ENERGY TECHNOLOGY R&D PORTFOLIO

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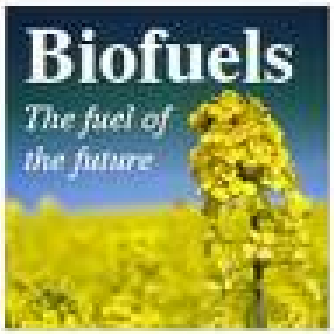
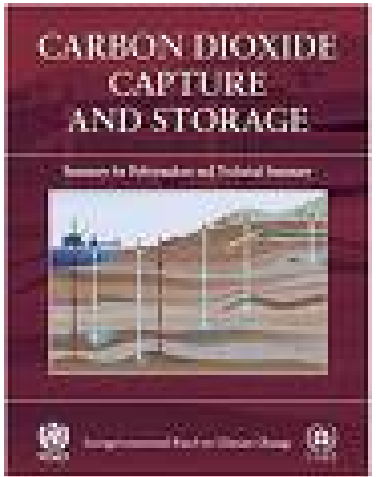
PATHWAYS TO CLIMATE SOLUTIONS: ASSESSING ENERGY TECHNOLOGY AND POLICY INNOVATION

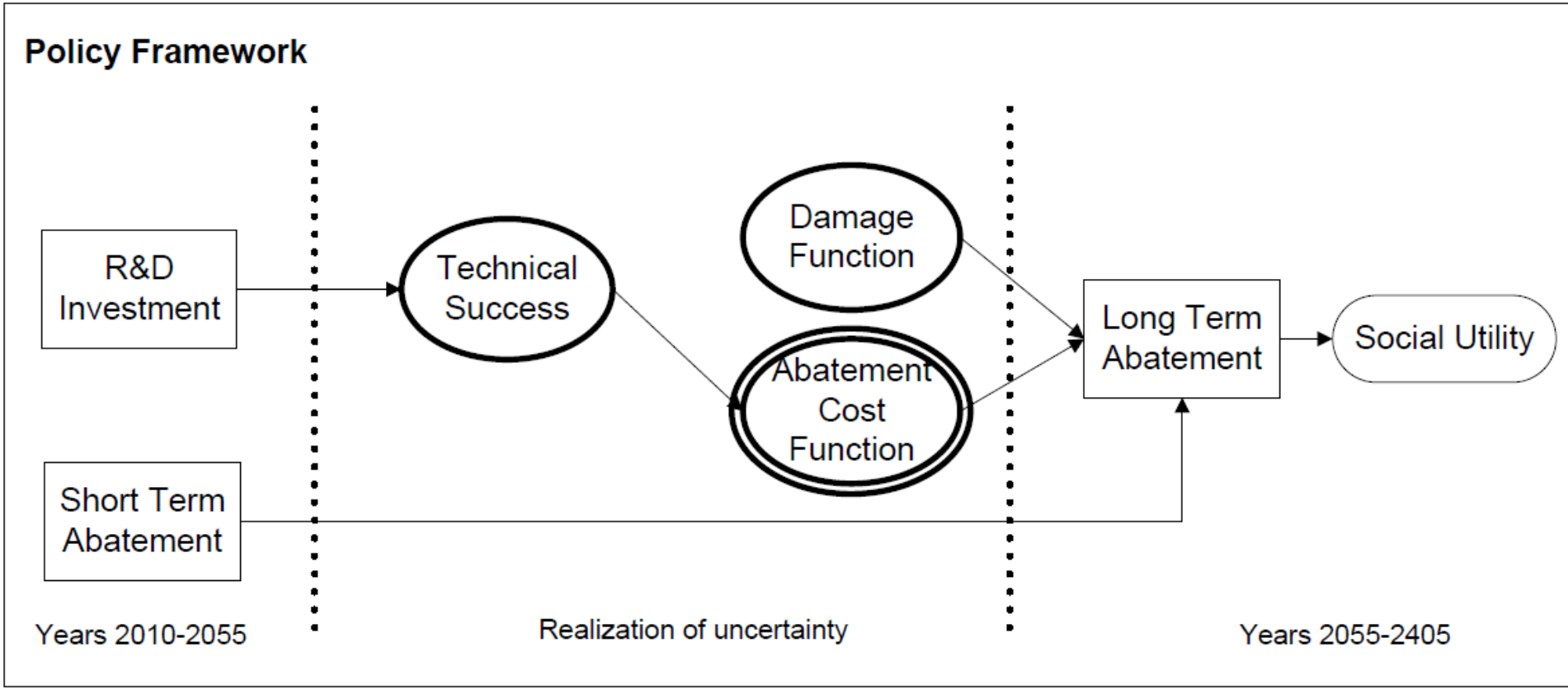
Aspen, CO, February 27, 2014

Tying it all together: Choosing an energy technology R&D portfolio.

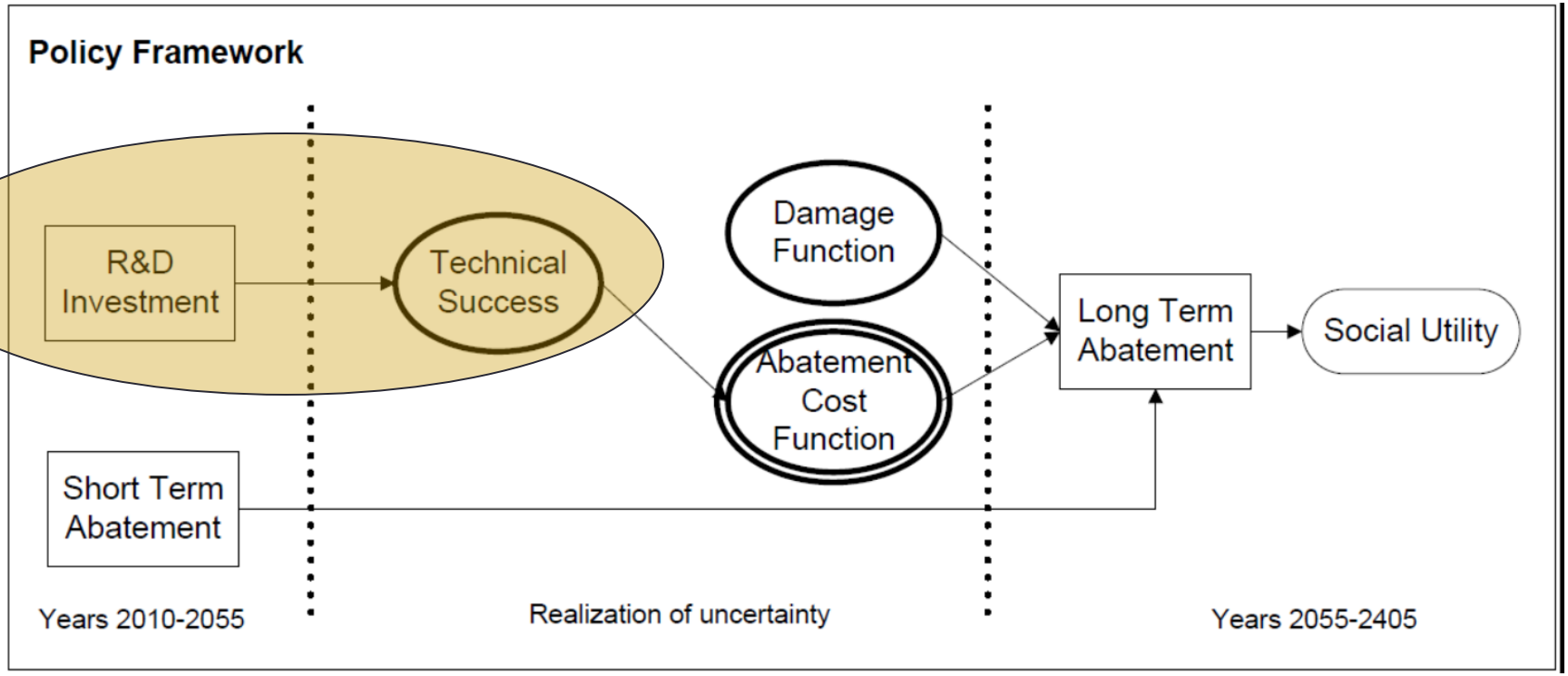




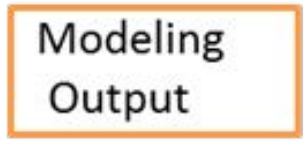
Paradigm: Act – Learn – Act

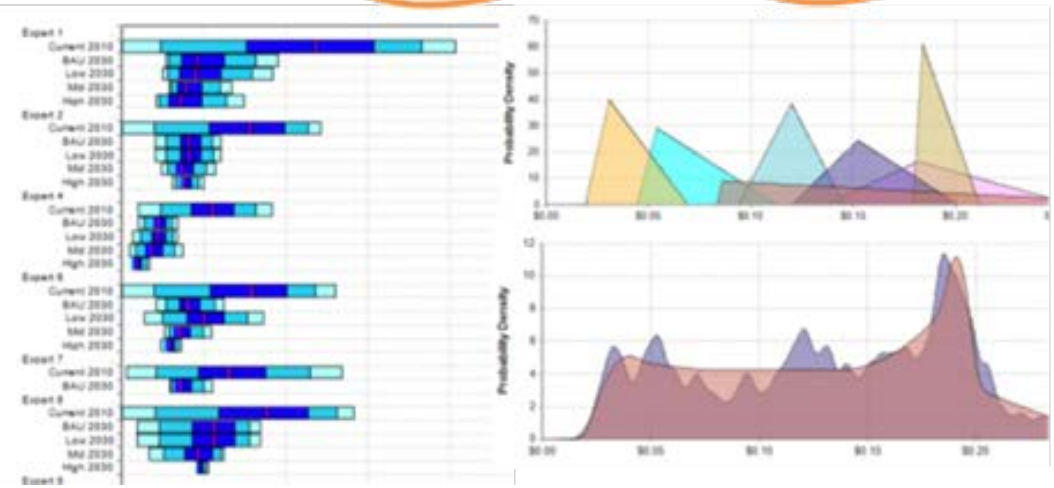


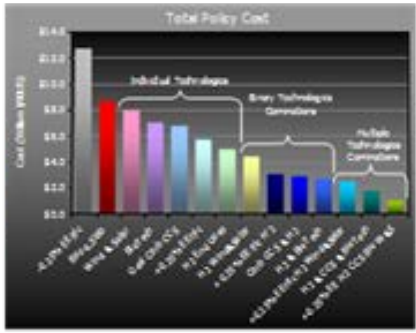
Today's talk: how R&D influences probability over technical success; and optimal portfolios



TEaM: The Elicitation and Modeling Project



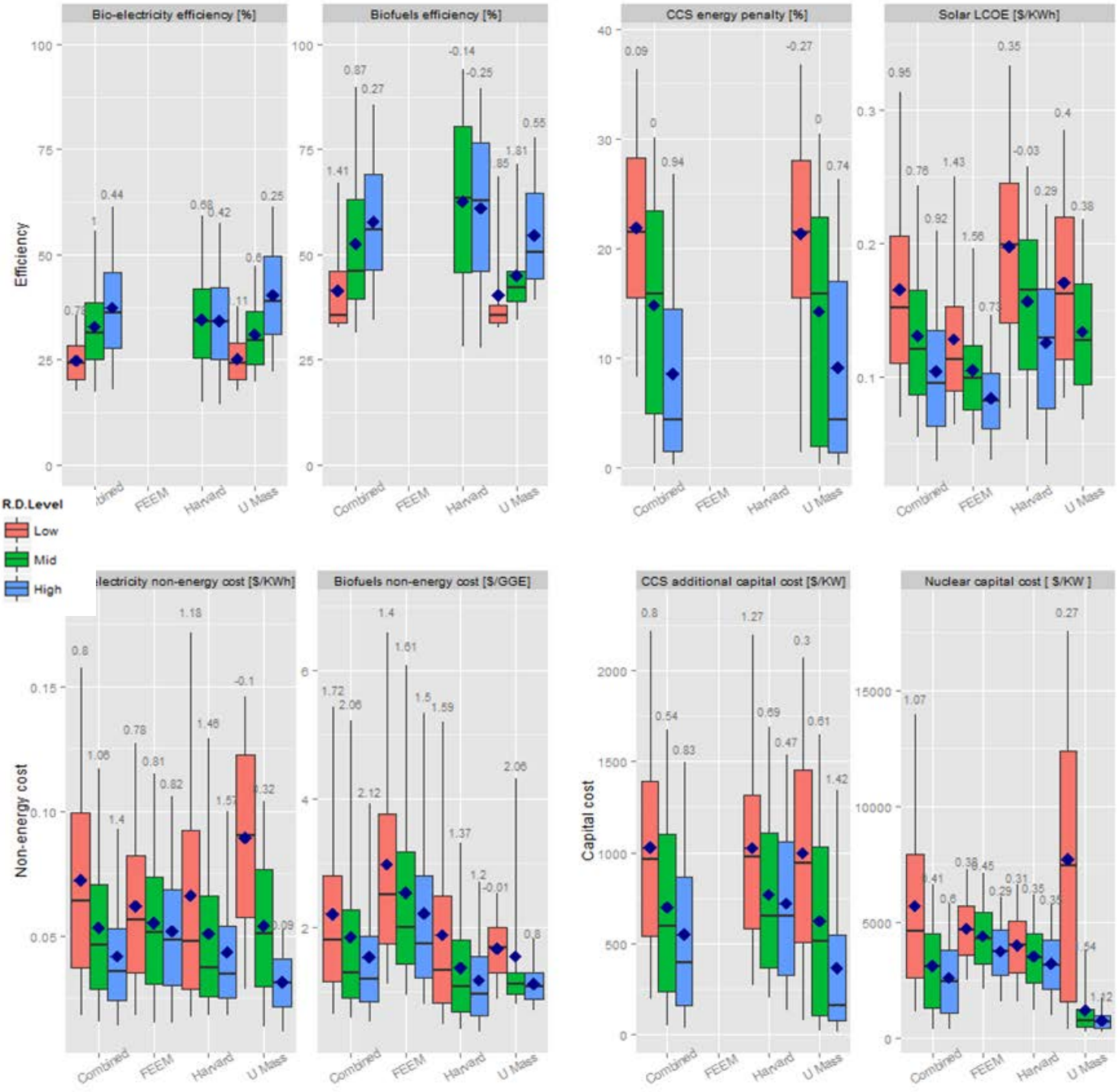




Value of technology investments

Erin Baker, Umass Amherst;; Valentina Bosetti, FEEM; Laura Diaz Anadon, Harvard; Max Henrion, Lumina. With senior researchers from Stanford, Wisconsin, MIT, PNNL, BNL

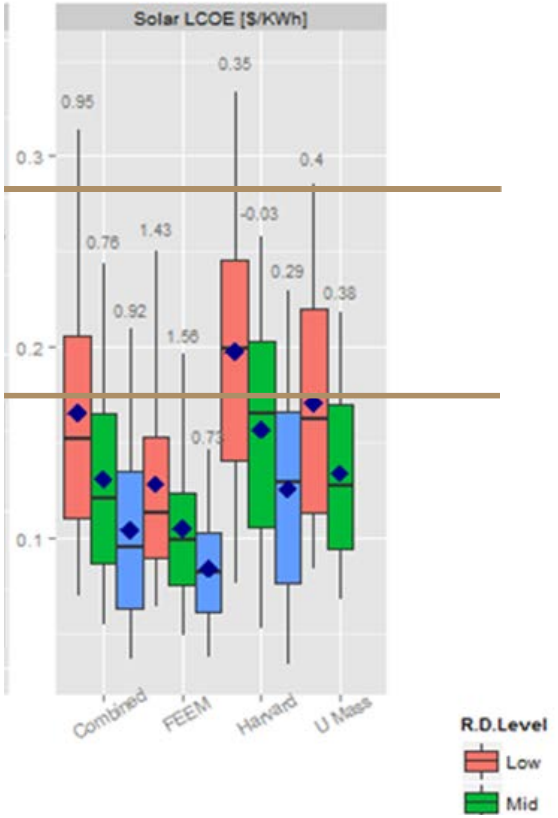
Harmonized TEaM Results



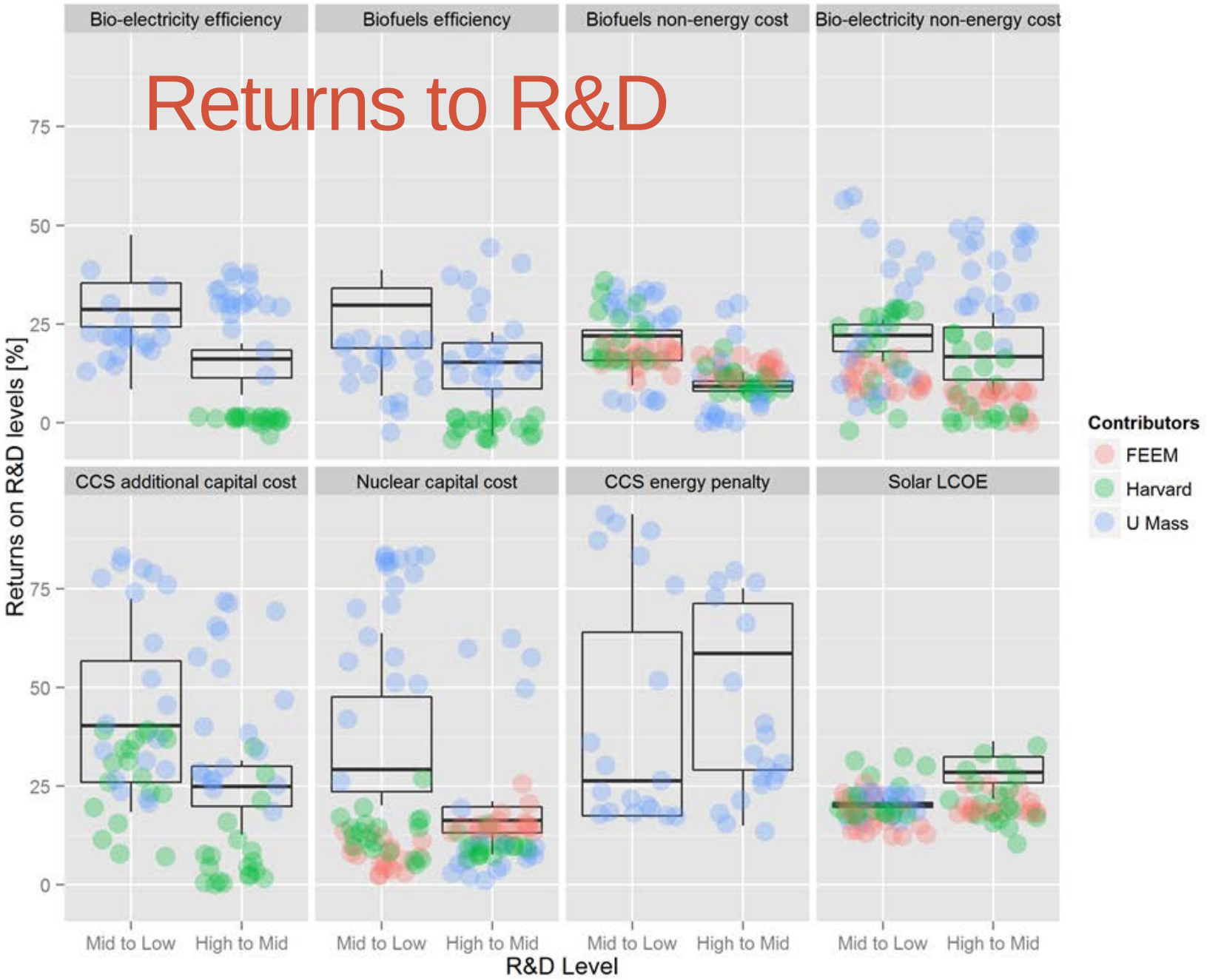
UMass	Low	Mid	High
Solar	25	140	NA
Nuclear	40	480	1980
CCS	13	48	108
Biofuels	13	201	838
Bio electricity	15	50	150
CCS Umass 2	0	750	NA
Harvard			
Solar	143	409.1	4091
Nuclear	466	1883	18833
CCS	701	2250	22500
Biofuels	214	585	5850
Bio electricity	214	585	5850
FEEM			
Solar	163	244	326
Nuclear	942	1883	18833
CCS	NA	NA	NA
Bio fuels	160	240	320
Bio electricity	161	242	322
Funding Levels $M/yr			

The Solar LCOE was harmonized using a capacity factor of 12%

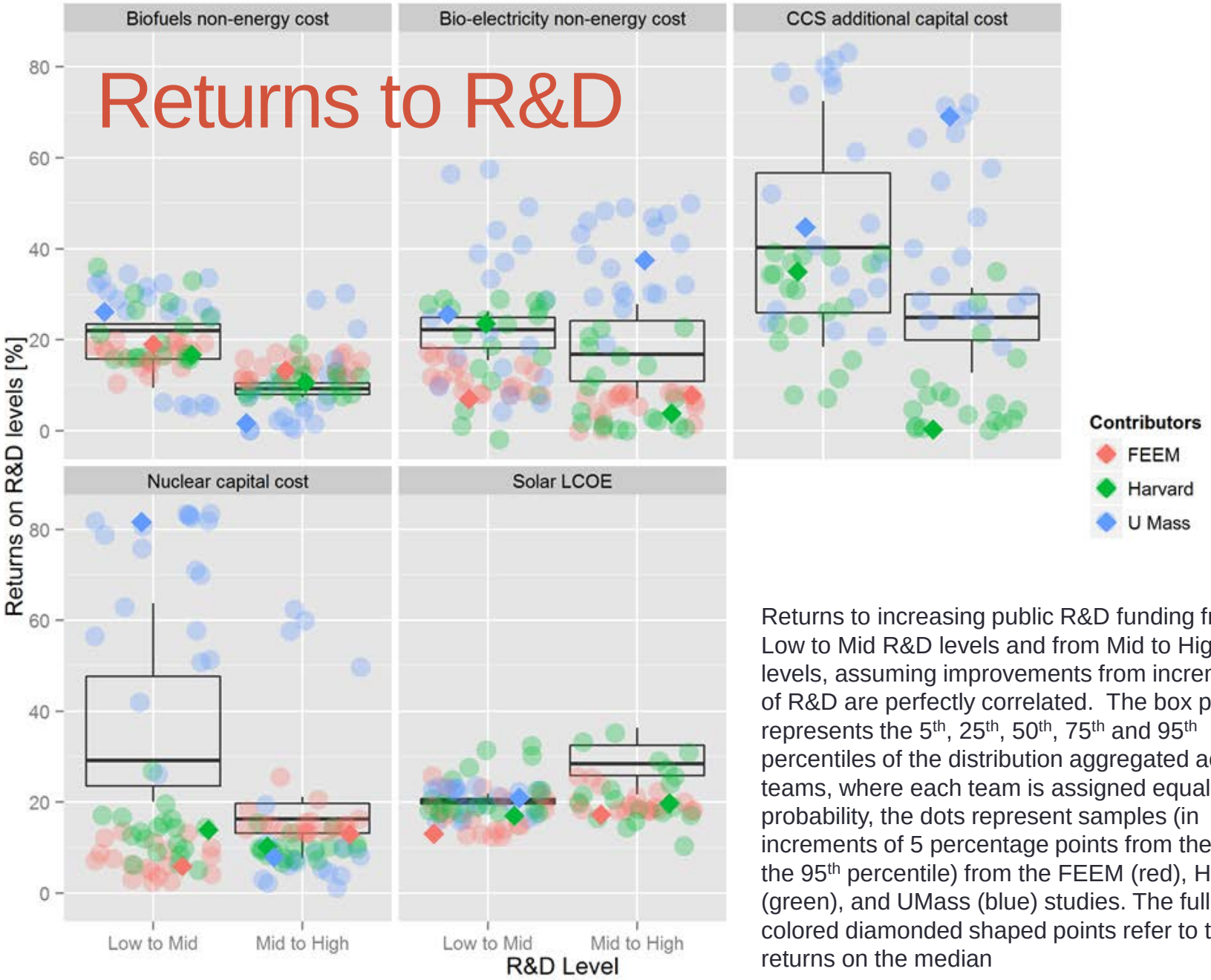
Reference	Module cost 2050 ($/Wp)	Module cost 2025 ($/Wp)	Module cost 2014 ($/Wp)	BOS ($/Wp)	lifetime	LCOE TEaM
China			0.75	0.73	20	$0.17
China			0.75	1.67	20	$0.28
UMass, medium	0.35	0.51		0.73	30	$0.13
UMass, aggressive	0.17	0.25		0.35	15	$0.08



Returns to R&D



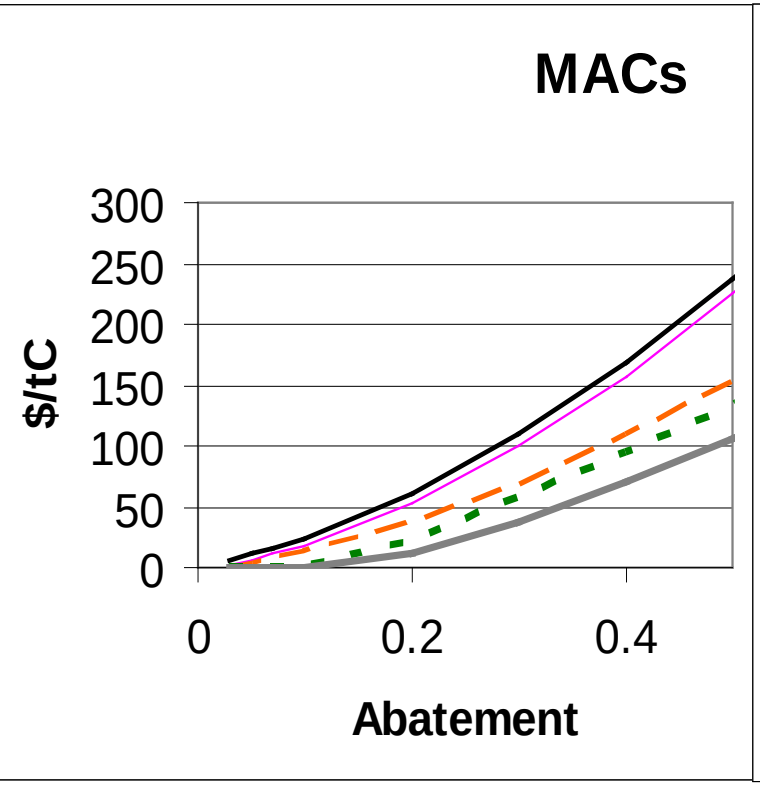
Returns to R&D

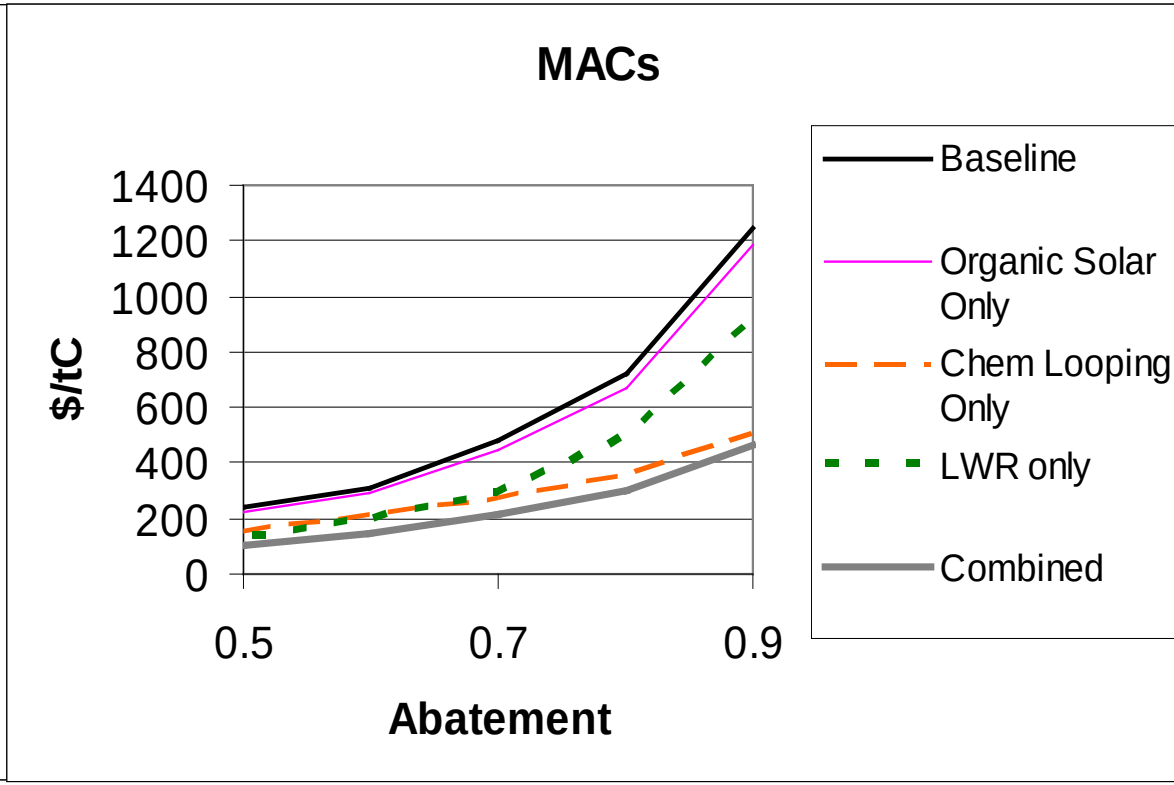


Returns to increasing public R&D funding from Low to Mid R&D levels and from Mid to High R&D levels, assuming improvements from increments of R&D are perfectly correlated. The box plot represents the 5th, 25th, 50th, 75th and 95th percentiles of the distribution aggregated across teams, where each team is assigned equal probability, the dots represent samples (in increments of 5 percentage points from the 5th to the 95th percentile) from the FEEM (red), Harvard (green), and UMass (blue) studies. The full colored diamonded shaped points refer to the returns on the median

Impact of technology on the MAC

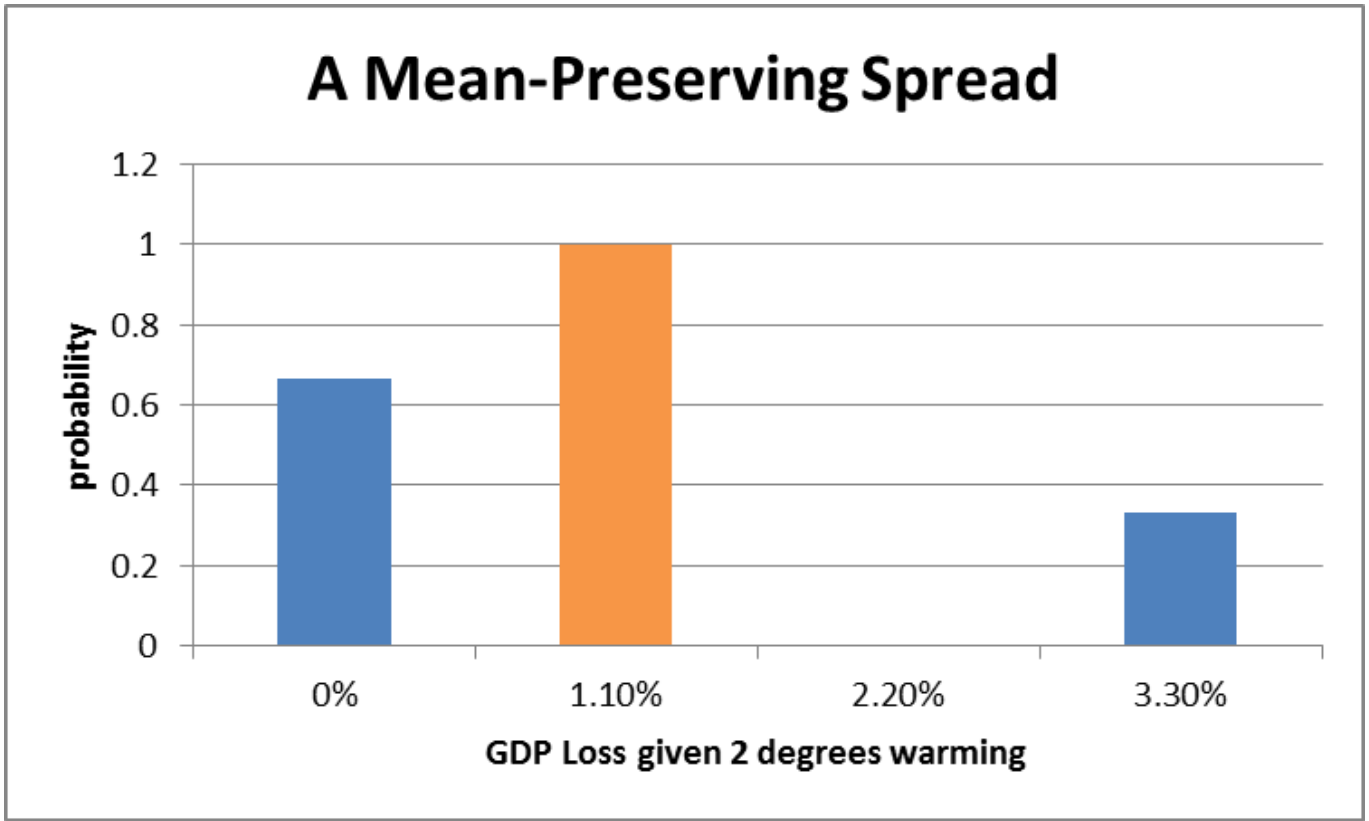
- GCAM, MAC in 2050



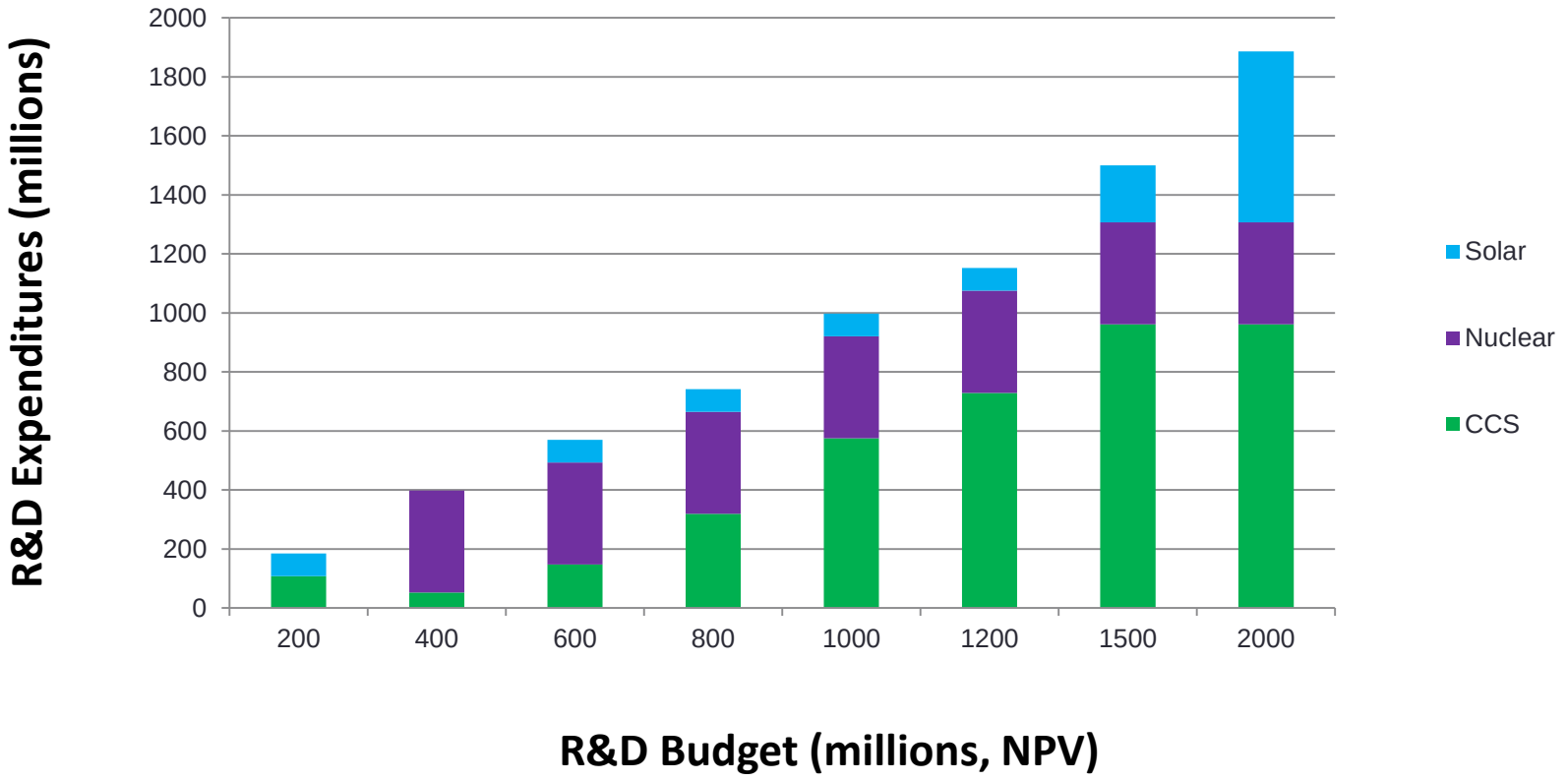


Different representations of climate risk

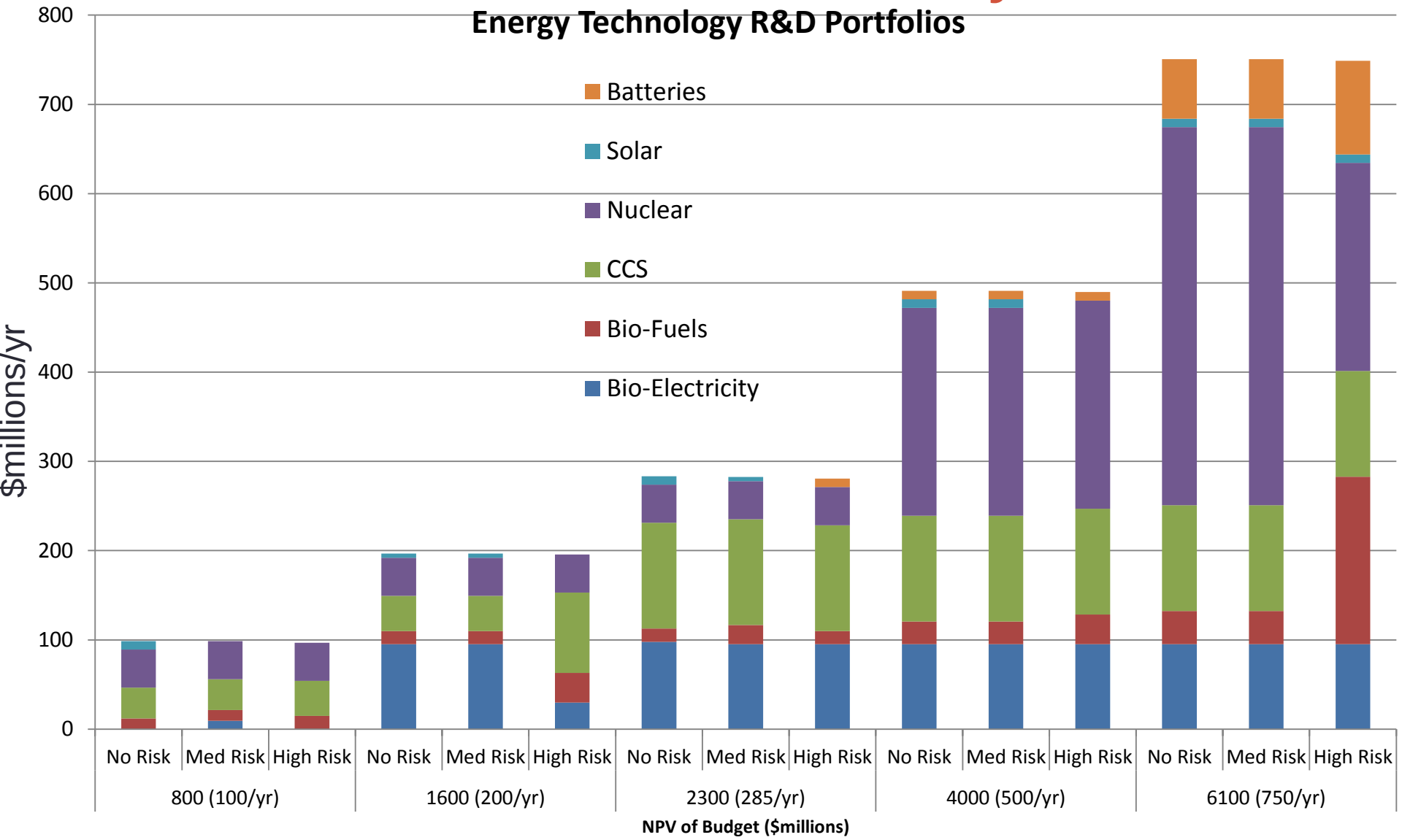
	No risk (1)	Medium risk (2)		High risk (3)		Very high risk (4)		Intermediate (5)		
Probability	1.000	0.667	0.333	0.945	0.055	0.973	0.028	0.309	0.673	0.018
GDP Loss	1.1%	0.0%	3.3%	0.0%	20.0%	0.0%	40.0%	0.0%	1.1%	20.0%
π	0.003	0.000	0.009	0.000	0.063	0.000	0.167	0.000	0.003	0.063



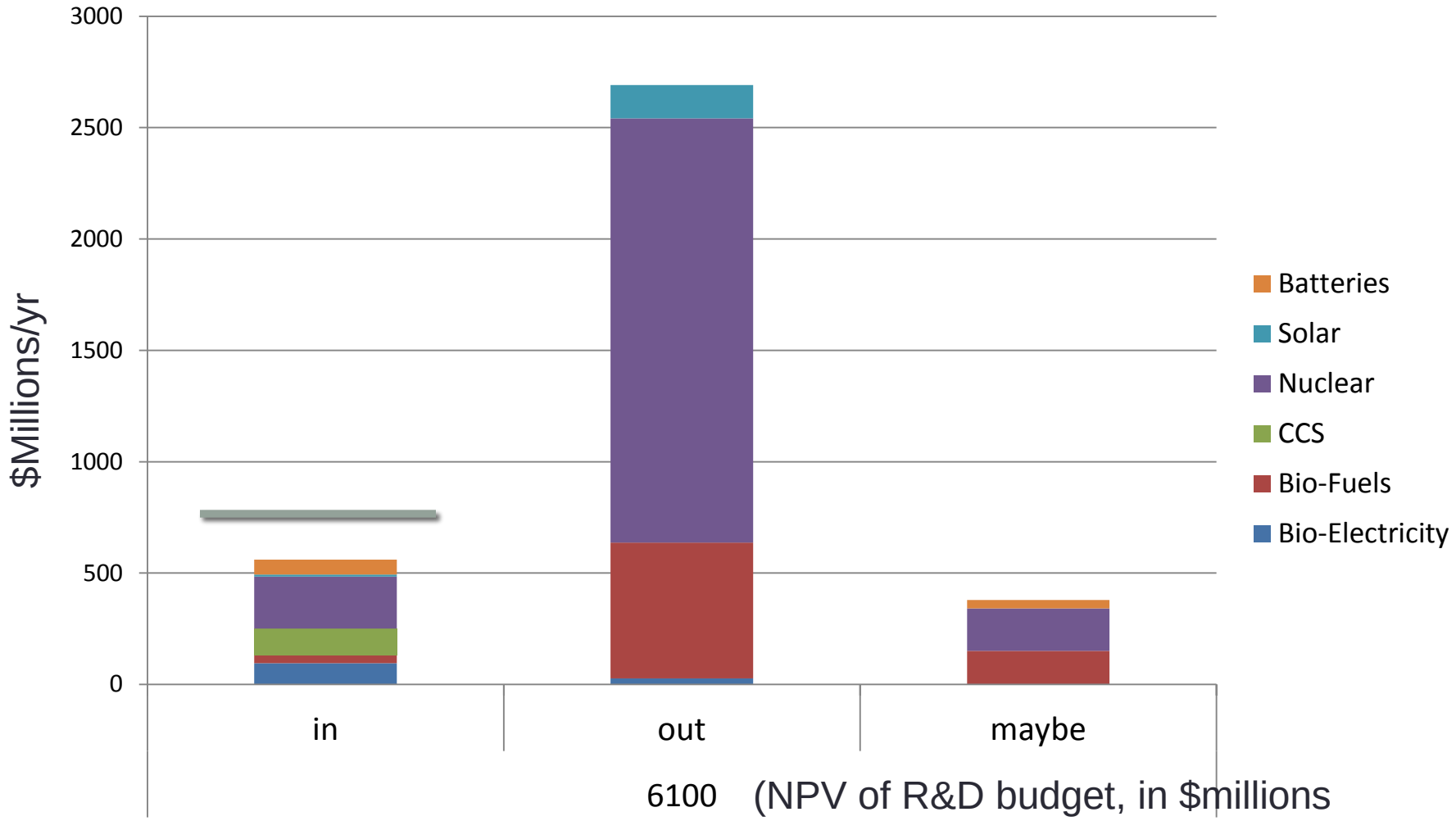
In initial work, we found that the composition of the optimal portfolio did not change with damage risk.



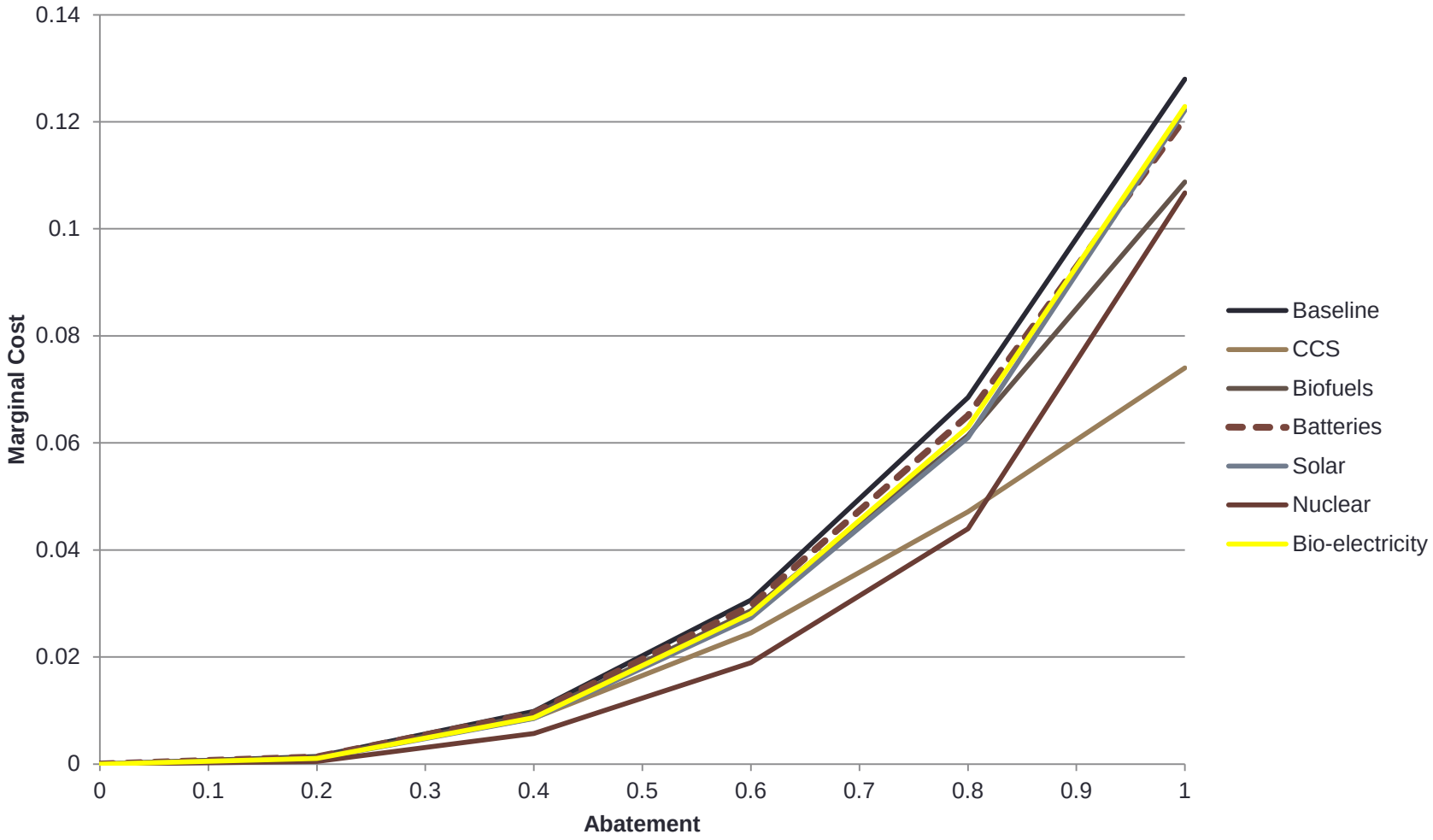
CCS, batteries, and biofuels increase in risk; nuclear, solar, bio-electricity decrease



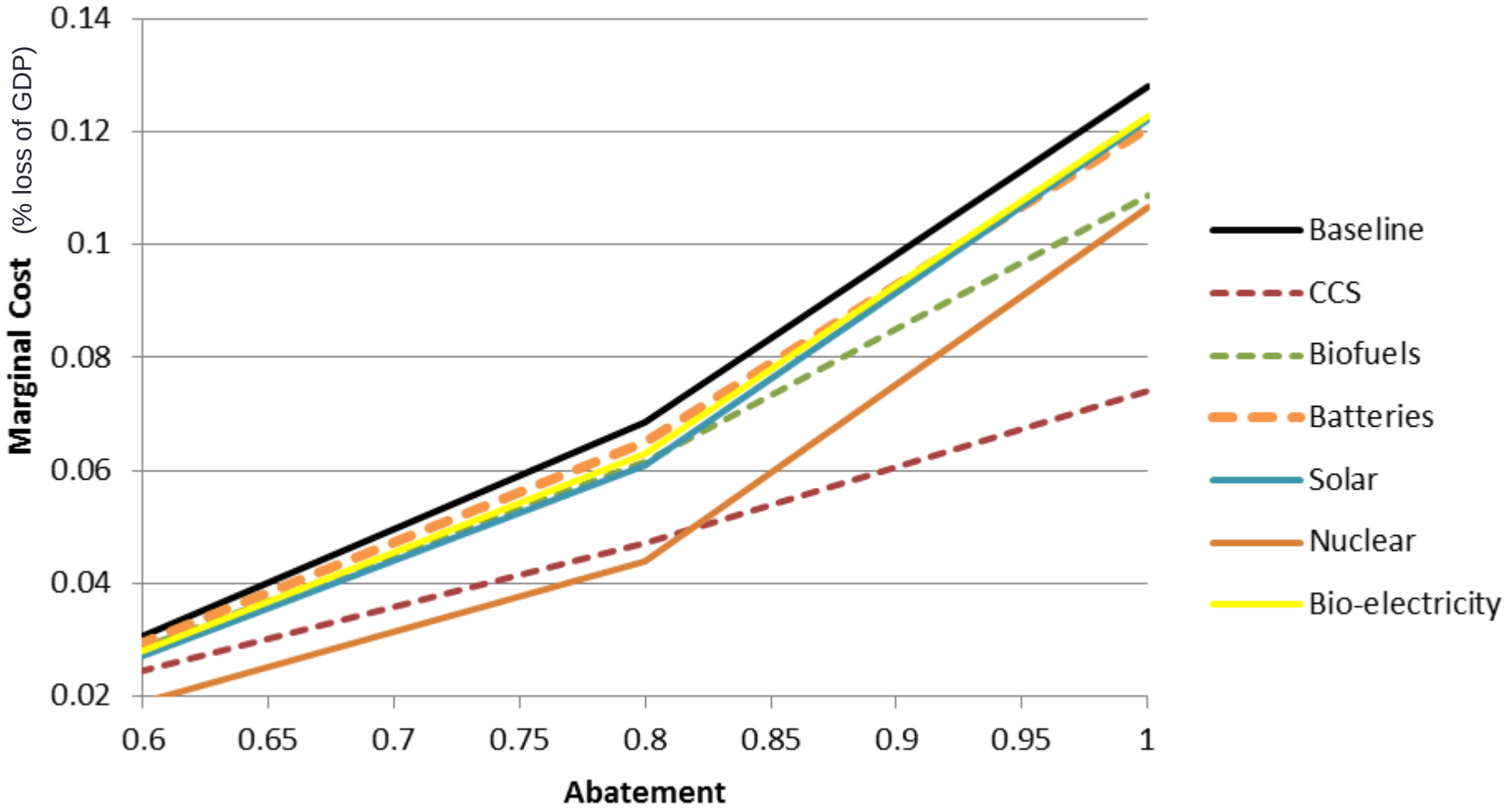
Robust Portfolio Analysis



The response to risk depends on the shape of the MAC



Technologies that pivot down are better in high risk

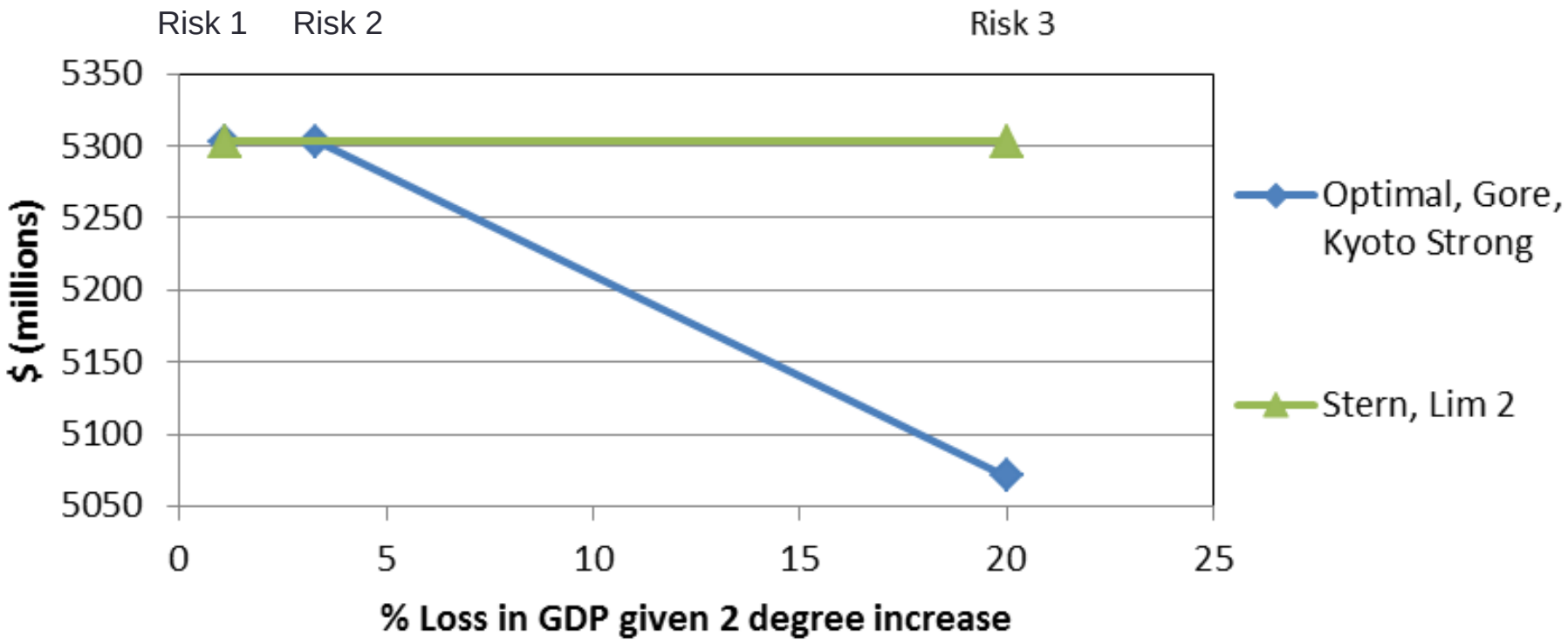


Experiments

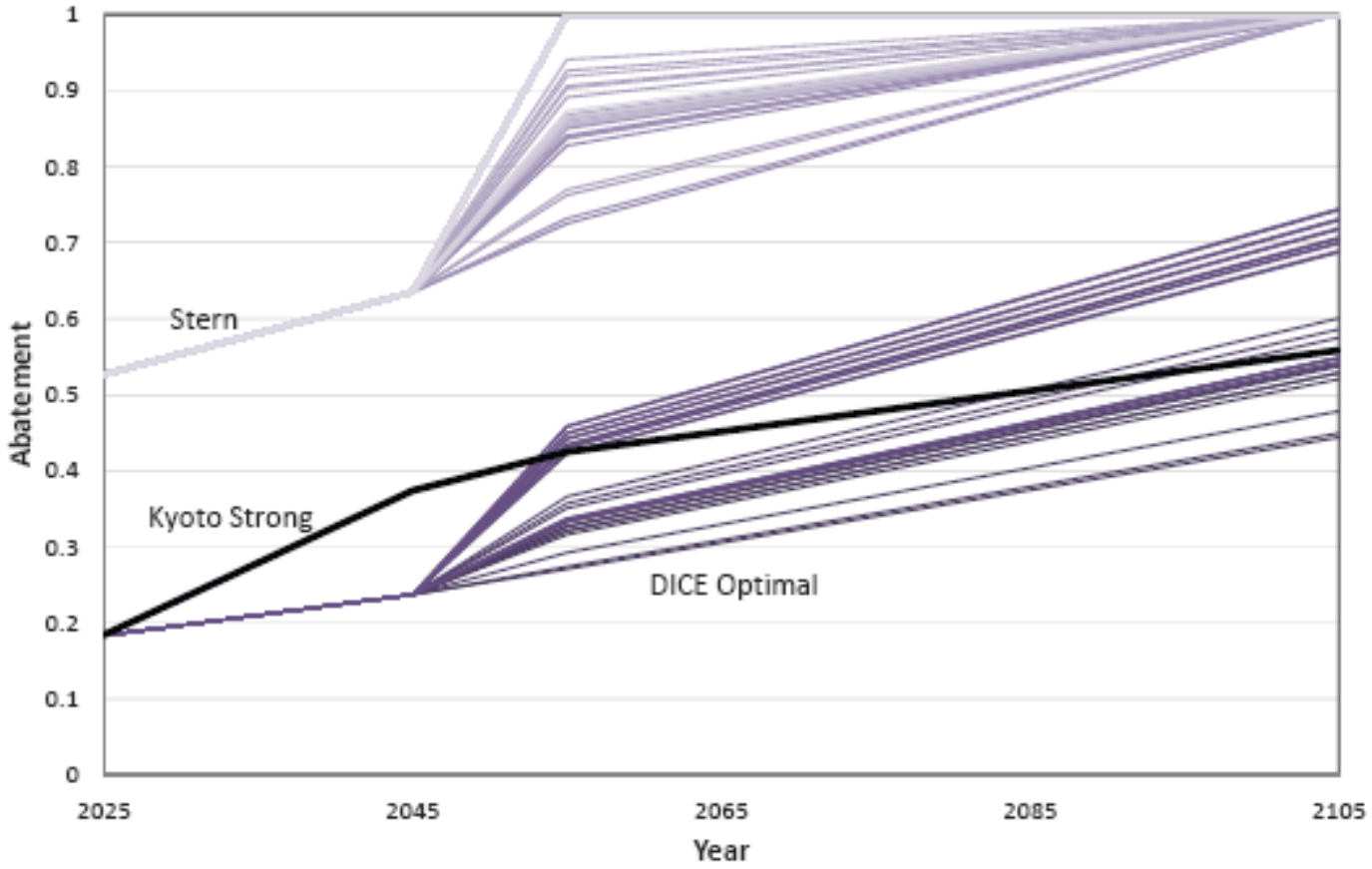
Focus on comparing different policy environments

Policy	Abatement	Key characteristics
Baseline no-controls	0	
DICE Optimal	optimal	
Stern	optimal	Abatement chosen under low interest rate
Stern Fixed	optimal	Abatement and R&D chosen under low interest rate
Gore	Lower bound between 0.25 - 0.95	Limited participation
Kyoto Strong	fixed for 150 years	Limited participation
2 degrees	optimal	Upper bound on temperature

Optimal R&D Investment is robust

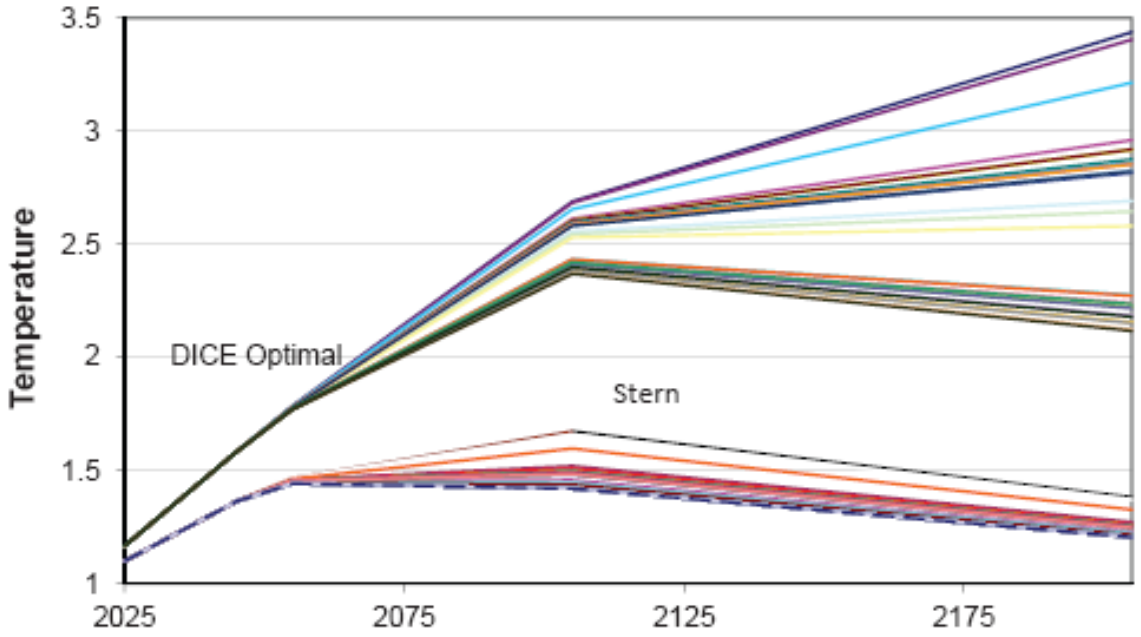


Abatement path depends on technology (and damages).

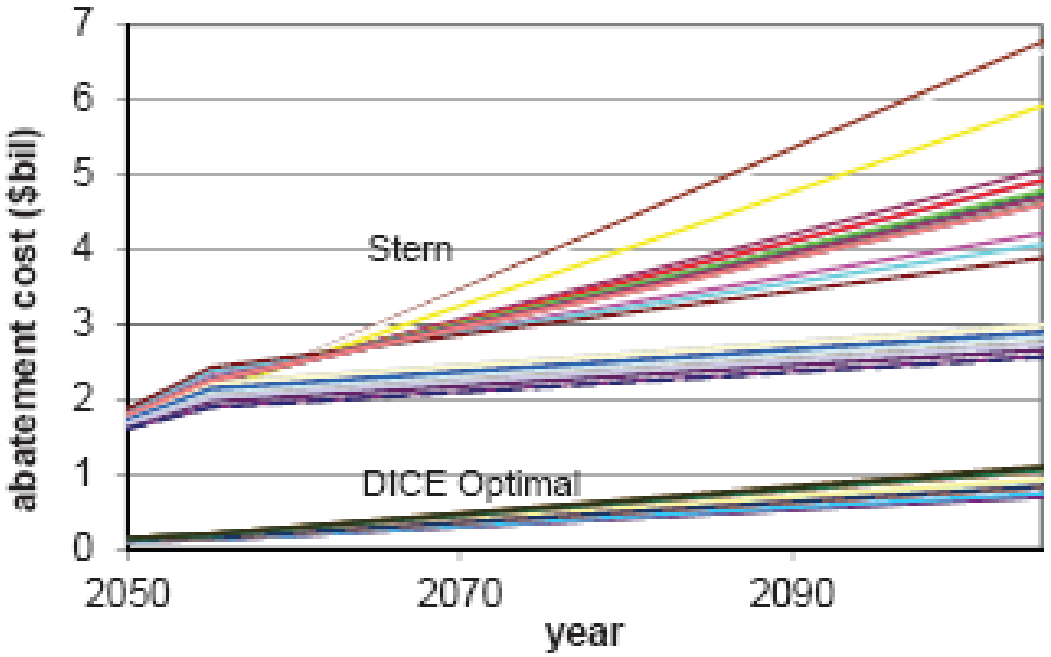


R&D has different impacts in the different policy environments

Temperature Paths



Abatement Cost Paths



Policy Implications

- Expert studies show disagreement about which technologies are most promising – indicating that a broad portfolio might make sense.
  - We need to look at how the technologies impact the cost of addressing climate change.
  - We will compare different elicitation teams, different models, and different decision frameworks
- Optimal R&D investment is fairly robust to risk, policy, opportunity costs.
  - Technologies that do relatively well at very high abatement levels, do better as risk increases.
- The role of R&D is important but different in different policy environments and risk cases
  - If abatement is high, it mostly effects costs
  - If abatement is low, it mostly effects environmental variables.

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