CLIMATE POLICY FACT SHEET

To: Senator Kirsten Gillibrand
From: Legislative Assistant to the Senator
Subject: Alternative Options for Reducing Climate Risk
Date: April 9th, 2019

Beyond emissions reduction: alternative options for reducing climate risk

ADAPTATION

All climate policy must consider **adaptation** as a means of reducing climate risk, in part because the planet can no longer avoid all of the effects of climate destabilization. For example, farmers may plan to plant crops that thrive in marginally warmer climates than their current, while also planting a wider variety of crops that can together withstand significant interannual weather variations.[1] In this case, governments may choose to subsidize the adaptive choices of farmers—which would justly support them as victims of climate change—while tethering subsidies to crops that are more advantageous for the public good. Governments should also conduct research and educate private firms on climate challenges in their sector. Indeed, there are significant fiscal gains to be reaped from investments in adaptation:

Country	Sector	Net impact w/o adaptation	Net impact w adaptation
U.S.	Agriculture	-\$8 to -\$18 bn	+\$3 to -\$11bn
U.S.	Coasts	-\$6 to -\$12 bn	-\$0.1 to -\$0.6 bn
India	Agriculture	-\$3 to -\$4 bn	-\$1.4 to -\$2.4 bn

Source: R. Mendelsohn (2000), "Efficient Adaptation to Climate Change," *Climatic Change* 45: 583-600; citing various studies.

Figure 1: Fiscal Impact of investments in adaptation

Beyond stabilizing private markets, governments should also guarantee a base level of adaptive potential for their citizens. As the number of extreme hot weather days continues to rise, it is crucial to ensure that households across the socioeconomic spectrum are able to afford and access cooling systems–the lack of which will prove increasingly fatal.[2] Yet, as governments undergo the complex calculus of climate policy, it is necessary to understand that *investments in adaptation are by no means substitutes for abatement initiatives*. Both strategies are crucial elements of any sound climate policy initiative.

LAND USE

Averted deforestation can have an immediate and significant impact on emissions, as deforestation is estimated to be the second largest source of GHG emissions globally.[3]

Table 2. Average annual ha deforested and carbon emitted as a result between 2005 and 2030

	Million ha·yr⁻¹ (Gt CO₂·yr⁻¹)			
Model	Central and South America	Africa	Southeast Asia	Global
GTM	4.84 (1.86)	4.58 (1.72)	2.23 (1.07)	11.65 (4.69)
DIMA	3.62 (1.15)	4.98 (1.61)	1.14 (0.31)	10.60 (3.22)
GCOMAP	4.31 (1.57)	5.99 (1.37)	1.90 (0.38)	12.20 (3.31)

Figure 2: Annual emissions due to deforestation based on three land use models

Governments should seek to compensate land managers for avoiding deforestation on their properties. In addition, they should incentivize **reforestation and afforestation**, while promoting savvy water management and sustainable agriculture practices–a combination of which could save up to 5 $GtCO_2$/year at potentially low costs (see Figure 4). Climate-conscious land management will have to compete with current agricultural practices, but is instantly ready to deploy at scale.

CARBON DIOXIDE REMOVAL (CDR)

Point-source carbon capture and storage (CCS) allows for the continued use of fossil fuels in industrial factories while capturing and storing emissions. This technology could have a significant impact on total CO_2 concentrations.[4]

Table SPM.1. Profile by process or industrial activity of worldwide large stationary CO_2 sources with emissions of more than 0.1 million tonnes of CO_2 ($MtCO_2$) per year.

Process	Number of sources	Emissions ($MtCO_2$ yr^{-1})
Fossil fuels		
Power	4,942	10,539
Cement production	1,175	932
Refineries	638	798
Iron and steel industry	269	646
Petrochemical industry	470	379
Oil and gas processing	Not available	50
Other sources	90	33
Biomass		
Bioethanol and bioenergy	303	91
Total	**7,887**	**13,466**

*Figure 3: Total emissions from stationary industrial sites, in **$MtCO_2$/year***

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[1] Mendelsohn, R. (2000) "Efficient Adaptation to Climate Change." *Climatic Change*
[2] Kahn, Matthew E., (2016) "The Climate Change Adaptation Literature" *Review of Environmental Economics and Policy*
[3] Kinderman, G.et al, (2008) "Global cost estimates of reducing carbon emissions through avoided deforestation" *Proceedings of the National Academy of Sciences*
[4] IPCC Working Group III (2005) "Special Report: Carbon Dioxide Capture and Storage" *Summary for Policymakers*

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There are, however, significant technical, economic, and political issues with CCS, including the cost and location of storage facilities and transportation of CO_2. Even if most factories are equipped with CCS capabilities, there are still vast amounts of non-point-source carbon emissions, such as from planes and cars, that would continue to escalate atmospheric CO_2 concentrations.[5]

AIR CAPTURE

Non-point source CO_2 may still be removed from the atmosphere through **"air capture"** technologies. This category includes the capture of CO_2 through biomass or with air "scrubbing" facilities.

The most promising avenue for biological capture is to ultimately use the biomass as a fuel, while capture its emissions with CCS (a process termed **"bioenergy with capture", or BECSS**). [6]

TABLE 2.2 Summary of the Potential Impacts of Various CDR Strategies

	CDR Method	Rate of Capture or Sequestration [$GtCO_2/yr$]	Cumulative CDR to 2100 [$GtCO_2$]	Cost [$\$/tCO_2$]	Limitations
Combined Capture and Sequestration	Land management Afforestation/ Reforestation	2-5[a]	100[b]	1-100[c]	• Irreversible land changes from deforestation or past land uses • Decreased biodiversity • Competition for land for agricultural production
	Accelerated weathering Land	2 (U.S. only)	~100 (U.S. only)	20-1,000[e]	• Land—available cheap alkalinity and aggregate markets for product • Ocean—available cheap alkalinity
	Ocean	1[d]	~ 100	50-100[f]	
	Ocean iron fertilization	1-4[g]	90-300	500[h]	• Environmental consequences and potential co-benefits • Uncertainty in net carbon sequestration
Capture	Bioenergy with capture	15-18[i] (Theoretical)	100-1,000[j]	~100[k]	• Sequestration of 18 $GtCO_2/yr$ requires ~1,000 million acres of arable land (1,530 million acres available worldwide actual amount of arable land available for bioenergy production will likely be significantly less because much of arabl land area is required for food productio
	Direct air capture	10[m] (U.S. only)	~1,000 (U.S. only)	400-1,000[n]	• Land available for solar ~100,000,000 ac of BLM land in southwestern United Sta

Figure 4: Potential Impacts of various CDR strategies

BECSS is limited by scale–it would require the use of a significant proportion of total arable cropland–and cost, as it would require expensive investments in transportation and storage. However, the theoretical rate of sequestration is promising enough that it warrants further investments in research and development.

Ocean fertilization and chemical "weathering", on the other hand, are environmentally and politically risky methods, with the potential for adverse impacts that may far outweigh benefits.

Direct air capture (DAC) facilities can be advantageously located at a storage site. While little has been invested in DAC technology, some economists estimate that costs could lower to $100/tC, which would make it cost effective by some estimates of the social cost of carbon. On these grounds CCS ought to be explored further.[7]

Table 2b – Cost of air capture as a percentage of global GDP, assuming 2.5% global GDP growth to 2100 after Stern (2007).

	$500/tC	$360/tC	$100/tC
450 ppm cost to 2050	3.0%	2.2%	0.6%
550 ppm cost to 2050	0.0%	0.0%	0.0%
450 ppm cost to 2100	2.7%	2.0%	0.5%
550 ppm cost to 2100	2.0%	1.4%	0.4%

Figure 5: Sourced from Pilke Jr., Roger A. (2009) "An idealized assessment of the economics of air capture of carbon dioxide in mitigation policy"

GEOENGINEERING

Geoengineering, or the deliberate modification of climate through solar deflection, is an economically and scientifically feasible route for keeping global temperatures in check.[8] Yet, it poses severe and irreversible planetary risks that are ultimately impossible to predict.

For this reason, governments should *invest heavily in climate adaptation, promising carbon dioxide removal technologies, and savvy land use practices* (all of which are relatively well understood) before even considering the deployment of geoengineering techniques. That being said, it is worth continuing to study geoengineering as a potential strategy of last resort.

[5] Lackner, Klaus S., et. al (2012) "The urgency of air capture" *Proceedings of the National Academy of Sciences*
[6] Ibid.
[7] Stern N. (2007) "The Economics of Climate Change: The Stern Review" *Cambridge University Press*
[8] Barret, S. (2007) "The Incredible Economics of Geoengineering". *Environmental Resource Economics*