Symposium - Plan B: Engineering a Cooler Earth
Saturday, December 9, 2017
Hameetman Auditorium - California Institute of Technology, Pasadena, CA 91125

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Geoengineering: Some Limited Lessons from Energy Policy and Finance

For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled.

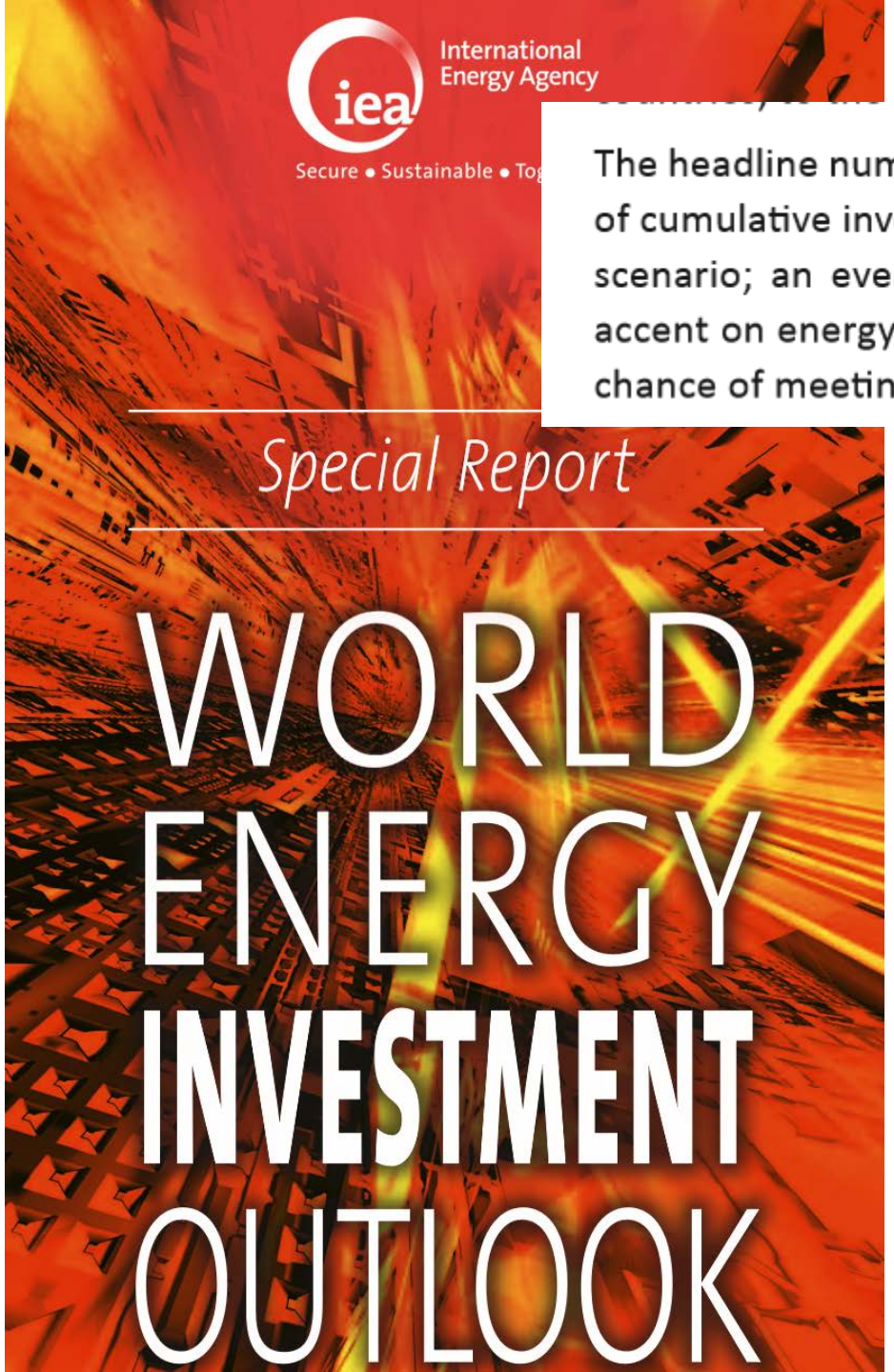
-- Richard Feynman

SRM – Some remarkably low cost projections

"Climate models have consistently shown that albedo modification, when used in moderation and combined with emissions cuts, has the potential to reduce climate changes around the globe. It could stop rising temperatures and keep the world below the 1.5° Celsius target agreed upon at the Paris climate talks — a goal that is extremely unlikely to be achieved by emissions cuts alone.

Albedo modification could also curb the rise in peak temperatures, which cause dangerous heat waves, and reduce extreme rainfall that often leads to flooding. Early evidence suggests it may even have the potential to slow sea-level rise, which threatens many coastal areas. **Furthermore, albedo modification could achieve all of these results relatively rapidly (within years to decades) and inexpensively (with some estimates ranging from $1 to $10 billion per year).**" Keith Group (*emph added*)
https://keith.seas.harvard.edu/geoengineering#benefitsandrisks

"Spending **just $9 billion** on 1,900 seawater-spraying boats could prevent all the global warming set to occur this century." Bjorn Lomborg (*emph added*)



The headline numbers revealed by this analysis are almost too large to register: $48 trillion of cumulative investment in energy supply and efficiency are required by 2035 in our main scenario; an even higher sum, $53 trillion, with a different composition and a greater accent on energy efficiency, is needed to move us onto an alternative path that gives us a chance of meeting the 2 °C climate change target.

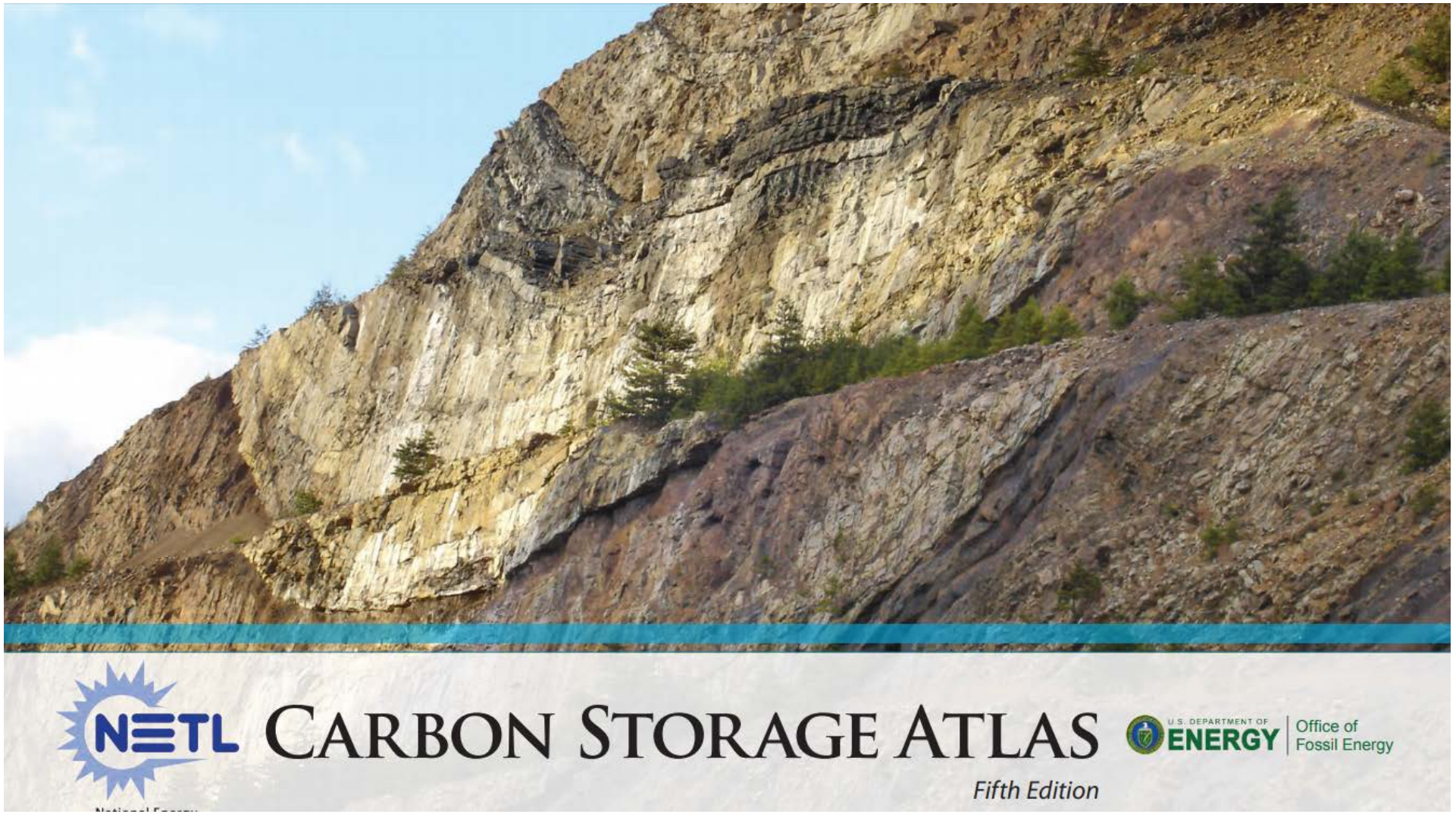
SRM projected costs pale in comparison to decarbonization cost projections. So financing would be the most trivial of the issues surrounding SRM

Big spending gap towards decarbonization

IEA's Annual Spending on Clean Energy 2016-2040 by Category ($ billions/yr)				
Category of Spending	**2010-2015 Average**	**"450 Scenario" 2016-2040**	**Multiple 450 vs. Today (x)**	**Dollar Change vs. Today**
Renewables	$282	$503	1.8x	$220
Electricity Networks	229	288	1.3x	59
Other Low CO_2 (CCS, Nuclear, Etc.)	13	114	8.8x	101
Energy Efficiency	221	1,402	6.3x	1,181
Totals:	$746	$2.3T	≈3x Current Spending	$1,561

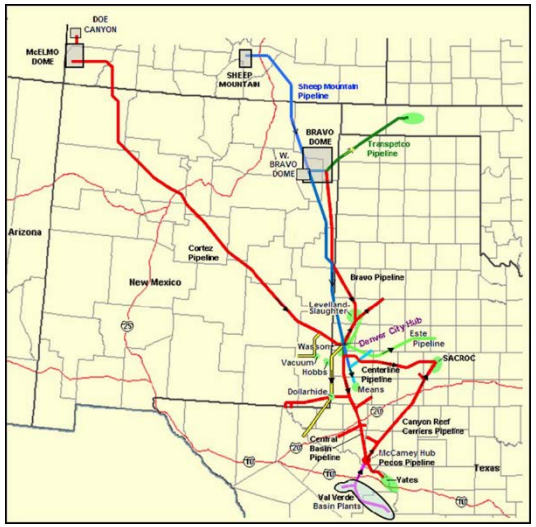
By contrast, a massive scale up of CDR would present many financing issues

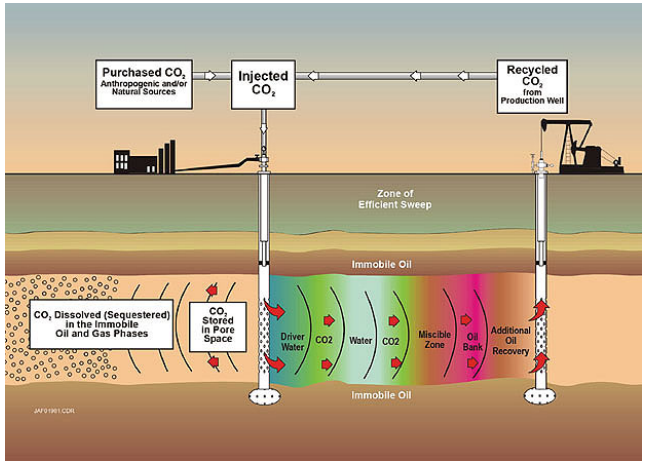
What to do with the CO2? Geologic sinks?



New types of CO2 utilization?

Opus 12





EOR?

- **CO_2 would enable the production of hundreds of billions of barrels of low-cost oil from old, low-risk, easily-accessible and fully-characterized fields while sequestering CO_2***
- **Not, of course getting us to decarbonization, but does present a big dynamic regarding the economics of the CO_2**

- * Estimates range up to 1.3 trillion barrels of oil production (increment attributable to CO_2 EOR) and requiring the sequestration of 370 gigatonnes of CO_2 (American Chemical Society, 2013; Kuuskraa, et. al. 2013)

Policy shifts required for CDR scale up

- General policy shift
- Economics (CO2 pricing, mandates, etc.)
- Specific project approvals

CO2 pricing is all over the map

$13.80/MT CARB Cap & Trade Auction

	Current 2017 Vintage		Advance 2020 Vintage	
	USD	CAD	USD	CAD
Auction Reserve Price	$13.57	$18.51	$13.57	$18.51
Settlement Price	$13.80	$18.82	$13.57	$18.51
Maximum Price	$50.70	$69.16	$16.86	$23.00
Minimum Price	$13.57	$18.51	$13.57	$18.51
Mean Price	$14.47	$19.74	$13.61	$18.57
Median Price	$14.01	$19.11	$13.60	$18.55
Median Allowance Price	$14.12	$19.26	$13.60	$18.55
Auction Exchange Rate (USD to CAD)				1.3641

Source: CARB

$1,020/MT in certain RPS scenarios

50% RPS	**Rooftop Solar Scenario**	**Relies in large part on distributed residential and commercial rooftop solar PV installations**	**$1,020 per MT**

Source: E3

Project approvals are not a given

San Bernardino County rejects a controversial solar power plant proposed for the Mojave Desert

A desert bighorn sheep at the base of Soda Mountain near the Mojave National Preserve. (Don Bartletti / Los Angeles Times)

Values Matter

We have this terrible struggle to try to explain things to people who have no reason to want to know.

-- Richard Feynman