Public Utility Research Center | 05 February 2008

Can nuclear technology meet climate policy challenges?

Nathan E. Hultman | hultman@umd.edu
Assistant Professor, School of Public Policy
University of Maryland

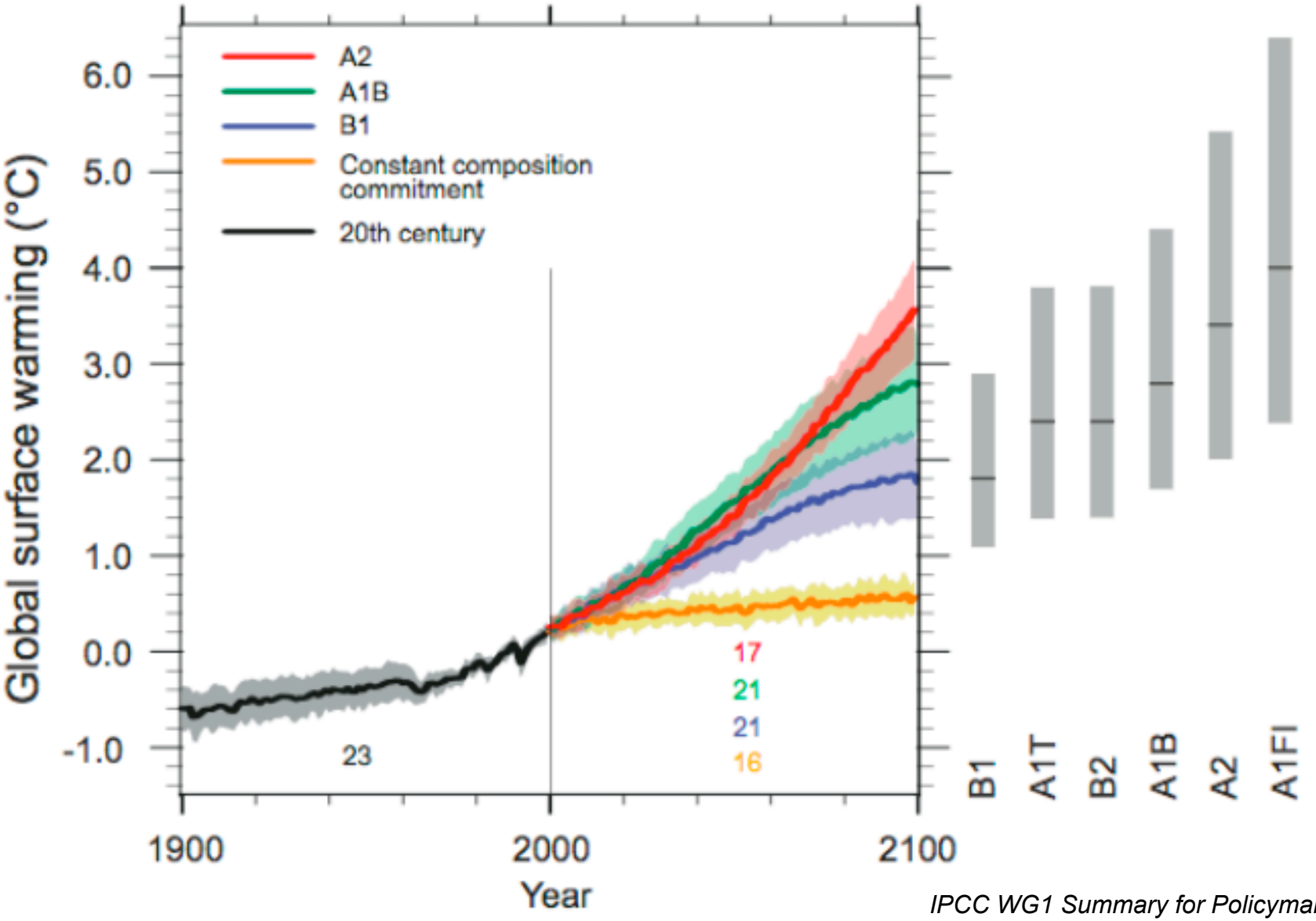
Assistant Director, Joint Global Change Research Institute
Pacific Northwest National Laboratory

Associate Fellow, Martin Institute for Science & Civilization
University of Oxford

1

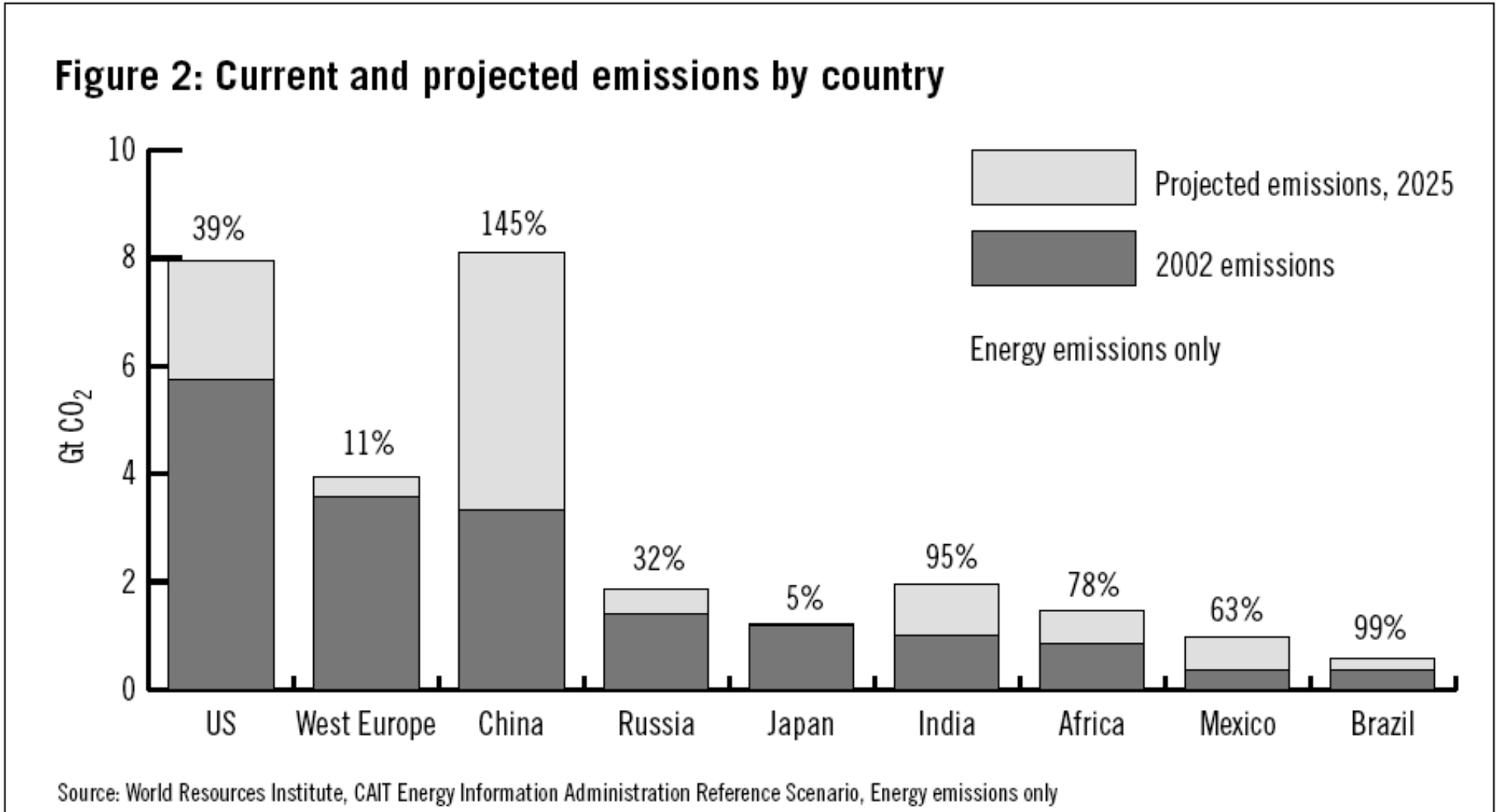
policy context

Future temperature scenarios



IPCC WG1 Summary for Policymakers 2007

Growth in emissions 2002-2025



Stern 2006

Turning the battleship

- Use less energy to provide same services
  - Efficiency in design and building
  - Conservation
- Use lower-carbon energy sources for supply
  - Wind, solar, geothermal, tidal
  - Biomass
  - Nuclear (?)
- Capture greenhouse gases
  - Fossil fuel CO2 capture & storage
  - Methane capture from landfills
  - Carbon sequestration in forests & ag

40-60 years

Policies for reducing emissions

- Regulated emissions reduction
- Market-based policy instruments
  - Emissions tax
  - Emissions trading
  - Hybrid system ("safety valve")
- R&D for new technologies
- Technology policies
- Reduction of deforestation

Kyoto set expectation of Trading system for GHG

- EU ETS, Australia, California, RGGI
- market is already active and expanding

2

corporate perspective

“Climate risk” for business

Physical risks from climate changes or impacts of climate change

Regulatory risks from policy decisions on carbon or GHG constraints

Business risks from regular operations in carbon/GHG markets

“We’d be out of our minds if we wrote weather insurance on the opinion global warming would have no effect at all.”

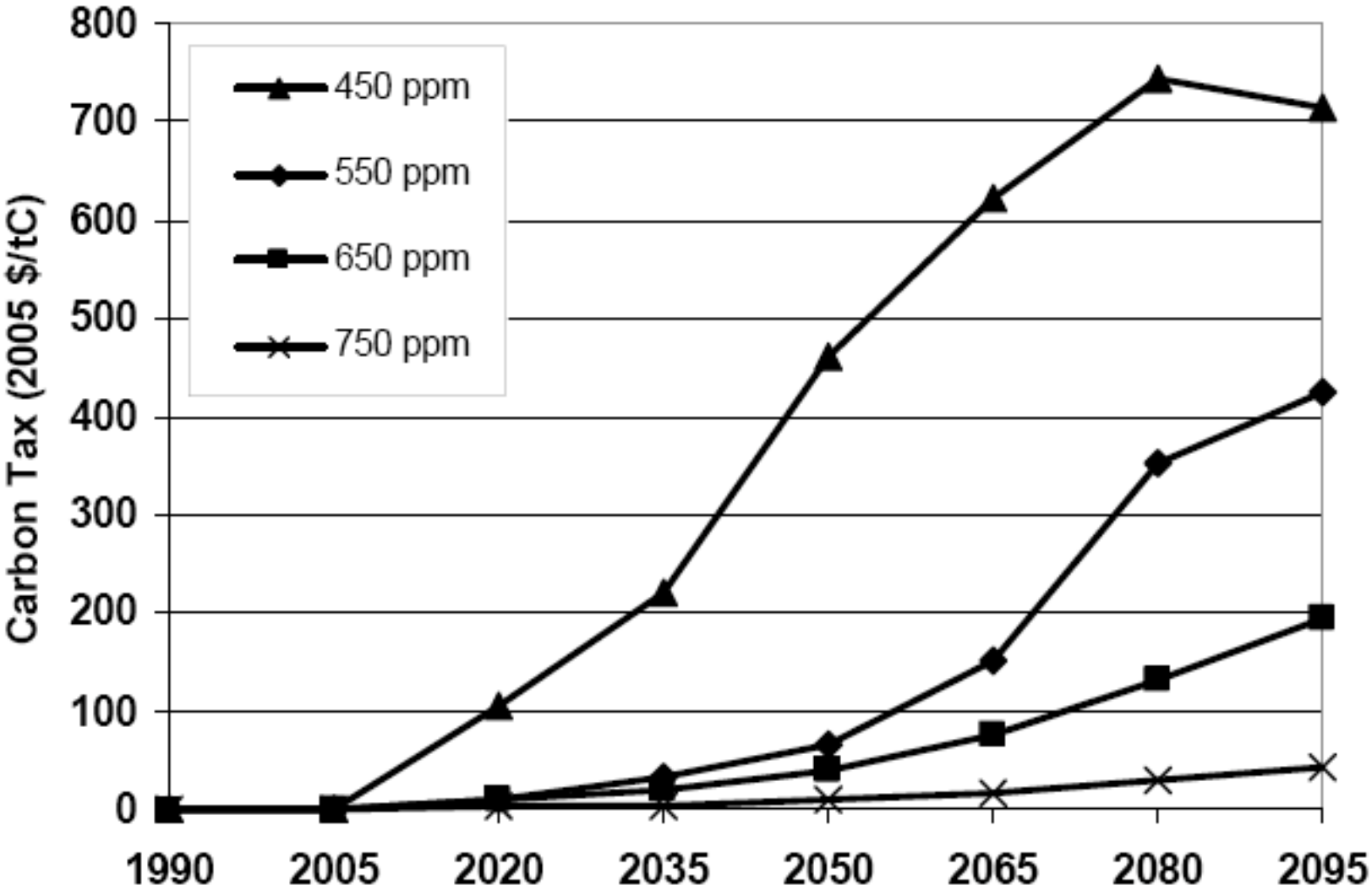
Warren Buffett
2006

PHYSICAL RISK	REGULATORY RISK	FIXED ASSET RISK
✓ Changes in weather	✓ Effect of GHG regulations	✓ Physical exposure
✓ Water availability	✓ Secondary effects	✓ Age and projected life
✓ Changes in temperature	✓ Changes in consumer demand	✓ Energy use and fuel mix
✓ Health effects on workforce	✓ Future cost of carbon, resulting from emission reductions	✓ Fuel switching capabilities
✓ Cost of adaptation		✓ Vulnerability to interruptions in power/water
		✓ Proximity to coastlines

PRODUCT RISK	COMPETITIVE RISK
✓ Direct and indirect GHG emissions	✓ Aggregate GHG emissions of operations
✓ Energy demand and fuel use	✓ Ability to respond to changing regulations and new markets
✓ Energy efficiency and clean energy design	✓ Introduction of new climate-friendly products
✓ Low GHG alternatives	✓ Corporate reputation, brand value, credit risk, and legal risk
✓ Low GHG R&D	
✓ Supply chain issues	

CERES 2006

Modeled C taxes



Kim & Edmonds 2007


I'VE BEEN PRE-APPROVED FOR A CARBON CREDIT CARD!
THAT'S NICE DEAR...
fox

3

nuclear technology risk & cost

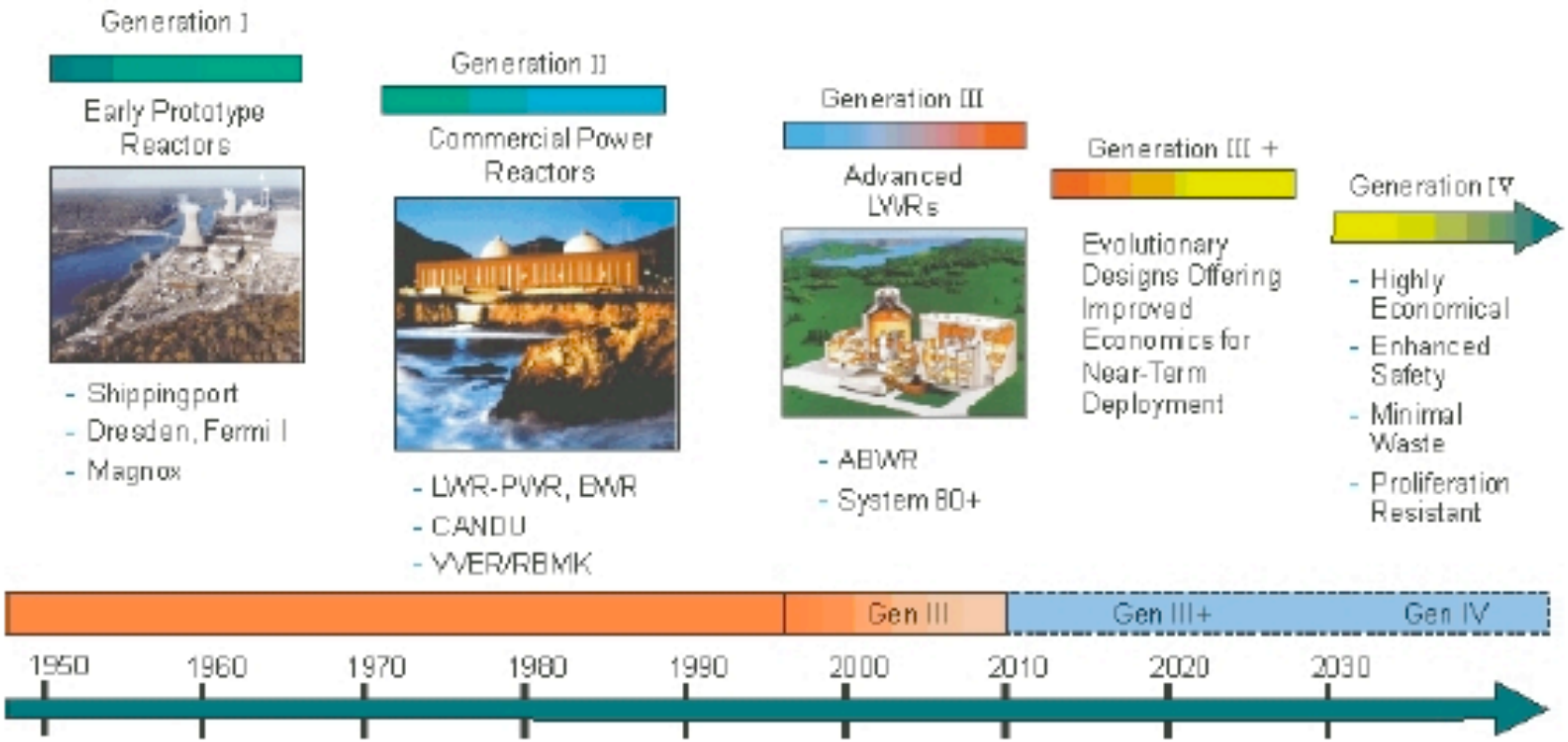
A Technology Roadmap for Generation IV Nuclear Energy Systems

December 2002

Ten Nations Preparing Today for Tomorrow's Energy Needs

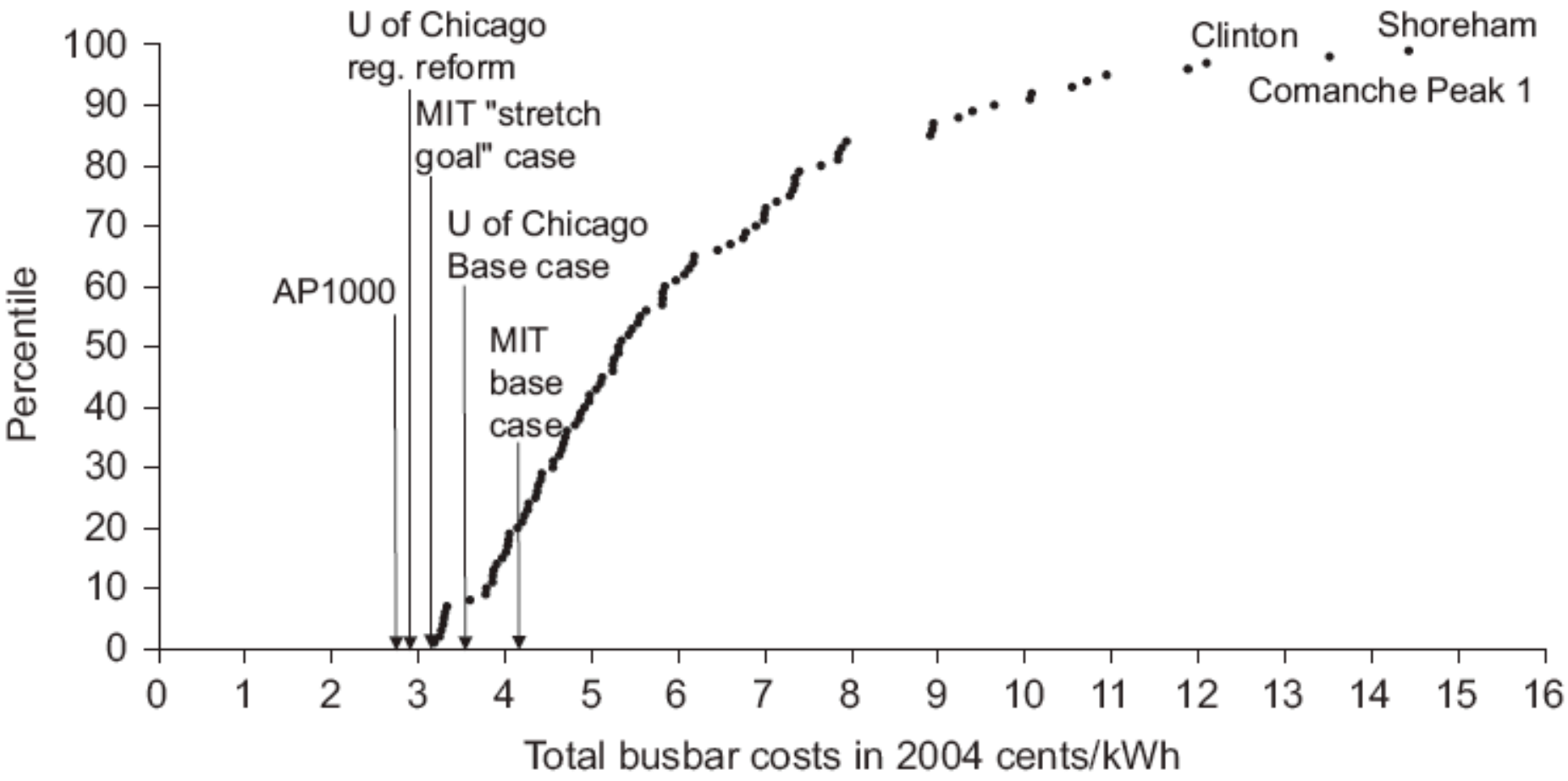
Issued by the
U.S. DOE Nuclear Energy Research Advisory Committee
and the Generation IV International Forum

The Generations of Nuclear Energy



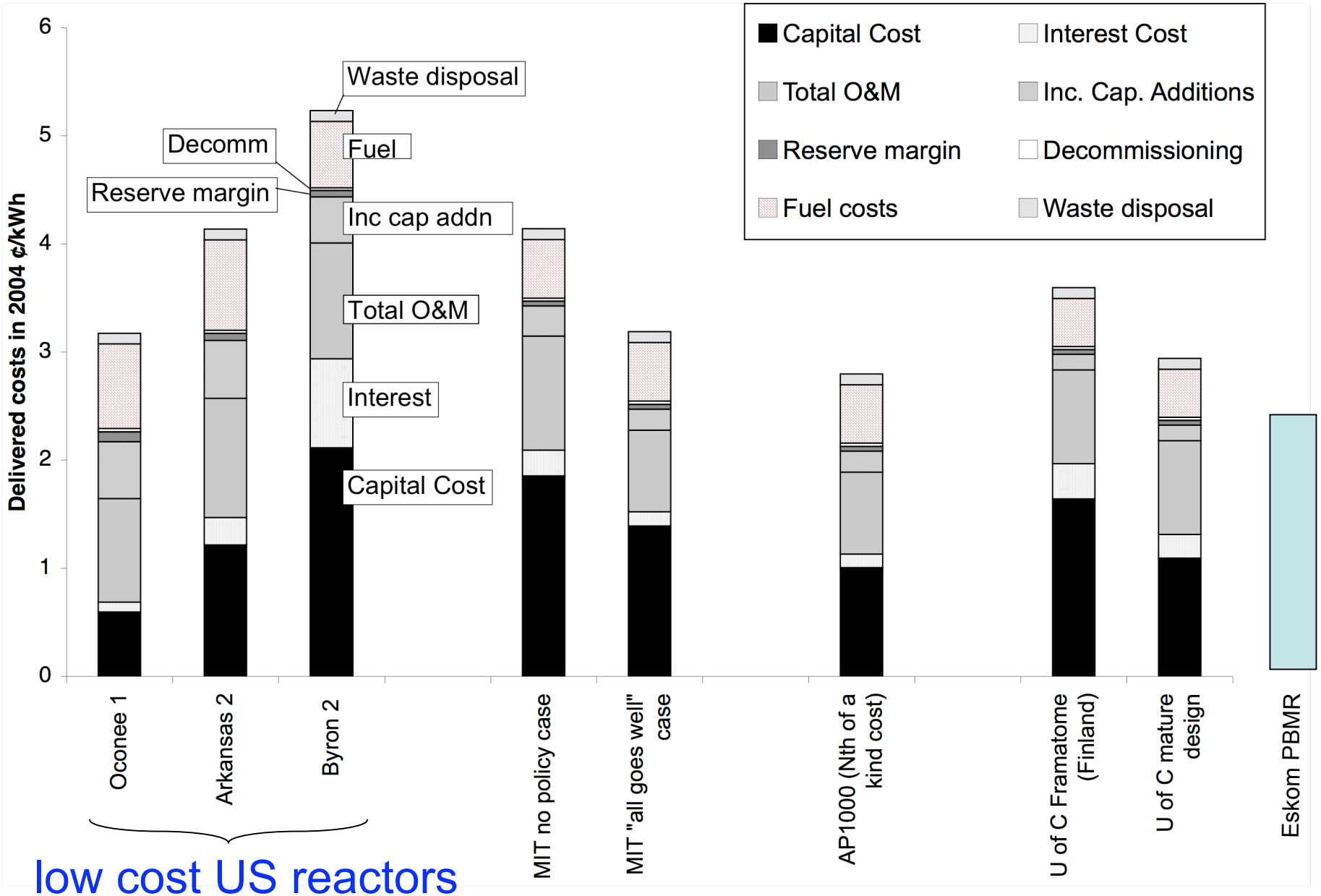
Source: DOE Generation IV Project

Distribution: Total costs



Koomey & Hultman 2007

Comparison to Projections

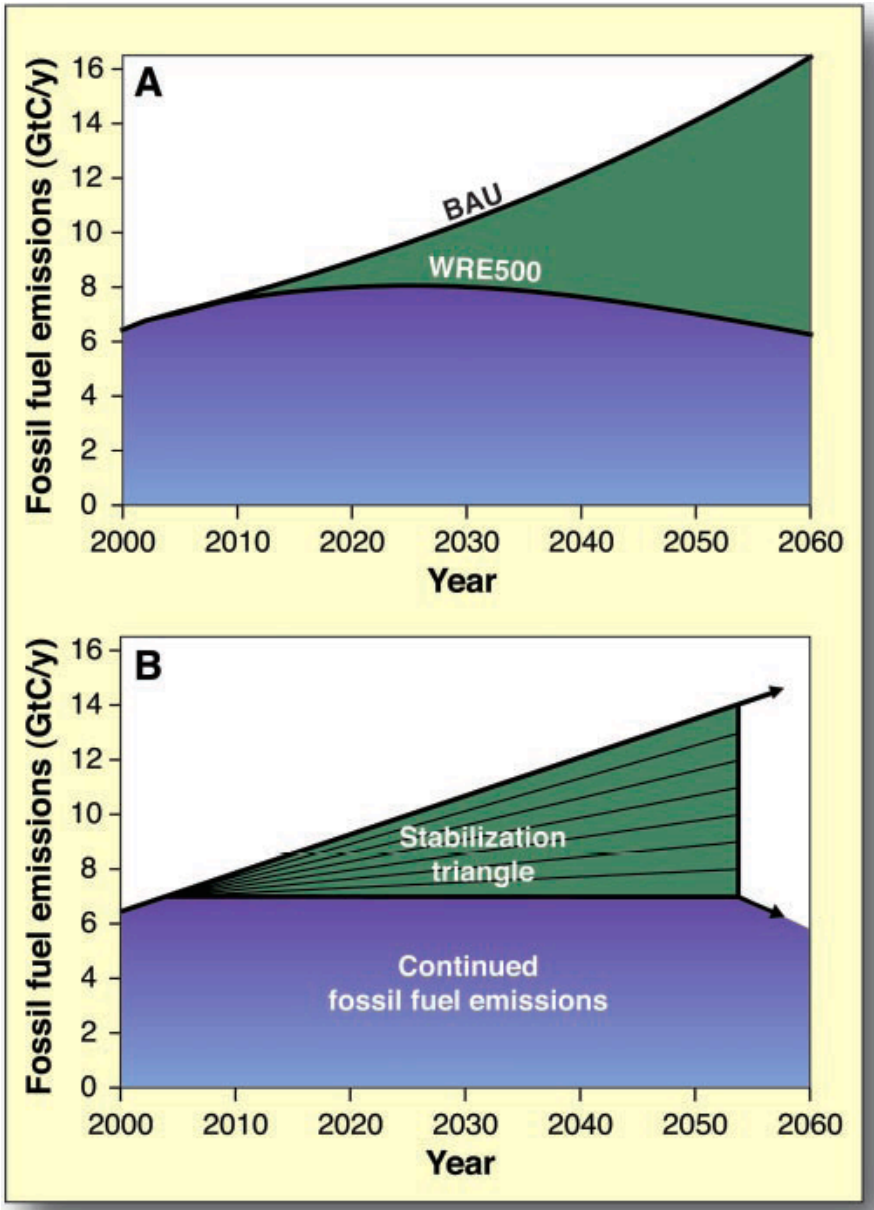


low cost US reactors

4

nuclear in the global portfolio

“Stabilization Wedges”



- Efficient Vehicles
- Eff. Buildings
- Eff baseload coal
- Repower coal w/gas
- CO2 capture
- Nuclear
- Biomass
- Wind
- PV
- And 6 more

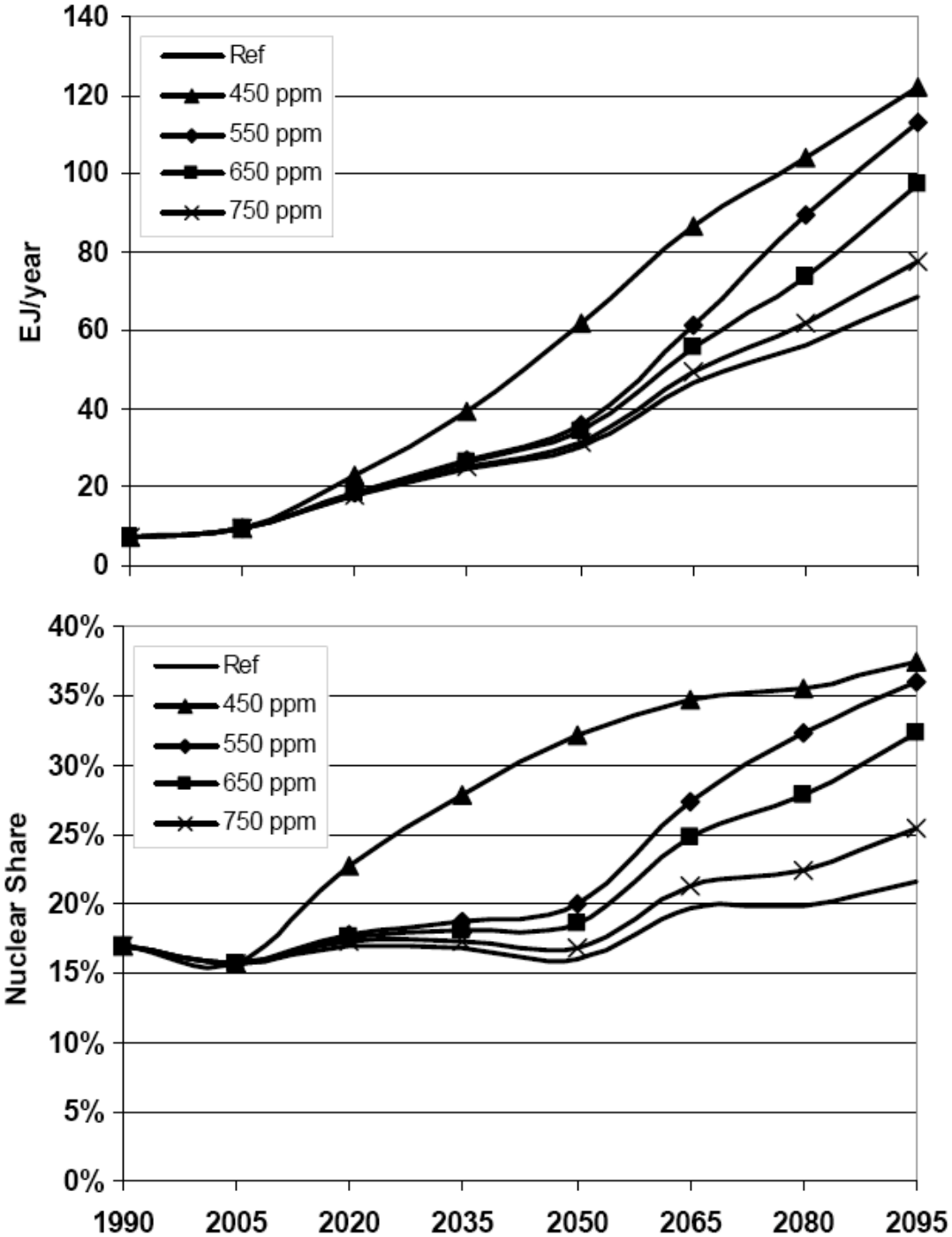
Pacala and Socolow 2004

A nuclear "Stabilization Wedge"

7 Gt reductions by 2050 divided into 1 Gt slices

- Minimum 700 GW producing 5400 TWh/y
- Tripling of capacity and output by 2050.
  - Replace all existing reactors
  - 1200 reactors over 50 years, ~ 25 / year
- Add several 1000's tPu
  - 1000 tPu, = all the world's spent fuel
  - 100 tPu = inventory in U.S. weapons.
- Uranium fuel supply
  - Not a major constraint
  - Does not *require* alternatives to once-through fuel cycle.

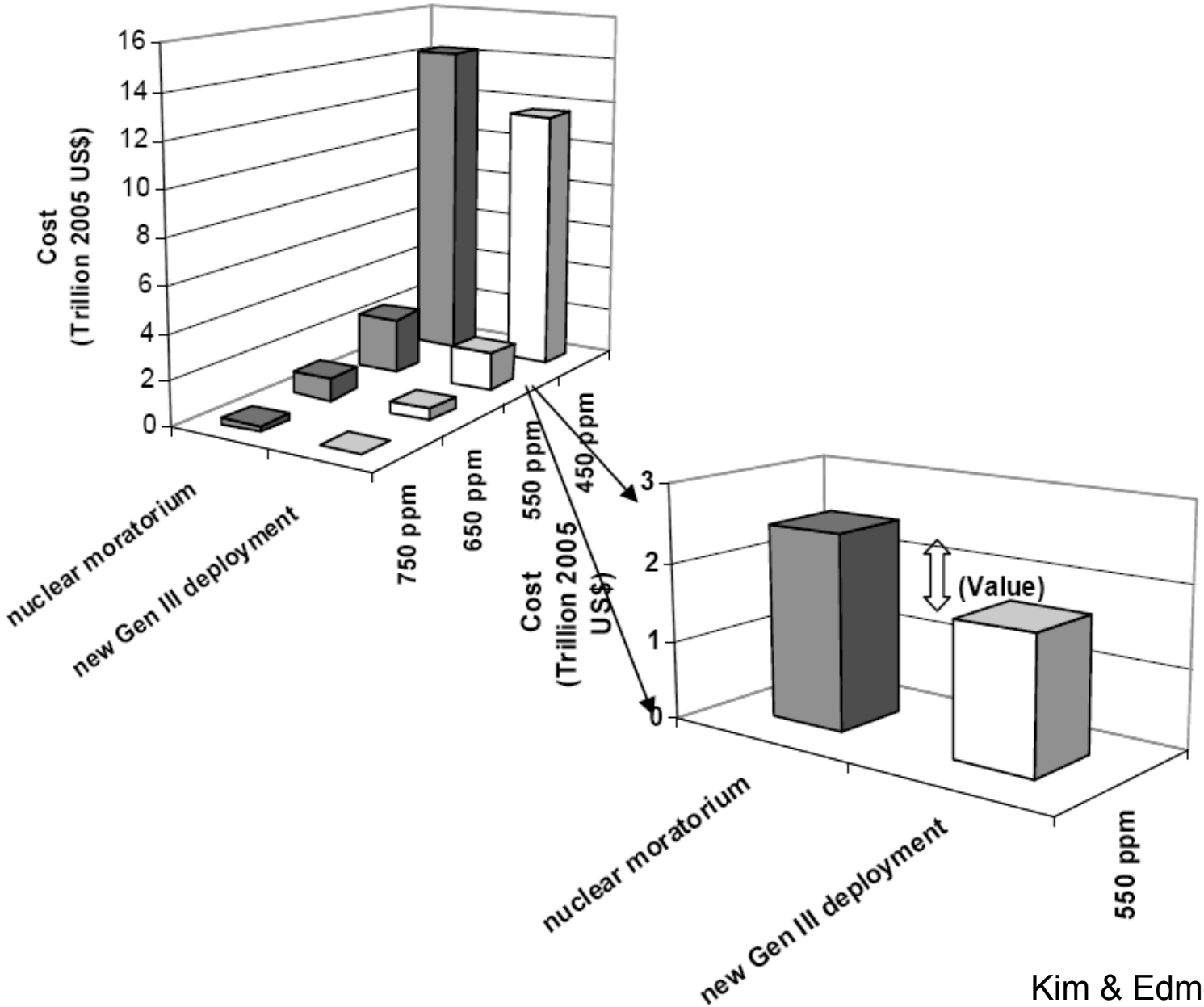
Pacala and Socolow 2004



Modeled Nuclear Generation

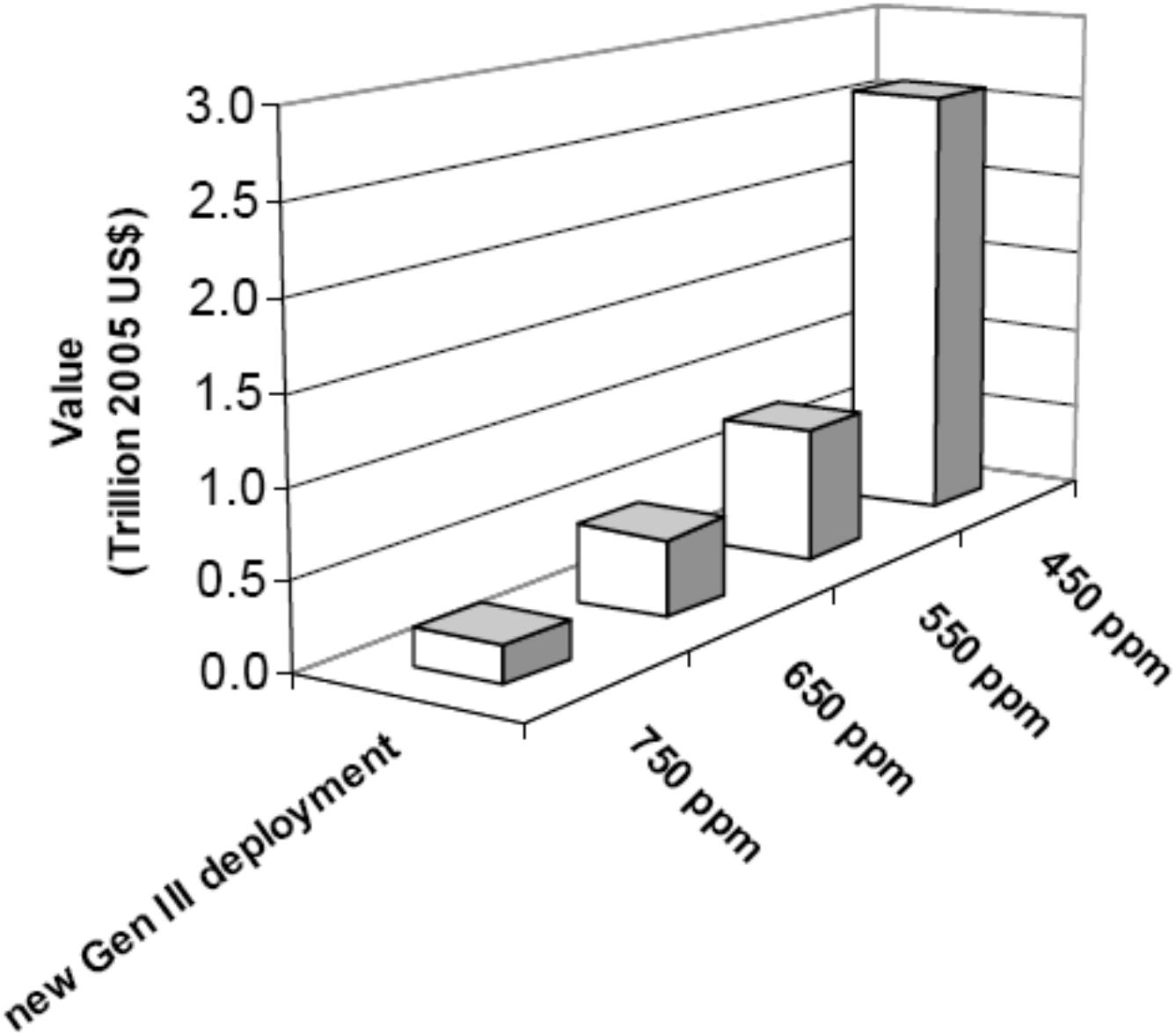
Kim & Edmonds 2007

Modeled value of nuclear



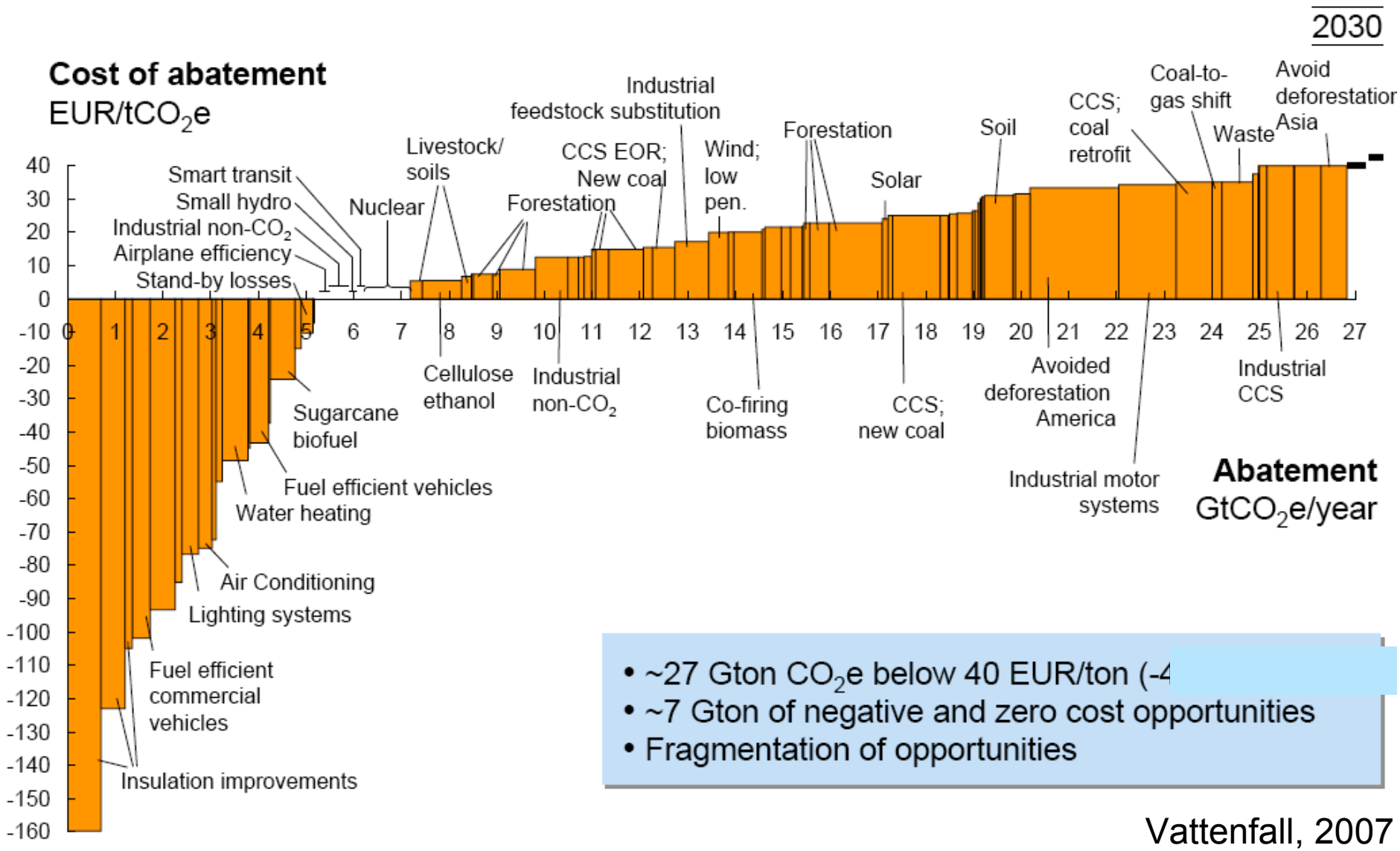
Kim & Edmonds 2007

Value of nuclear for different stabilization targets



Kim & Edmonds 2007

Global CO_2 Abatement Opportunities



- ~27 Gton CO_2e below 40 EUR/ton (-4
- ~7 Gton of negative and zero cost opportunities
- Fragmentation of opportunities

Vattenfall, 2007

The Nuclear Future

- Nuclear will not disappear
  - Large baseload model; coal now highly risky
  - Carbon prices favor low-carbon technologies
  - Remains enmeshed in national identity
- Nuclear faces major obstacles
  - Nuclear vs. other low-carbon energy
  - Nontrivial possibility of high cost surprise
  - Social risks still present
  - Waste disposal & Decommissioning
  - Proliferation still a concern
  - Climate change risks to nuclear: Unstudied

Can nuclear technology meet climate policy challenges?

- By itself
  - **absolutely not — not even close!**
- Will be a useful option in a portfolio of cost-competitive low-carbon technologies
  - Efficiency
  - Wind, solar, other renewables
  - Biofuels
  - Plug-in Hybrids

References

Kim, S. and Edmonds, J. (2007) "**The Challenges and Potential of Nuclear Energy for Addressing Climate Change**" JGCRI/PNNL Working Paper, 39pp.

Hultman, N.E., J.G. Koomey, and D.M. Kammen (2007). **"What history can teach us about the future costs of nuclear power."** *Environmental Science & Technology*, 41(7): 2088–2093.

Hultman, N.E. and J.G. Koomey **"The risk of surprise in energy technology costs."** *Environmental Research Letters* **2**(034002):1-6.

Koomey, J.G. and N.E. Hultman. **"A Reactor-level analysis of busbar costs for U.S. nuclear plants, 1970-2005."** Forthcoming in *Energy Policy.*

MIT and University of Chicago Studies on the Future Costs of Nuclear Power