Emissions from bioenergy, juggling and the usefulness of emission intensities

David Neil Bird

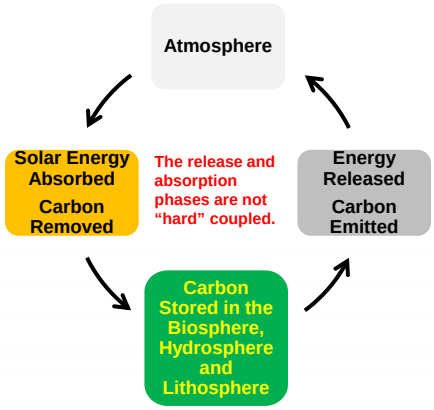
IEA Bioenergy Task 38 - Expert Working Meeting

How to present the timing of emissions from bioenergy in LCA and GHG accounting

Argonne National Laboratory, April 12th 2012

Timing, the problem….

Even though bioenergy is in the long term a low carbon energy source, in the short term it may cause more emissions than fossil energy



Causes

1. Use existing carbon capital for bioenergy
2. Bioenergy is more carbon intense and less efficient than fossil energy
3. Accelerating the energy release phase causes a temporary increase of carbon in the atmosphere
4. Accelerating the absorption phase can compensate but it is difficult to accelerate at the same magnitude
5. Continuous or increasing use causes a persistent increase of carbon in the atmosphere

The Effect of Constant or Increasing Demand

3

- There is a persistent emission that is larger for bioenergy systems with a longer time to first benefit (*pay-back time*)
- Analogy to a juggler
  - A single ball when thrown in the air returns to Earth
  - A juggler continuously throws balls in the air
    - After a transition phase there is constant number of balls in the air
    - To influence the number of balls in the air
      - Throw the balls higher with the same frequency
        "Use biomass with longer decay times or that regrows quickly"
      - Throw the balls more frequently with the same height
        "Increase the biomass use"

THE INNOVATION COMPANY

Example – Forest Residues to Biorefinery for Bioethanol

4

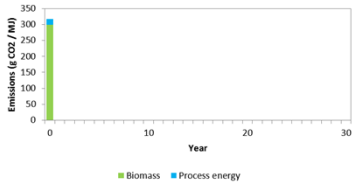
- Location – Austria
  - Average temperature – 8.1 C
  - Annual precipitation – 795 mm
- Bioenergy System
  - Biorefinery producing bioethanol and phenols
  - Approx. 30% conversion efficiency
  - Supply-chain emissions = 18 gCO2/MJ
- Reference System
  - Residues decay, average lifetime = 12.9 years
  - Gasoline, process emissions = 85 gCO2/MJ

THE INNOVATION COMPANY

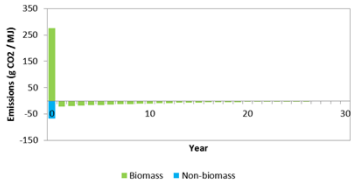
Example – Forest Residues to Biorefinery for Bioethanol

5

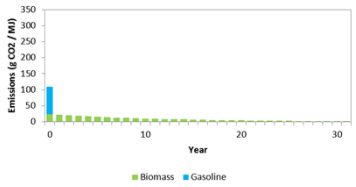
Bioenergy System Single Use



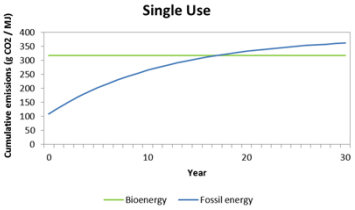
Net Emissions Single Use



Fossil Energy System Single Use



Cumulative Emissions Single Use

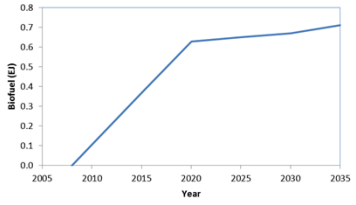


THE INNOVATION COMPANY

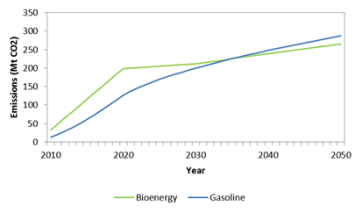
The Juggler Effect

6

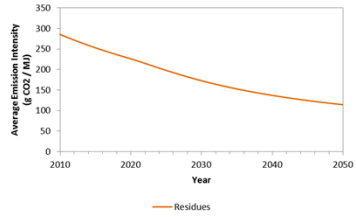
Predicted EU Biofuel Demand



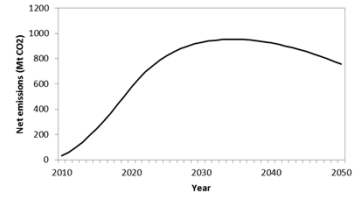
Emissions



Emission Intensity

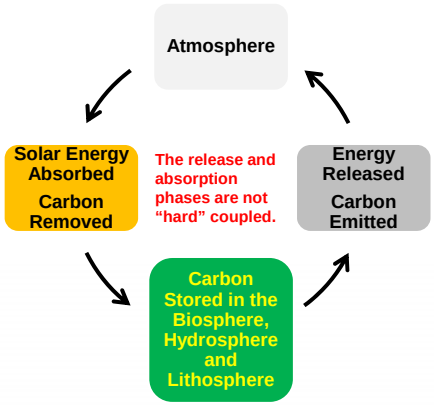


Cumulative Net Emissions



THE INNOVATION COMPANY

Timing – Solutions



Solutions

1. Reduce the time until the bioenergy system is better than the fossil energy system
   a. Use efficient conversion systems (*heat versus liquid fuels*)
   b. Replace carbon intense fossil fuel systems (*black coal versus natural gas*)
   c. Use material with short decay times (*grasses versus wood*)
   d. Use material with short regrowth time (*annual crops or coppice systems versus high forests*)

THE INNOVATION COMPANY

Good and Bad Bioenergy Systems

- What metrics or indicators should we recommend to help policy makers decide which bioenergy systems to support
  - Payback period, conversion efficiency, supply chain emissions ?
  - Emission intensity at specific times ?
  - Others ?

THE INNOVATION COMPANY