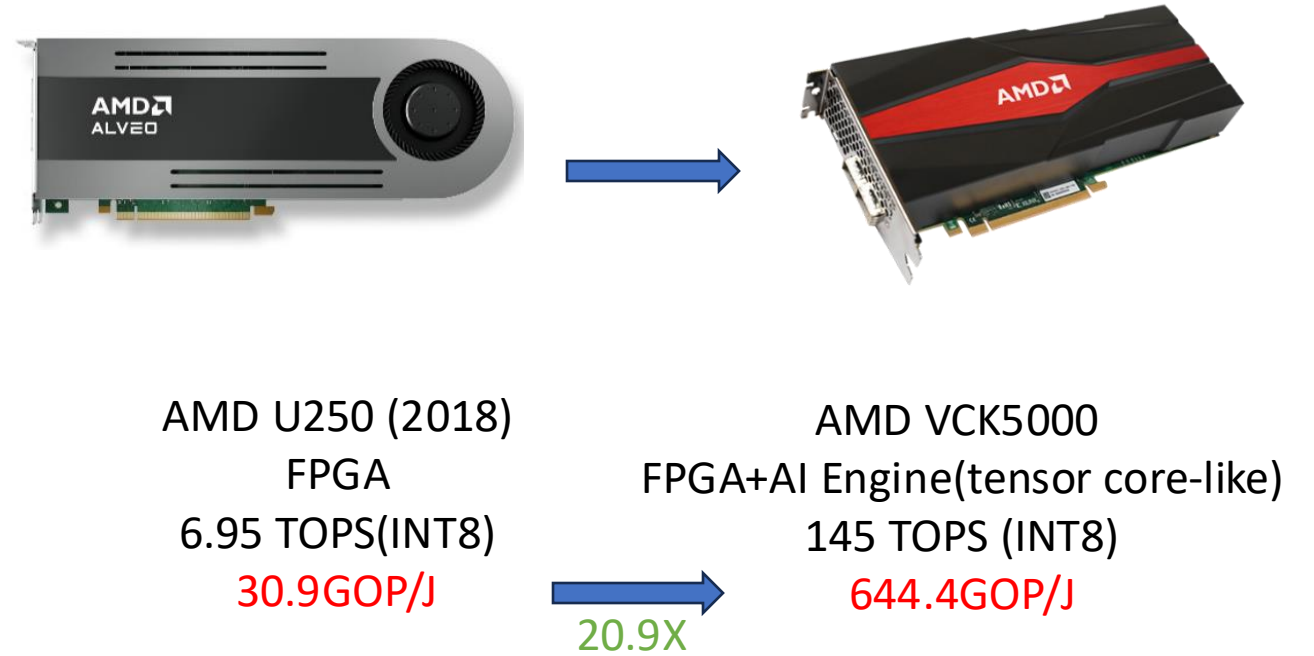
Syracuse University

# Challenges of Extending Device Lifetime

Parameter size of different AI models



AMD U250 vs. AMD VCK5000

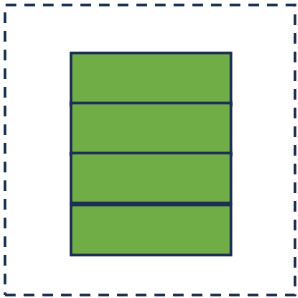


Applications are evolving:  
Old devices may not handle

Accelerator are evolving:  
New devices have better energy efficiencies

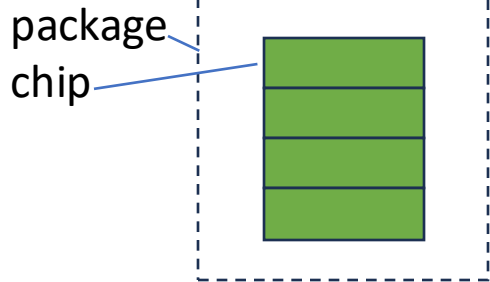
# Baseline Approaches

Approach 1:  
Keep old device



2021  
Embodied cost:  
*0 KgCO<sub>2</sub>e*  
Operational cost:  
*122.8 KgCO<sub>2</sub>e*

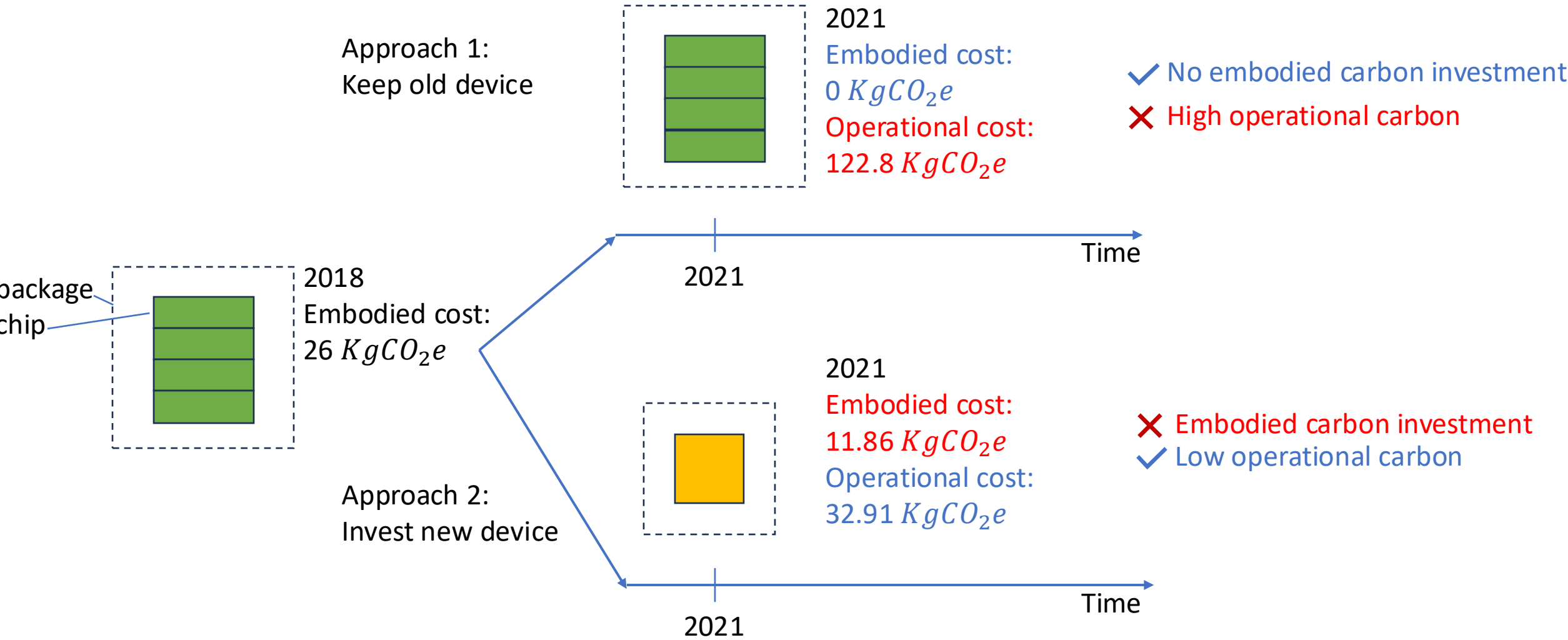
- ✓ No embodied carbon investment
- ✗ High operational carbon



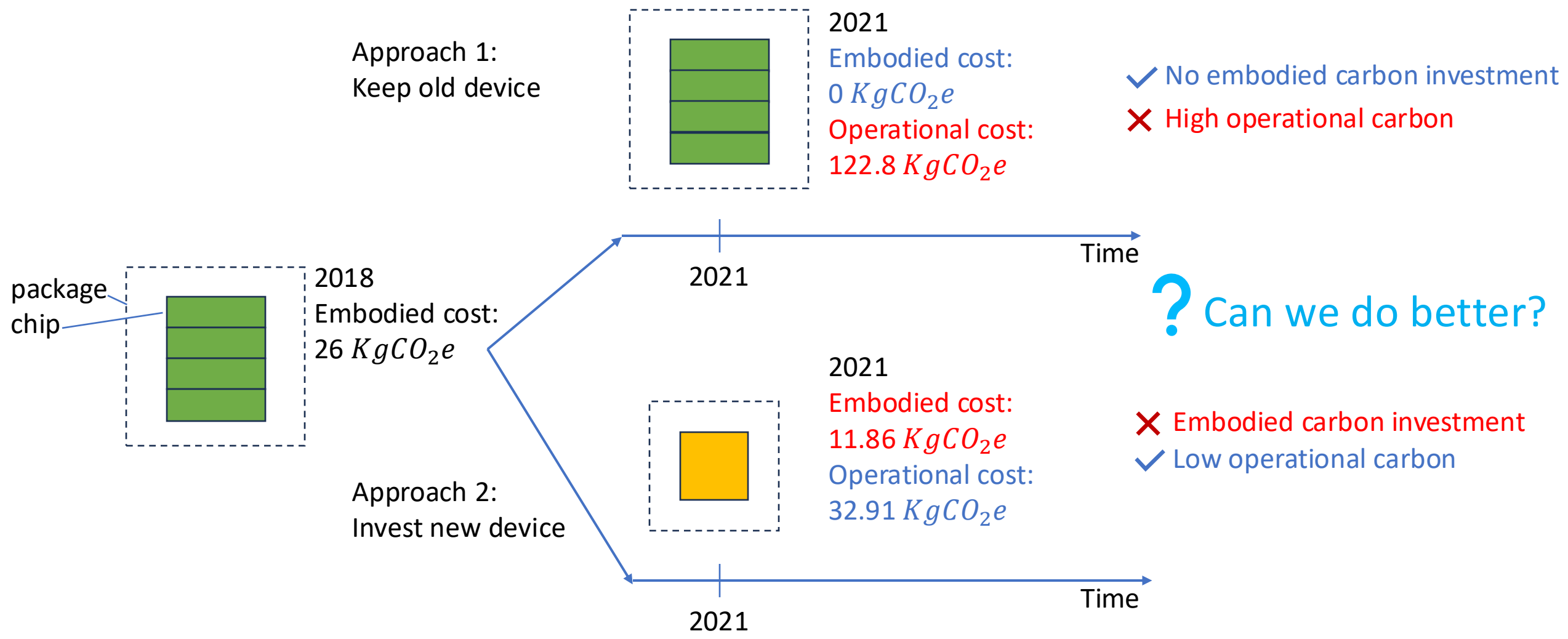
2018  
Embodied cost:  
*26 KgCO<sub>2</sub>e*



# Baseline Approaches



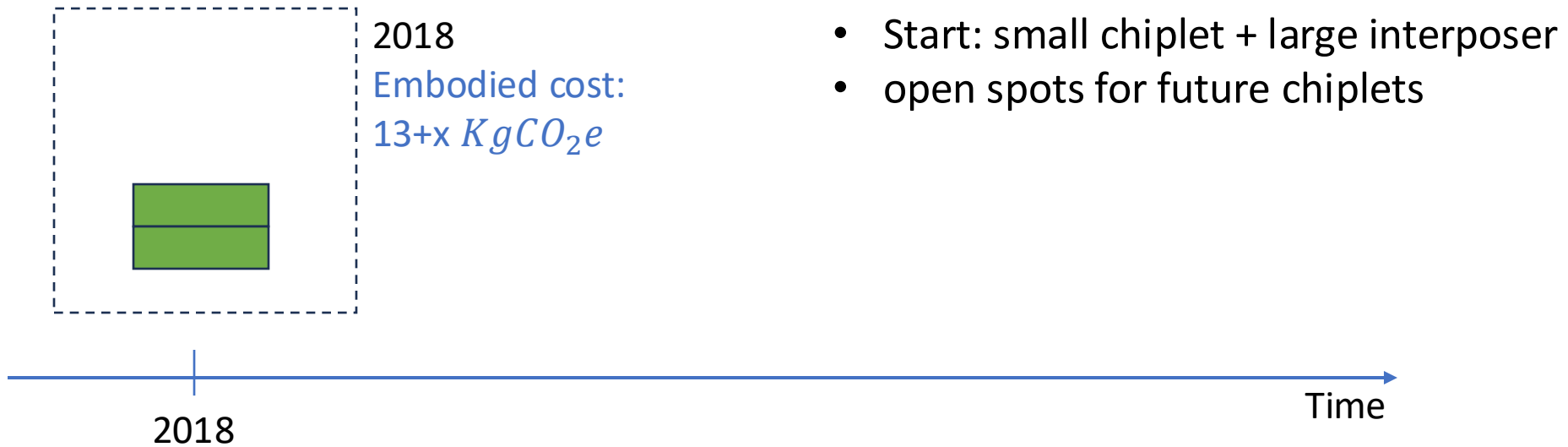
# Baseline Approaches



? Can we do better?

# We Can Do Better with the Chiplet Technologies

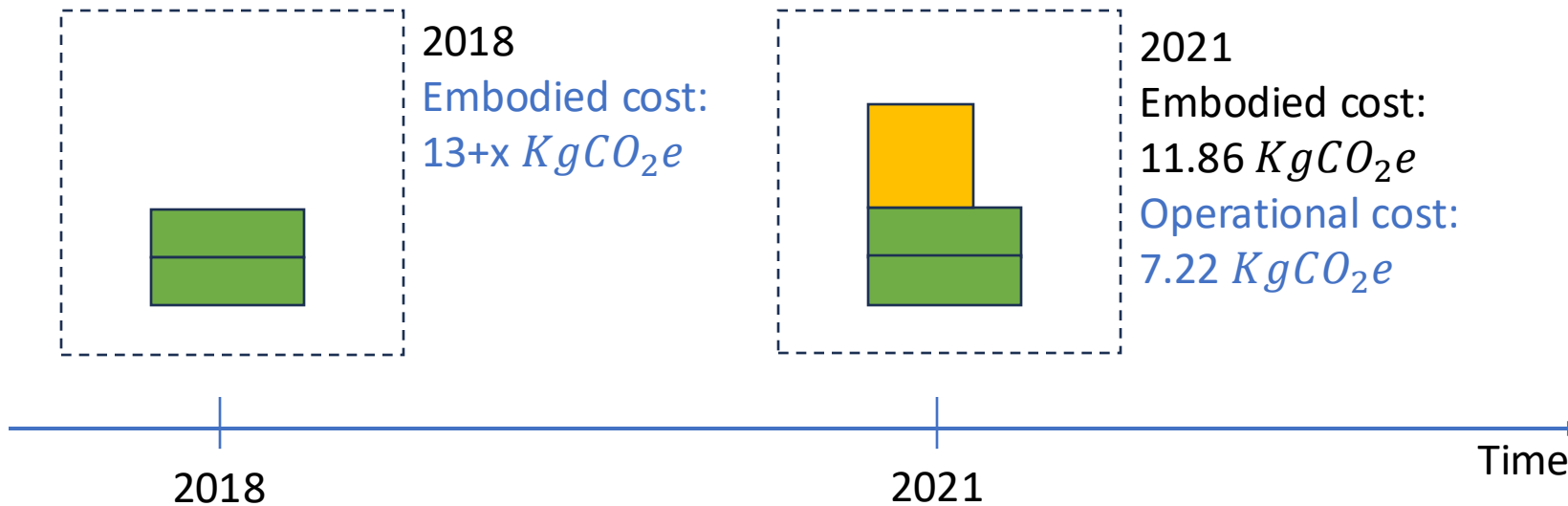
## Embodied carbon optimized (ECO) FPGA systems



# We Can Do Better with the Chiplet Technologies

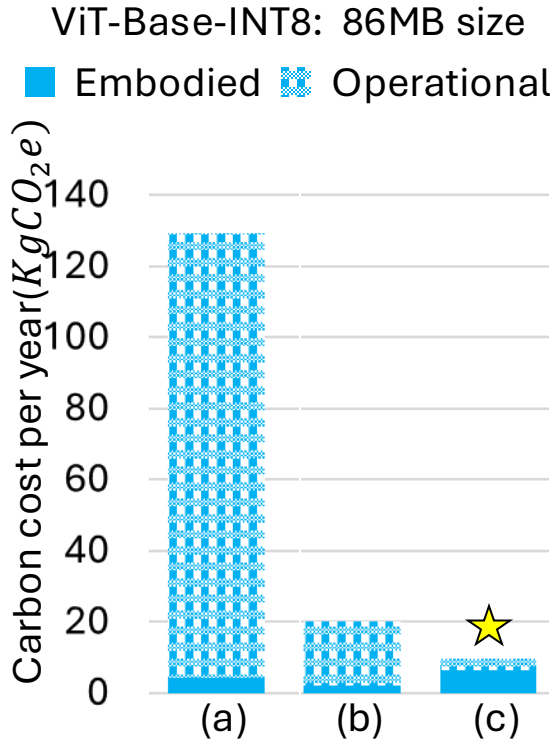
## Embodied carbon optimized (ECO) FPGA systems

- Start: small chiplet + large interposer
- Keep old chiplet + Invest New chiplet



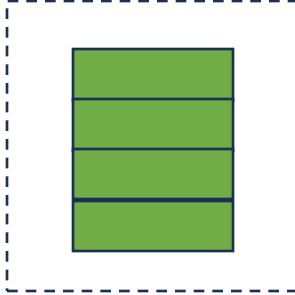
- ✓ Amortized embodied carbon
- ✓ FPGA design is sized to problem size

# We Can Do Better with the Chiplet Technologies



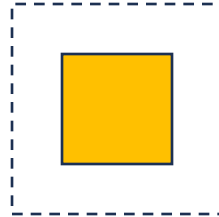
- (a): approach 1 (2018 FPGA)
- (b): approach 2 (2021 FPGA w/t tensor core)
- (c): ECO FPGA (2018 FPGA + 2021 FPGA w/t tensor core)

Approach 1



2021  
 Embodied cost:  
*0 KgCO<sub>2</sub>e*  
 Operational cost:  
*122.8 KgCO<sub>2</sub>e*

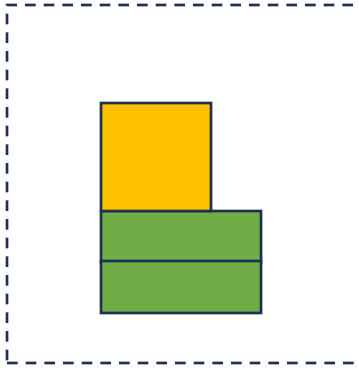
Approach 2



2021  
 Embodied cost:  
*11.86 KgCO<sub>2</sub>e*  
 Operational cost:  
*32.91 KgCO<sub>2</sub>e*

Better operational cost

Same embodied cost in 2021  
 Better operational cost

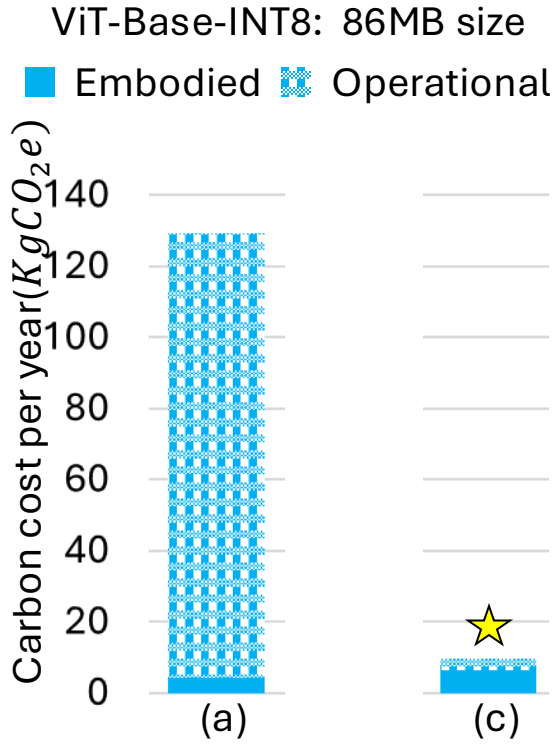


ECO-FPGA

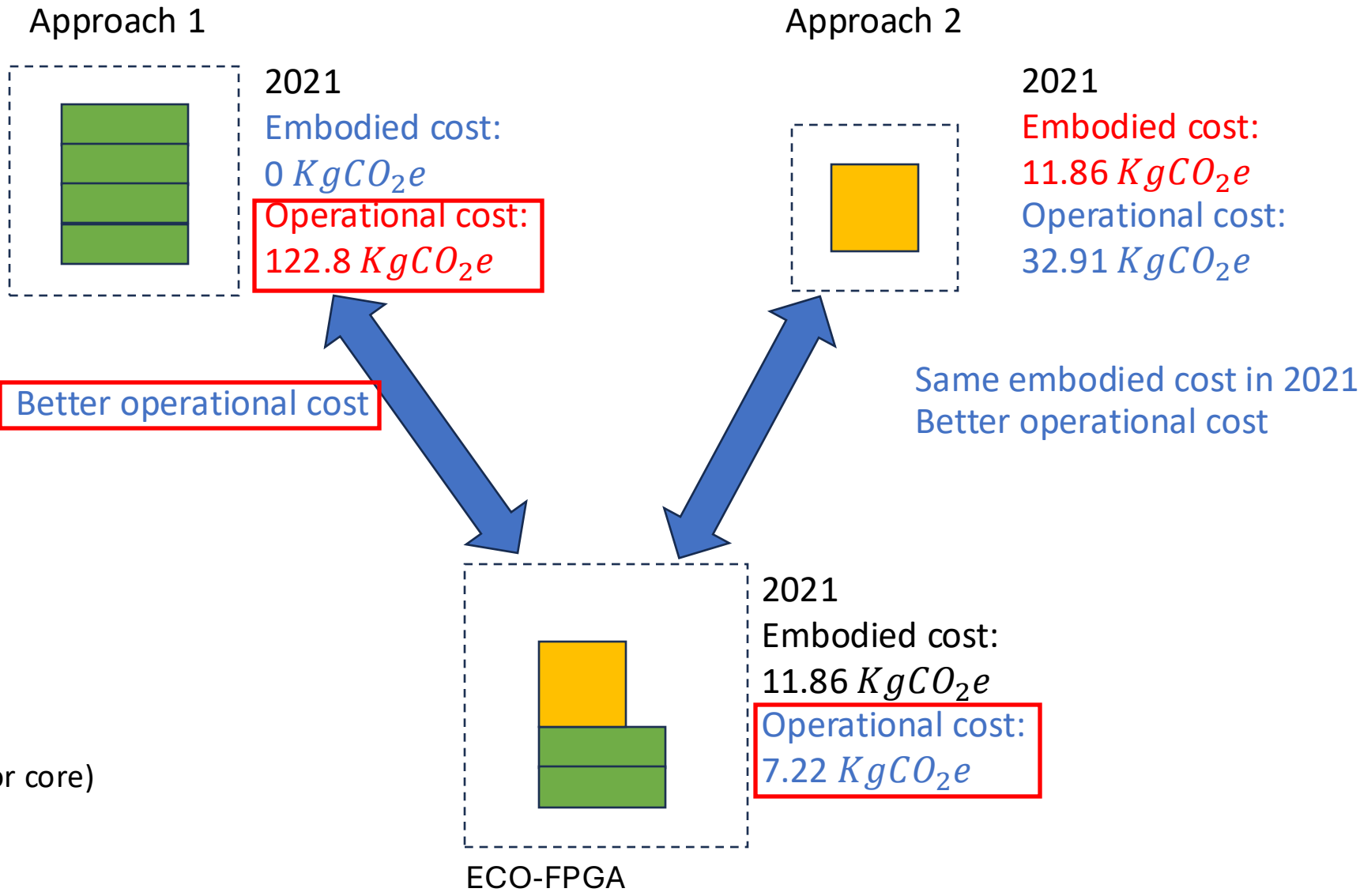
2021  
 Embodied cost:  
*11.86 KgCO<sub>2</sub>e*  
 Operational cost:  
*7.22 KgCO<sub>2</sub>e*



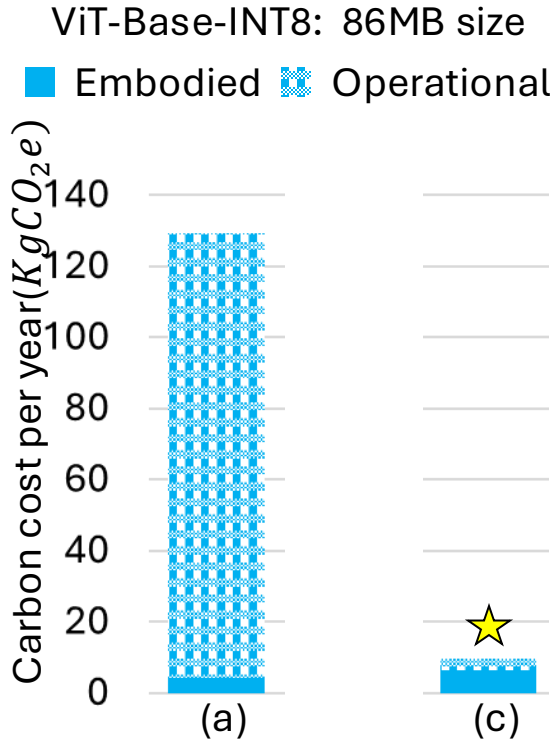
# We Can Do Better with the Chiplet Technologies



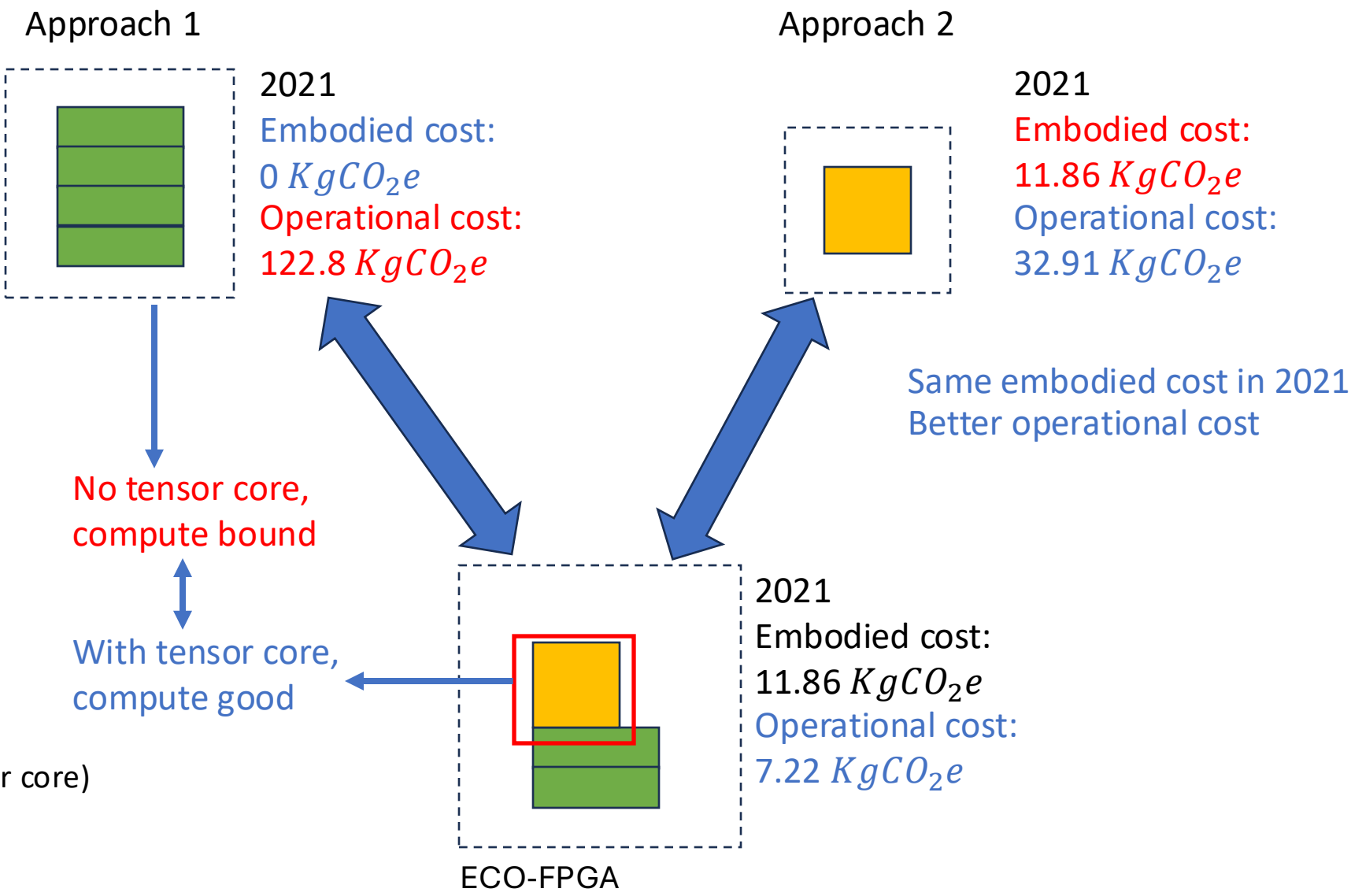
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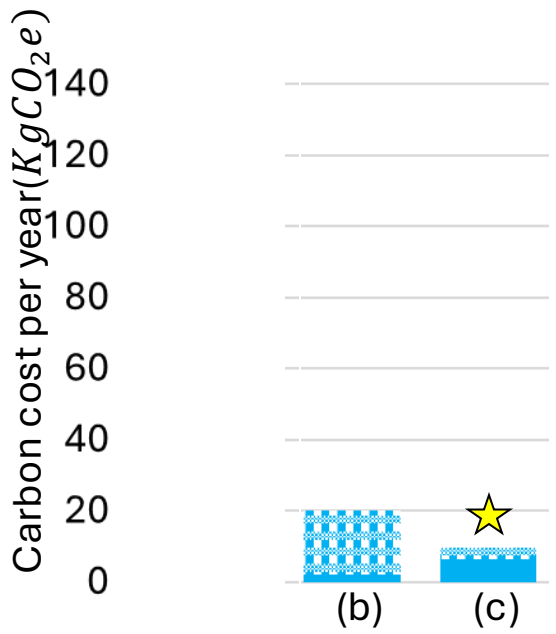


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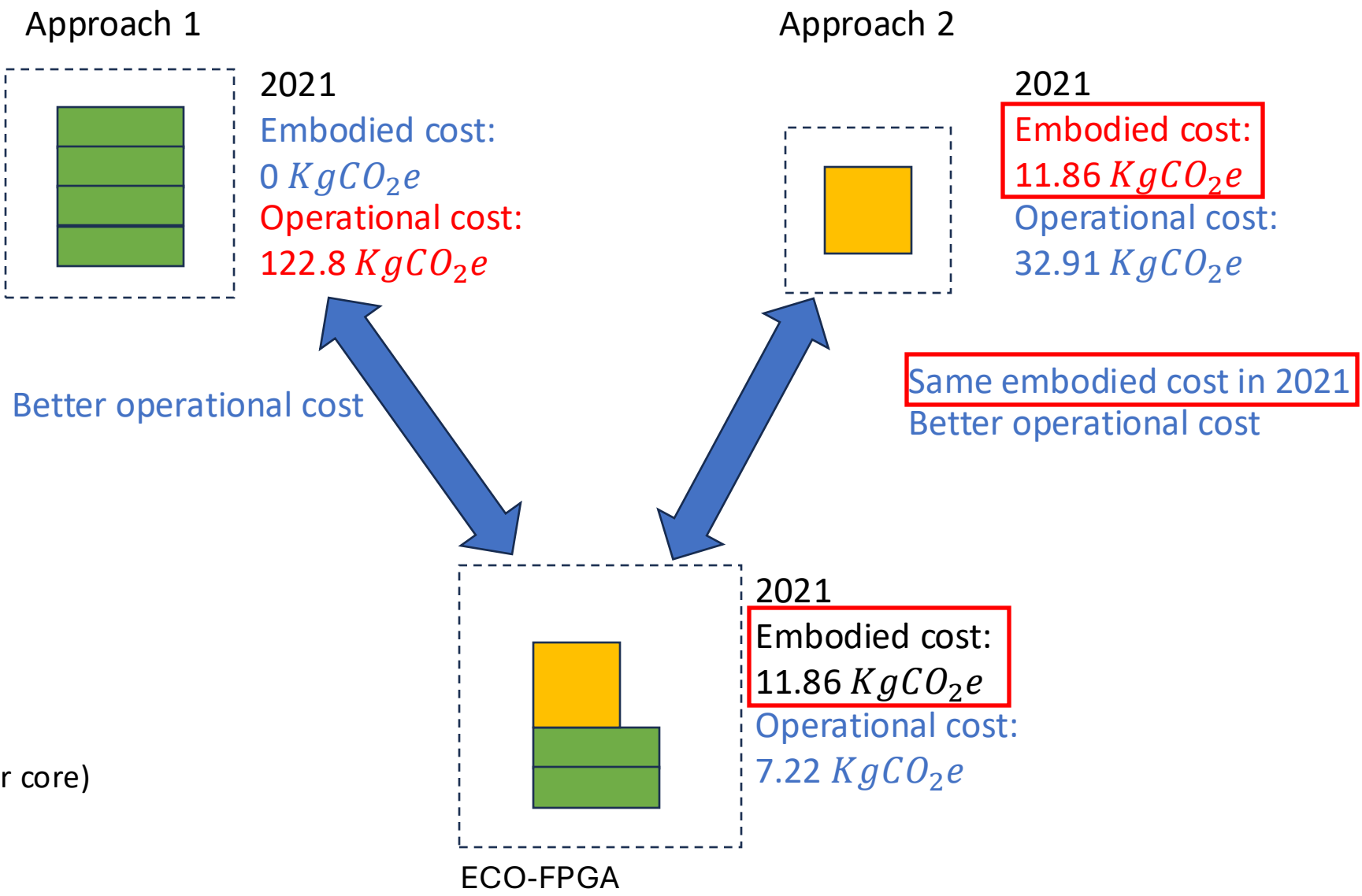


# We Can Do Better with the Chiplet Technologies

ViT-Base-INT8: 86MB size  
 ■ Embodied ■ Operational

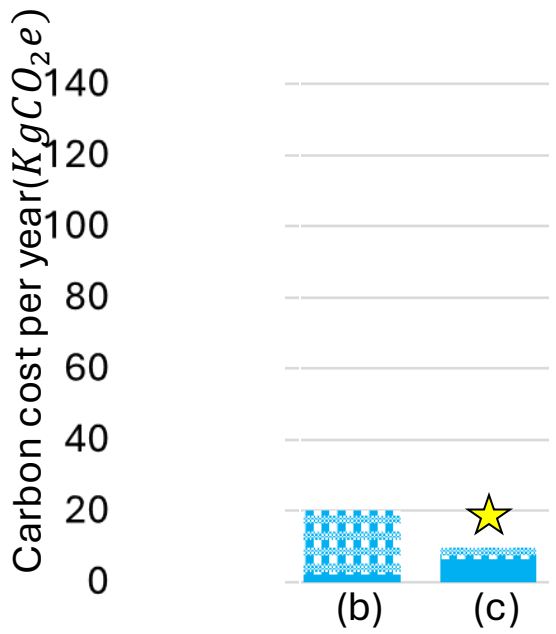


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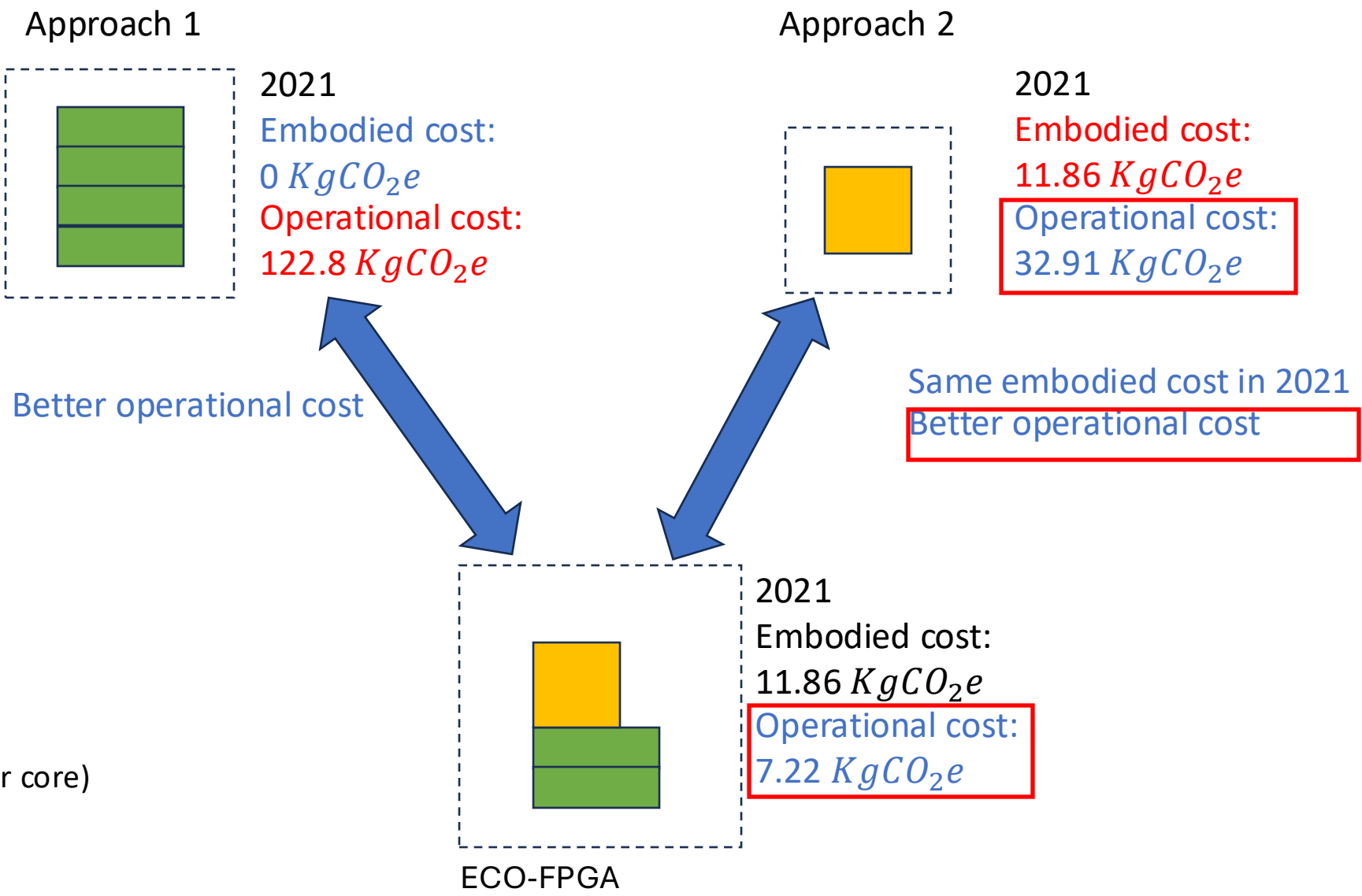


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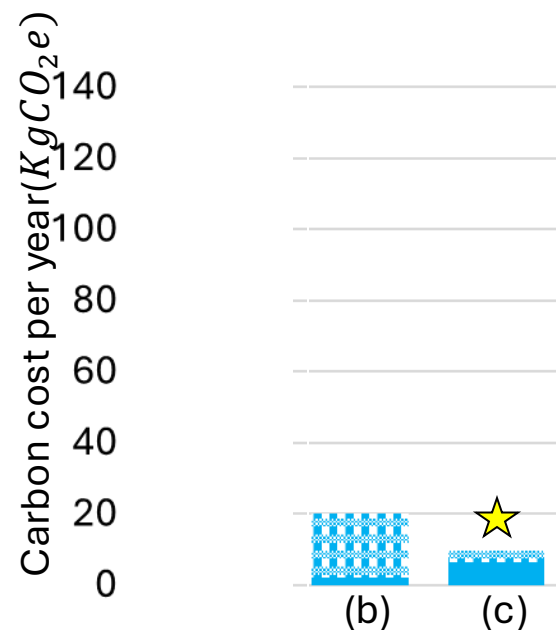


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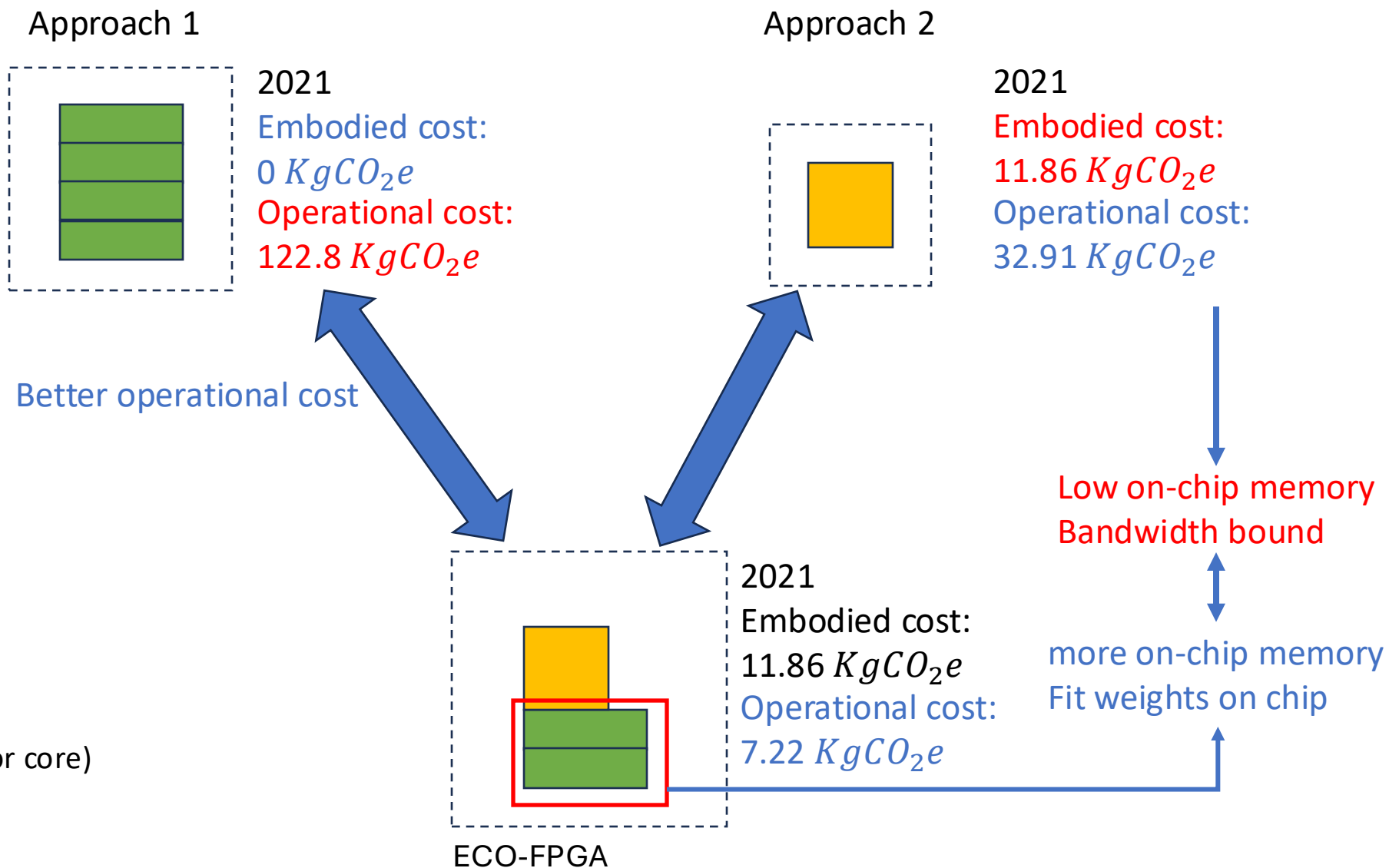


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**Thank You**

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