Restoring the Carbon Balance - Session 3: Policies and Financing
May 11th, 2017

#carbonbalance

Andy Revkin
Senior Reporter
ProPublica

Edward Saltzberg, Ph.D.
Managing Director
Security & Sustainability Forum
December 15, 2016 - Webinar 1: The Imperative
February 1, 2017 - Webinar 2: The Technologies
May 11, 2017 - Webinar 3: Policies, Financing, Regulations
June 8, 2017 - Webinar 4: How Sustainable is Our Climate Ethos?
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**Agenda**

**Introduction:** Andy Revkin, ProPublica

**Presentations:**
- Klaus Lackner, Arizona State University
- Fatima Ahmad, Center for Climate and Energy Solutions
- Noah Deich, Center for Carbon Renewal
- Richard Mattison, CEO of Trucost

**Discussion Moderated by Andy Revkin**

**Audience Q&A:** *Use the box in the go to Webinar window*

**Summary**

Download Today’s Slides From the Window

*(Please Take the Brief Exit Survey)*
Andy Revkin is the senior reporter for climate and related issues at ProPublica. He joined the Independent public-interest newsroom in December 2016, after 21 years of writing for The New York Times. Andy began writing on climate change in the 1980s. He has won most of the top awards in science journalism, along with a Guggenheim Fellowship, Columbia University’s John Chancellor Award for sustained journalistic excellence and an Investigative Reporters & Editors Award.
Panelists

Klaus Lackner, Director of Arizona State University’s Center for Negative Climate Emissions and Professor at the School of Sustainable Engineering

Fatima Ahmad, Fatima Maria Ahmad is a Solutions Fellow at the Center for Climate and Energy Solutions (C2ES) where she co-leads the National Enhanced Oil Recovery Initiative with the Great Plains Institute

Noah Deich, co-founder at the Center for Carbon Removal and a former management consultant on clean energy and corporate sustainability projects for large companies across North America

Richard Mattison, CEO of Trucost and a member of the EU Sustainable Finance High Level Expert Group and the Global Advisory Council of the Oxford Smith School Stranded Assets Program
Carbon Negative Scenarios for the Future

Klaus S Lackner

May 2017
Business as usual will lead to economic collapse

- Constant rate of CO$_2$ dumping will drive CO$_2$ levels to 650 ppm by 2100
  - Fossil fuel consumption results in CO$_2$ dumping
  - Economic growth drives continued rise in emissions
  - Fossil fuels are likely to stay plentiful and cheap

- CO$_2$ dumping is not sustainable, economically not viable, potentially catastrophic
  - High level of warming leads to ocean rise, crop failures, ecosystem collapse
  - Ocean acidification will cause failure of coral reefs by making carbonate formation difficult
  - Warming will release carbon in methane hydrates, amplifying warming
  - Potential for a global existential crisis

Business as usual is not an option
Need to take back the “empties”
Transition to carbon management

- Carbon management is a form of waste management
- **Reduce – Reuse – Restore**
  - Mitigation reduces and reuses carbon – not sufficient to solve the problem
  - Waste management adds disposal/restoration

Decarbonization
- Energy efficiency
- Renewables
- Biomass
- Nuclear?

Adaptation
- Managing impacts of climate change
- Ocean rise, crop losses, …

Capture & Use
- Transforming CO$_2$ into valuable products.
- Fuels, feedstocks

Capture & Storage
- Restoring C-balance through long-term sequestration

Progress, but Not Fast Enough
- Not Large Enough

Increasingly Necessary

Market Driven Approach

Waste Disposal Paradigm

Graphics adapted from CO$_2$ Initiative
Reduce, Reuse, Restore

For every ton of carbon taken from the ground another needs to be returned

- **Reduce**
  - Efficiency and conservation reduce emissions, tempered by economic and population growth
  - Replace fossil energy sources, even though they tempt through low cost

- **Reuse**
  - Making fuels from CO\(_2\) through biomass or directly from point sources, the air or the ocean
  - Large parts of the carbon cycle can only close through the environment
    - Air planes, ships and heavy trucks continue to emit, past emissions are already out there

- **Restore**
  - Excess CO\(_2\) is collected and stored safely and permanently
    - In underground reservoirs, in mineral carbonates, in long-lived infrastructure, in natural carbon reservoirs
  - Excess matches fossil carbon extraction, creates negative emissions
  - Need for certifying negative emissions

A tipping fee for disposal creates a carbon price for reduction and reuse
Many different pathways to negative carbon

- Agriculture and forestry for carbon dioxide removal
  - Photosynthetic binding of carbon with subsequent use or storage

- Technical approaches to carbon extraction from the environment
  - Absorption from the air, extraction from ocean water

- Disposal of carbon in natural and man-made reservoirs
  - Soil carbon, biomass carbon, underground pore space, mineralization

- Reuse in useful materials
  - Fuels, plastics, carbon composites, carbonates
  - Only fuels are large enough to match emissions
  - Past emissions and future fossil fuel use will require large scale storage

All pathways require carbon removal and storage
One possible scenario:
Deep penetration of solar photovoltaics energy

- **PV is beginning to undercut fossil electricity costs whenever the sun shines**
  - Levelized cost of PV is dropping below the marginal cost of coal and gas power plants
  - Intermittency is now the problem of the competitor
  - Deeper PV penetration is limited by the lack of storage – fighting the duck curve

- **Deep market penetration is enabled by on-site fuel production**
  - Direct air capture and electrolysis add flexible consumption for “reverse combustion”
  - Excess electricity goes into hydrogen and liquid fuel production—air capture provides the CO₂

- **Large solar farms will include much smaller mechanical tree farms**
  - Providing CO₂ for fuel production without pipelines
  - Nearly all point sources are replaced with electric power
  - Much of transportation runs on liquid fuels
  - Electricity is backed up by super capacitors, batteries, hydrogen, liquid fuel
    - *Storage medium depends on cycle time—storage in excess of one day belongs to liquid fuels*

The deserts of the world could easily support the world’s power and fuel demand, but just closing the carbon cycle leaves excess carbon in the air
Managing waste carbon dioxide

For every ton of carbon taken from the ground another needs to be returned

- The world is dumping CO$_2$ into a single sink – Cleanup can happen anywhere
  - Atmosphere/ocean/biosphere – direct air capture, ocean extraction, biomass capture
  - Balancing past and current fossil fuel consumption

- Establishing safe, certifiable carbon sinks
  - CO$_2$ storage may need to exceed 20$^{th}$ century emissions

- Need to convince the public that storage is legitimate, safe and permanent
  - Must go beyond offsets, true removal, accepting responsibility for long-term storage

Sewage and garbage made the transition more than a century ago
A future world with carbon waste management

- **Demand for carbon cleanup will create waste management businesses**
  - Volunteer efforts and regulation will result in buying back carbon

- **The price of carbon cleanup will motivate reuse**
  - Creates a strong link to renewable energy to produce carbon-neutral fuels

- **Efforts need to be large to cope with 40 Gt CO\(_2\) annually**
  - However, still smaller than the scale for transitioning to renewable energy infrastructures
  - How to finance a trillion dollar industry?

- **Like all waste management, balancing carbon will require regulations**
  - Regulations can learn from past experience (requirements, certification, etc.)
  - Sewage and garbage removal started with volunteers
  - Recycling of waste started with volunteers

  **Voluntary buy-back of carbon requires trust in the results**
  **Volunteers demonstrate feasibility and bring costs down**
  **Regulations protect climate**
Policies and Financing:
Current Opportunities to Accelerate Carbon Capture Deployment

Fatima Maria Ahmad

C2ES Solutions Fellow
• About C2ES

• National Enhanced Oil Recovery Initiative (NEORI)

• Federal and State Policy Opportunities

• Financing Through Innovative Business Models
Independent, nonpartisan, nonprofit organization

Mission: To forge practical solutions to reduce greenhouse gas emissions, expand clean energy, and strengthen resilience to climate impacts.

A key objective is a national market-based program to reduce emissions cost-effectively.

Brings city, state, and national policymakers together with businesses and other stakeholders.

Ranks regularly among the top environmental think tanks in the world.
Carbon Capture is an Essential Technology

• IEA Analysis: CCS can provide 13% of cumulative emissions reductions needed by 2050.

Source: IEA Energy Technology Perspectives 2015
Climate Benefits of Carbon Capture

• IPCC Analysis: More than 1/2 of the models failed to limit warming to 2C without CCS. For those that could, costs rose 138%.
• It is the only practical solution to achieve deep decarbonization in the industrial sector (18% of U.S. CO2 emissions).

Photo by U.S. Department of Energy
Lifecycle Analysis of CO2-EOR

• **Clean Air Task Force analysis**
  
  • Net storage benefit of 0.19 metric tons of CO2 per barrel of oil produced (includes emissions from the oil).
  
  • EOR using power plant CO2 results in a 63% net reduction of the total injected volume of CO2 or a 37% reduction in the life cycle emissions from oil.

• **Negative Emissions: Bioenergy with Carbon Capture and Storage (BECCS)**
  
  • First step is carbon capture on ethanol plants - ADM (2017)
NEORI Participants

Coal Producers
- Arch Coal
- Cloud Peak Energy
- Peabody Energy

Electric Power Generators
- Great River Energy
- NRG Energy
- Summit Power Group
- Tenaska Energy

Industrial CO₂ Suppliers and Technology Vendors
- Air Liquide
- Air Products
- Archer Daniels Midland
- GE Oil & Gas
- Jupiter Oxygen
- Linde
- Praxair

Project Developers
- Lake Charles Methanol

Environmental NGOs
- Center for Carbon Removal
- Clean Air Task Force
- Natural Resources Defense Council

Labor Unions
- AFL-CIO
- International Brotherhood of Boilermakers
- International Brotherhood of Electrical Workers
- SMART Transportation Division
- United Mine Workers of America
- Utility Workers Union of America

Oil Companies
- Occidental Petroleum
- Core Energy

Observers
- Chaparral Energy
- Interstate Oil and Gas Compact Commission
- Enhanced Oil Recovery Institute, University of Wyoming
- Mitsubishi Heavy Industries of America
- Tellus Operating Group
• **H.R. 4622, the Carbon Capture Act (2016)**
  - Permanent tax credit
  - $30/ton for EOR; $30/ton for saline storage
  - 150,000 ton threshold for power sector and industrial sector

• **S. 3179, the Carbon Capture Utilization and Storage Act (2016)**
  - 7 year commence-construction period; 12 year tax credit
  - $35/ton for EOR and other utilization; $50/ton for saline storage
  - 100,000 ton threshold for the industrial sector
Federal Policy: PABs and MLPs

• **Private Activity Bonds**
  - The Carbon Capture Improvement Act (2017)
  - S. 843: Introduced by Sens. Portman (R-OH) and Bennet (D-CO)
  - H.R. 2011: Introduced by Reps. Curbelo (R-FL) and Veasey (D-TX)

• **Master Limited Partnerships**
  - S. 1656; H.R. 2883, the Master Limited Partnerships Parity Act (2016).
CO2 Utilization: $20M NRG COSIA Carbon X-Prize


LATEST UPDATES

CARBON XPRIZE TEAM SEMI-FINALISTS TO TRANSFORM CO2 WASTE INTO BUILDING MATERIALS, BIOFUELS AND TOOTHPASTE

- Nov. 2017: 2 $2.5 million Prizes announced
- Mar. 2020: 2 $7.5 million Grand Prizes announced
• Research into potential uses of manmade CO2 is ongoing.

**Construction Materials**
- Cement and concrete
- Asphalt
- Aggregate
- Timber/super hardwood

**Industrial gas & fluids**
- Enhanced oil recovery
- Enhanced coal bed methane recovery
- Enhanced water recovery
- Semiconductor fabrication
- Power cycles

**Fuel**
- Synthetic (methanol, butanol, natural gas, syngas, etc.)
- Micro-algae fuel
- Macro-algae fuel

**New materials**
- Carbon fiber
- Carbon nanotubes and fullerenes
- Graphene

**Polymers**
- Polyurethene foams
- Polycarbonate (glass replacement)
- Acrylonitrile butadiene styrene
- Many more

**Agriculture & food**
- Algae-based food or animal feed
- Microbial fertilizer
- Biochar, bio-pesticides, bio-cosmetics

**Chemicals**
- Preservatives (formic acid)
- Medicinal
- Antifreeze (ethylene glycol)
- Carbon black
- Many more

Source: CO2-based products market analysis by McKinsey and Company and CO₂ Sciences
Financing Through Innovative Business Models

Solutions Forum Webinar: Financing Carbon Capture Technology - Corporate Partners Lead the Way

Addressing climate change will require tremendous investment in low and zero carbon energy technologies. Estimates are as high as $1 trillion per year through 2030. Some of that investment will need to go to carbon capture technology, which could provide 13 percent of global emissions reductions through 2050.

This webinar explores corporate partnerships as a model for financing carbon capture technology and features an interactive discussion about opportunities and potential challenges.

Thursday, October 27, 2016
Noon – 1:00 pm ET

Watch video of this event
View slides

Speakers:

David C. Brown,
Senior Vice President, Federal Government Affairs and Public Policy, Exelon Corporation

Bill Brown
CEO, Net Power LLC, Co-Founder and CEO, 8 Rivers Capital LLC

Walker Dimmig
Principal, 8 Rivers Capital LLC

Fatima Maria Ahmad
Solutions Fellow, Center for Climate and Energy Solutions
Financing Through Innovative Business Models

- NET Power demo project (LaPorte, Texas)

Image by NET Power LLC
Financing Through Innovative Business Models

• NRG Petra Nova project (near Houston, Texas)

The Carbon Capture and Enhanced Oil Recovery Project

The world’s largest post-combustion carbon capture and enhanced oil recovery project is located in Texas at NRG Energy’s coal-fired W.A. Parish Generating Station. Also known as the Petra Nova Carbon Capture Project, the development is scheduled for completion by the end of 2016.
Center for Carbon Removal

Carbon Removal Policy Options
May 11, 2017

www.centerforcarbonremoval.org
@CarbonRemoval
We are a non-partisan, 501c3 organization advancing fresh solutions to clean up CO₂ from the air.

**Mission:** to catalyze technology, policy, and financial innovations for atmospheric CO₂ capture and storage.

**Vision:** to see innovators develop and deploy carbon removal solutions across forests, agriculture, and industrial CO₂ technology that fuel economic growth and reduce climate risks.

**Headquarters:**
Oakland, CA

**Official academic partner:**
Berkeley Energy and Climate Institute (LBNL & UC Berkeley)
Our approach: Advance a portfolio of complementary carbon removal

<table>
<thead>
<tr>
<th>NATURAL</th>
<th>TECHNOLOGICAL</th>
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<tbody>
<tr>
<td>Storage in plants and soils</td>
<td>Storage in rocks and materials</td>
</tr>
<tr>
<td>Forestry</td>
<td>Energy &amp; Industry</td>
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</tbody>
</table>

- **Includes:**
  - Afforestation
  - Reforestation
  - Wetlands

- **Includes:**
  - Agroforestry
  - Biochar
  - Farm management aimed at increasing soil carbon stocks

- **Includes:**
  - Bioenergy with CCS (BECCS)
  - Direct air capture + storage
  - CO₂ mineralization

Less costly
- Closer to deployment
- More vulnerable to reversal

More costly
- Greater R&D needs
- Less vulnerable to reversal
Carbon removal solutions can expand the climate solution set

<table>
<thead>
<tr>
<th>Forestry/Ecosystems</th>
<th>Agriculture</th>
<th>Energy / Manufacturing / Mining</th>
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<tbody>
<tr>
<td><strong>Natural Solutions</strong></td>
<td><strong>Technology solutions</strong></td>
<td></td>
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<tr>
<td>Traditional mitigation</td>
<td>Conservation</td>
<td>On farm GHG emission abatement</td>
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<tr>
<td>Expanded mitigation w/ negative emissions potential</td>
<td>Expansion and enhanced management</td>
<td>Soil carbon sequestration</td>
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| | | *Capture*: CCS on fossil fuels and other industrial stationary sources  
*Storage/use*: Enhanced oil recovery, geologic formations (e.g. saline aquifers) |
| | | *Capture*: CCS on bioenergy, direct air capture  
*Storage/use*: utilization in long-lasting materials, geologic storage in underground reservoirs, and/or accelerated CO2 mineralization |
Policies that help conventional CCS approaches can also advance...
Carbon removal solutions can build off of existing climate policies

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<tr>
<td><strong>Natural Solutions</strong></td>
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<tr>
<td><strong>Barriers</strong></td>
<td></td>
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<tr>
<td>• Difficult to monitor and verify biological carbon storage</td>
<td>• High costs due to lack of technical and commercial demonstrations</td>
<td></td>
</tr>
<tr>
<td>• Weak incentives to change management practices to carbon sequestering options</td>
<td>• Few market incentives compared to fossil CO$_2$ capture tech.</td>
<td></td>
</tr>
<tr>
<td><strong>Expanding existing climate policies</strong></td>
<td></td>
<td>• Expand and increase 45Q tax incentives to cover carbon removal approaches</td>
</tr>
<tr>
<td>• Farm Bill changes (e.g. increasing conservation title funding, changing crop insurance to incentivize carbon sequestering practices, etc.)</td>
<td></td>
<td>• Vastly increase DOE funding for Fossil Energy, EERE, Advanced Manufacturing, Office of Science, and ARPA-E basic and applied research for carbon removal tech</td>
</tr>
<tr>
<td>• USFS Fire Borrowing legislation fix</td>
<td></td>
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<tr>
<td>• Clarifying and strengthening the “+” in REDD+</td>
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Examples of existing and proposed carbon removal policies around the world:

<table>
<thead>
<tr>
<th>Geography</th>
<th>Solution Focus</th>
<th>Policy Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>All carbon removal</td>
<td>Research</td>
<td>~$10M basic research program announced by UK NERC and BEIS</td>
</tr>
<tr>
<td>US</td>
<td>Direct air capture</td>
<td>Research</td>
<td>US DOE funded $3M for direct air capture research out of Fossil Energy Office</td>
</tr>
<tr>
<td>US</td>
<td>Direct air capture</td>
<td>Innovation</td>
<td>Senators Barrasso and Schatz introduced legislation for $50M innovation prize for air capture administered by DOE (not enacted)</td>
</tr>
<tr>
<td>US</td>
<td>Bioenergy + CCS</td>
<td>Deployment incentives</td>
<td>US DOE supported bioethanol + CCS project in Decatur, IL</td>
</tr>
<tr>
<td>US</td>
<td>Bioenergy + CCS</td>
<td>Deployment incentives</td>
<td>Senator Manchin introduced legislation for $100M+ in support for bioenergy + CCS demonstration (not enacted)</td>
</tr>
<tr>
<td>US</td>
<td>Soil Carbon</td>
<td>Research and Demonstration</td>
<td>Rep. Huffman’s Healthy Soils and Rangeland Solutions Act legislation to boost soil carbon on Federal lands (not enacted)</td>
</tr>
<tr>
<td>US</td>
<td>Biochar</td>
<td>Deployment incentives</td>
<td>WECHAR program introduced in 2009 would have provided loan guarantees for biochar projects. (not enacted)</td>
</tr>
</tbody>
</table>
The policy grand challenge: we need faster, more ambitious climate action.

Meeting climate commitments requires unprecedented action:

Carbon removal solutions can:

- Deliver large-scale negative emissions (the blue line)
- Expand the climate solution advocacy tent (to build support for achieving the red and grey lines) by creating economic opportunities for turning waste CO$_2$ into a valuable resource for our buildings, consumer goods, and soils that grow our food and timber

To unlock this potential, we must start supporting carbon removal solutions today.

From Rockstrom et. al. in Science
Richard Mattison, CEO of Trucost and a member of the EU Sustainable Finance High Level Expert Group and the Global Advisory Council of the Oxford Smith School Stranded Assets Program

How to go about measuring risk and assessing opportunities?

Clarity for impact investors requires measures of benefits

Alignment with government policy and mandates

Aligning long term goals of investors with needs of research

Context is addressable markets and addressable benefits as cash flow is well in the future

Creating a model to allow innovation - Pharma and Tech
Financing Carbon Innovation

How to mobilize capital in order to restore the carbon balance

Dr Richard Mattison
Chief Executive Officer, Trucost

11th May 2017
Markets are now reacting to climate risks

Dec 2015
Over 200 nations sign climate agreement

California passes bill forcing biggest pension funds to divest from coal

The Montreal Pledge, which commits investors to measuring and disclosing the carbon footprint of their portfolios on an annual basis, has attracted 120 signatories representing just over $10trn in assets under management.

Norway Will Divest From Coal in Push Against Climate Change

Norway’s $890 billion government pension fund, considered the largest sovereign wealth fund in the world, will sell off many of its investments related to coal, making it the biggest institution yet to join a growing international movement to abandon at least some fossil fuel stocks.

ABP overhauls responsible investment strategy to focus more on selecting sustainable companies

Dutch giant will double environmental investments and cut CO2 emissions in equity portfolio

by Jan Wagner | October 14th, 2015
The Investment and Lending Chain

Supply of Capital/Beneficiaries | Capital Collectors/Allocators | Capital Markets | Demand for Capital/Issuers
---|---|---|---
Government | Banks | | Government
Corporates | Insurance Companies | Asset Managers | Corporates
Individuals | Retirement Benefit Schemes | | Individuals

Consultants/Advisors
Financial Advisors
Consultants/Advisors
Rating Agencies
Consultants/Advisors
Index Providers
Rating Agencies
Research Analysts

Providing essential intelligence
- ESG performance disclosure to beneficiaries
- ESG metrics for each asset class
- ESG metrics for each fund

Providing greater transparency
- ESG Reporting
- Asset-level scenario analysis
- Impact measurement
Understanding the Investment Chain

• There is a need to ensure adequate information is provided at each stage of the investment chain

• Investors currently lack adequate information on metrics that would facilitate a flow of capital towards sustainable investments

• The information currently available is not sufficiently robust, forward-looking or relevant enough for investors to use effectively

• Different measures of success, in a sustainability context, need to be able to be aggregated across the investment chain
FSB Chair Mark Carney said: “The disclosure recommendations will give financial markets the information they need to manage risks, and seize opportunities, stemming from climate change. As a private sector solution to a market issue, the Task Force has focused on the practical, material disclosures investors want and which all capital-raising companies can compile.”

Asset owners should provide GHG emissions, where data are available, associated with each fund or investment strategy.
Clear measures of benefits

**S&P Global**

Green Evaluation Ratings

Weighted aggregate of three:

- Transparency + Governance + Mitigation or Adaptation = Green Evaluation

Common approach used amongst second opinion providers:

- **Transparency**
  - Use of proceeds reporting
  - Reporting comprehensiveness

- **Governance**
  - Management of proceeds
  - Impact Assessment Structure

Unique to S&P Global Ratings:

- **Mitigation**
  - Buildings, industrial efficiencies, energy infrastructure, transport, and water

- **Adaptation**
  - Resilience capex such as flood defenses, asset protection etc.

- **Net Benefit Ranking**
  - eKPI’s: Carbon, Waste, Water Use

- **Cost Benefit Ranking**
  - Resilience benefit ratio: Estimate of reduction in damages if event occurs

- **Hierarchy Applied**

- **Environmental Impact**

- **Resilience Level**

- **Mitigation Score**

- **Adaptation Score**

**Final Green Evaluation (E1 - E4 or R1 - R4)**

eKPI – Environmental Key Performance Indicator

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Discussion

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