Sustainable carbon sources for industrial applications

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Warnings from climate scientists

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Climate tipping points – too risky to bet against

The growing threat of abrupt and irreversible climate changes must compel political and economic action on emissions.

Emission cuts now

Emissions per current commitments *

7.6%

2030 Goal: 25 Gt CO2e
Climate tipping points – too risky to bet against

The growing threat of abrupt and irreversible climate changes must compel political and economic action on emissions.
Global temperature increase

2100 WARMING PROJECTIONS
Emissions and expected warming based on pledges and current policies

Baseline: 4.1 – 4.8°C
Current policies: 3.0 – 3.4°C
Optimistic policies: 2.9°C
Pledges & Targets: 2.6 – 2.9°C
2°C consistent: 1.6 – 1.7°C
1.5°C consistent: 1.3°C

Historical

Source

Sept 2019 update
Biomass is sold as solution to:

- Electricity: 31%
- Stationary energy excluding electricity: 18%
- Land sector & other: 14%
- Fugitive emissions: 10%
- Industrial processes and product use: 6%
- Aviation & Shipping: 4%
- Land Transport: 15%
- Australian GHG emissions
Rapid reduction pathways

- PV/wind: 31%
- Energy efficiency & productivity
- Active, public & electric transport
- Land sector & other: 14%
- Fugitive emissions: 10%
- Industrial processes and product use: 6%
- Aviation & Shipping: 4%
- Stationary energy excluding electricity: 18%
- Land Transport: 15%
- Industrial processes and product use
• Reduce iron ore with either biomass or hydrogen instead of coal

• Drop-in fuel for aviation, shipping
Terrible mismanagement

- The role of trees in regulating natural cycles (e.g. cooling areas, retaining topsoil, influencing rainfall) has been ignored
- Australian deforestation is comparable to Amazon, Borneo, Congo
- Tension between biomass / wildlife / negative emissions / jobs

Before and after August 2017
In 2009: “The historical clearing of approximately 15% of the continent for agriculture is likely to have contributed to a hotter and drier climate and exacerbated the effect of the El Niño by increasing the severity of droughts, especially in south-east Australia.”

Things are even worse now
(imagine how bad an El Nino would be)
All agricultural land is in use

Purple + pink = conserved

An expanded biomass industry means less land for food agriculture
What sources have been explored

- Biomass
- Forestry crops and residue
- Municipal solids + sewage
- Industrial food waste
- Ag residues
- Animal waste
- Algae
- Eucalypts/longer-lived crops
- Short-lived energy crops
- Diverted food crops

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But is it sustainable?

Depends on:
- Volume
- Could it impact food supply – contributing to famine elsewhere?
- Will it impact flora + fauna?
- Could it be otherwise used to drawdown emissions?
- Will it result in net emissions?
- Regional conditions
- Does the crop provide other benefits?
- How will climate change impact the crop?
- Better to have multiple feedstocks for processing

Biomass

- Forestry crops and residue
- Municipal solids + sewage
- Industrial food waste
- Ag residue
- Algae
- Animal waste
- Short-lived energy crops
- Eucalypt/longer-lived crops
- Diverted food crops
Depend on climate dependent crop to fix climate change?

- Production is weather + climate dependent
- Droughts, drying out etc. increase likelihood that forests will burn
- Mallee eucalypts are very combustible
- Risky to depend on a flammable crop in a flammable environment

Stubble potentially available for harvest in Australia

Crawford 2016
In Australia, we estimate ~ 8,000 ML* jet fuel p.a.

- From sustainable proportion of municipal waste, bagasse, wood residue, urban wood waste, some mallee crop plantations around cropping fields (provide many benefits)
- NO food grains, pulp logs, other energy crops
- Biomass *also* needed for chemical feedstocks etc.
- *(Not including losses (transmission, manufacturing, distribution), production of aromatics)*

i.e. Not enough to cover current aviation and shipping (and demand for both is unrealistically expected to boom)

<table>
<thead>
<tr>
<th>Aviation (Gasoline)</th>
<th>9,154</th>
<th>ML</th>
</tr>
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<tbody>
<tr>
<td>Shipping</td>
<td>1,373</td>
<td>ML</td>
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</table>
In Australia, we estimate ~ 56 Mt carbon

- Biomass proportion of carbon dependent upon crop
- But again – we need carbon for chemical feedstocks!

**Fig. 9.** A Van Krevelen diagram illustrating C/O and H/C ratio for various solid fuels

Mousa 2016
Electric alternative for 2017-18

- Australian aviation = 346 PJ & shipping = 50 PJ
- **Minimum** electricity 141 TWh 20 TWh

- Much better to replace most domestic aviation (50 TWh) with high speed rail
- *(Not including losses (transmission, manufacturing, distribution), production of aromatics)*
- BZE estimates Eastern coast HSR = 2.2 TWh p.a.
  - This would cover 45% of regional travel
Electric alternative for 2017-18

- Australian iron ore: 800 Mt
- Australian iron: 174 Mt
- Total electricity for steel: 1000 TWh
- Maximum required carbon: 3.7 Mt
• IPCC estimates impact of aviation 2-4 times GHG emissions due to radiative forcing
Biomass demand and production must be carefully regulated.

There is not sufficient biomass for BAU demand for all sectors.

Ideally, we need demand reduction.