Meeting the Paris Goals: Clean Energy, Forests, and Soils

1.5°C or 2.0°C? Or how much higher

William R Moomaw
Global Development and Environment Institute
Tufts University
ISEE 2016 Washington DC
* The earth’s temperature is determined by the sun and the heat trapping gases in the atmosphere
* Human activities have added 240 GtC as CO₂ to the atmosphere since 1750
* In 2011, there was 829 GtC as CO₂
* Today CO₂ is 847 GtC or 401 ppm
* CO₂ has an average lifetime of over 1000 years in the atmosphere
* In addition there is an additional 300ppm of additional GHGs as carbon equivalent
* Global temperatures rise with GHG concentrations

**Greenhouse Gases and Climate Change**
* CO₂ Emissions to the Atmosphere

* Fossil fuels and industrial 7.8 GtC
* Land use changes 1.1 GtC
* Total annual emissions 8.9 GtC

IPCC AR5 WGI Chapter 6 2013
* CO\textsubscript{2} Removal from Atmosphere

- Oceans: 2.3 GtC/y
- Plants and soils: 2.6 GtC/y
- Total annual removal: 4.9 GtC/y
*CO₂ Additions 8.9 GtC/y
*CO₂ Removals -4.9 GtC/y

*Net CO₂ added each year +4.0 GtC/y

Need to prevent 4.0 GtC/y from entering atmosphere to get to carbon neutrality

*Net annual CO₂ additions to Atmosphere
* All 195 nations agreed to “avoid dangerous anthropogenic interference in the climate system” temperatures should not exceed 1.5 or 2.0°C

* 185 nations submitted their Nationally Determined Contribution of emissions reductions associated with their development strategy

*The Paris Accord*
Celebrating success in Paris

French President Francois Hollande, right, French Foreign Minister and president of the COP21 Laurent Fabius, second, right, United Nations climate chief Christiana Figueres and United Nations Secretary General Ban ki-Moon applaud after the final conference at the COP21, the United Nations conference on climate change, in Le Bourget, north of Paris, Saturday, December 12, 2015.
To have a 50% probability of staying within 2\degree C, IPCC estimates that only 224 GtC can be added to the atmosphere after 2011.

From January 2012 through June 2016 approximately 28 GtC were added.

That leaves 196 GtC to be emitted.

At current rates that is 22 years of fossil fuel use.

If feedbacks of methane and other Greenhouse gases from thawing permafrost are counted it is just 12 years of fossil fuels.

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**Total carbon budget to stay within 2\degree C**
* Need reduction in CO₂ emissions and removal
Increase in Global Temperature by 2100
Where will proposals from the climate negotiations lead?

- Business as usual
- 14 Dec '15 proposals
- Goals

- 4.5°C 8.1°F
- 3.5°C 6.3°F
- 2.0°C 3.6°F

* Even if emissions are stopped immediately, temperatures will remain elevated for centuries due to the effect of greenhouse gases from past human emissions already present in the atmosphere. Past, present and future emissions of carbon dioxide represent a substantial multi-century climate change commitment.

IPCC AR 5 2013
* Replace half fossil fuels (f.f.) with zero carbon renewables
  * Net CO₂ emissions natural removal 4.0 GtC/y
  * Replace half of f.f. energy with zero C -4.0 GtC/y
  * Net emissions 0.0 GtC/y
  * Replace remaining f.f. With zero carbon renewables 3.8 GtC/y

* Halt deforestation -1.1 GtC/y
* Total Net reductions -4.9 GtC/y

* Reduce CO₂ emissions
Even if emissions are stopped immediately, temperatures will remain elevated for centuries due to the effect of greenhouse gases from past human emissions already present in the atmosphere. Past, present and future emissions of carbon dioxide represent a substantial multi-century climate change commitment.

IPCC AR5 2013

Need to remove carbon dioxide from atmosphere
* Mobilize the Biosphere Through Restorative Development

* Halt deforestation 1.1 GtC/y
* Remove CO$_2$ by restoring forest capacity over next 50 years at average rates of
  * Allow current second growth forests to reach maturity 2 GtC/y
  * Restore degraded forests 1 GtC/y
  * Reforest recently deforested lands 1 GtC/y
* Restore carbon in degraded soils 1 GtC/y
  * Agricultural soils
  * Grassland soils
  * Wetland soils

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* French 4 Parts per Thousand program for restoring agricultural soils
* Intensive rotational grazing to restore grasslands
* Restore carbon in tidal wetlands
* Prevent release from freshwater wetlands and permafrost soils

*Restorative Management of soils*
HOW CAN SOILS STORE MORE CARBON?

The more soil is covered, the richer it will be in organic material and therefore in carbon.
Until now, the combat against global warming has largely focused on the protection and restoration of forests.
In addition to forests, we must encourage more plant cover in all its forms.

Never leave soil bare and work it less, for example by using no-till methods
Introduce more intermediate crops, more row intercropping and more grass strips
Add to the hedges at field boundaries and develop agroforestry
Optimize pasture management – with longer grazing periods, for example
Restore land in poor condition e.g. the world’s arid and semi-arid regions

“This international initiative can reconcile the aims of food security and the combat against climate change, and therefore engage every concerned country in COP21.”

Stéphane Le Foll, French Minister of Agriculture, Agrifood and Forestry

4 POUR 1000

Les sols pour la sécurité alimentaire et le climat
4 per 1000 - Soils for food security and climate
Understand the “4 per 1000” initiative

4 PER 1000
CARBON SEQUESTRATION IN SOILS FOR FOOD SECURITY AND THE CLIMATE

The quantity of carbon contained in the atmosphere increases by 4.3 billion tons every year.

The world’s soils contain 1,500 billion tons of carbon in the form of organic material.

If we increase by 4% (0.4%) a year the quantity of carbon contained in soils, we can halt the annual increase in CO2 in the atmosphere, which is a major contributor to the greenhouse effect and climate change.

CO2 emissions

- Forests
- Oceans
- Human activities
- Deforestation

Increased absorption of CO2 by plants:

- Farmlands
- Meadows
- Forests...

Storage of organic carbon in soils

1,500 billion tons carbon

+4% carbon storage in the world’s soils

- More fertile soils
- Soils better able to cope with the effects of climate change
* Halt CO$_2$ emissions - 4.9 GtC/y
* Increase all sinks (maximum rate) - 5.0 GtC/y
* Net removal (negative emissions) - 9.9 GtC/y

It now becomes possible to reduce CO$_2$ from 849 Gt 400 ppm to below 350ppm by 2100

* Decrease emissions and increase removal
* EU counts all CO$_2$ emissions form bioenergy as zero
* UK is importing wood pellets sourced by clear cutting in North Carolina, using them to replace coal and counting their emissions as zero carbon
* The US Congress is considering an amendment that will force EPA to count all forest bioenergy as zero carbon based upon false science

* Forest bioenergy is a move in wrong direction!
Harvesting raw materials for wood pellets in US
Sustainable Forestry Initiative certified biomass harvesting, Nova Scotia

Photo credit: Jamie Simpson
Treating “sustainably harvested” fuels as carbon neutral greenlights massive forest harvesting

Drax (3,000 MW plant in UK, 50% wood pellet fueled, ~18 million tons green wood/year):
"We are pleased that the US Environmental Protection Agency has signalled its intent to recognise the full carbon benefits of biomass where it is sourced from sustainably managed forests. Drax already has a robust, independently audited sustainability policy to ensure the sustainability of the wood fibre we use."

Image: Drax Power Station as seen from a train travelling north on the main East Coast line. 
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UK Pellet source in NC
Pellet industry harvesting in North Carolina: “Little remains but stumps and puddles in what was once a bottomland hardwood forest”

Joby Warrick, Washington Post 6/2/2015
“How Europe’s climate policies led to more U.S. trees being cut down”
Truck entering Enviva pellet plant in North Carolina with “thinnings”
Enviva wood pellet facility, Ahoskie, NC (850,000 green tons/year). Note whole trees on right.
50 MW McNeil plant, Burlington Vermont. ~625,000 green tons/year
The biopower industry is growing rapidly

~21% increase in capacity, 2008 - 2013

Actual and projected growth in the biopower industry (built capacity for 2008 from Energy Information Administration; built capacity and proposed capacity from 2008 onwards from Forisk, Wood Bioenergy US database, December 2013). Not all facilities will be built.
Wood pellets for electricity generation utilizes only 0.25% of the solar energy.

Striking the forest: PV panels are 20% efficient and produce 80 times as much electricity on the same area as a forest while producing zero carbon dioxide.

Why forest biomass makes little sense.

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Cooling towers belch steam at the Drax power plant in North Yorkshire, England. It is at the center of the debate over whether burning wood pellets reduces harmful greenhouse gas emissions. Photo by Jason Hawkes, courtesy of Flickr.
A simple physical fact: **Biomass power plants emit more CO₂ per MWh than coal or gas facilities**

<table>
<thead>
<tr>
<th>Fuel CO₂ per heat content (lb/mmbtu)</th>
<th>Facility efficiency</th>
<th>Fuel mmbtu required to generate 1 MWh</th>
<th>Lb CO₂/MWh</th>
</tr>
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<tbody>
<tr>
<td>Gas combined cycle</td>
<td>117.1</td>
<td>0.45</td>
<td>7.54</td>
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<tr>
<td>Gas steam turbine</td>
<td>117.1</td>
<td>0.33</td>
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<td>Coal steam turbine</td>
<td>205.6</td>
<td>0.34</td>
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<tr>
<td>Biomass steam turbine</td>
<td>213</td>
<td>0.24</td>
<td>14.22</td>
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</tbody>
</table>

**A biomass plant emits**

- ~150% the CO₂ of a coal plant
- ~250% the CO₂ of a gas plant
- ~340% the CO₂ of a combined cycle plant

Fuel CO₂ per heat content data are from EIA. Efficiency for fossil fuel facilities calculated using EIA heat rate data [here](http://www.eia.gov/cneaf/electricity/epa/epat5p4.html); biomass efficiency value is common value for utility-scale facilities.
* To increase US electricity use by 1% would require that the total timber harvest be increased by 18% - and burning it

* A 500 MW power plant requires 100,000 acres of forest in the Pacific Northwest to be cut and burned each year

* It takes a forest to make electricity
* The IPCC suggests counting bioenergy as land use change

* "The IPCC approach of not including bioenergy emissions in the Energy Sector total should not be interpreted as a conclusion about the sustainability or carbon neutrality of bioenergy."

* Industry and Congress want to count forest bioenergy as zero carbon because a replacement tree may grow in its place and absorb that CO₂

* Need correct accounting
* Need to set policies that discourage emissions by price
* Need to pay for ecosystem services including carbon capture and storage
* Need to account for forest bioenergy emissions appropriately when they are generated

* Need to have appropriate policies
* By reducing emissions and mobilizing the biosphere to absorb and store carbon from the atmosphere it may be possible to keep temperatures from rising more than 2.0°C

Emissions must be reduced rapidly in order for plants and soils to be able to remove and store the necessary carbon

* Restorative Development Enables Sustainable Development