Klimagassutslipp fra vannkraft og magasiner

Atle Harby
Centre for environmental design of renewable energy – CEDREN
SINTEF Energy Research
Graf fra tidlig 2000-tall

Utslipp CO2-ekvivalenter [tusen tonn] pr TWh

Churchill Falls, Canada
La Grande, Canada
Tucurui, Brasil
Gasskraft
Kullkraft

Source: WCD Thematic Review II.2 Global Change
+ some experts!

→ No more misleading science?
The picture is very clear:
Changing from fossil to renewable sources lead to very large reduction in GHG emissions
Even with CCS – Renewables are much lower
Reservoirs only affect active carbon cycle

Non-renewables introduce fossil carbon to the active cycle
Carbon path

Catchments

Rivers

Lakes, reservoirs

Rivers

Oceans

CEDREN
Centre for Environmental Design of Renewable Energy
Carbon path

Catchments

Lakes, reservoirs

Rivers

Oceans

CEDREN
Centre for Environmental Design of Renewable Energy
What happens in inland waters?

- Catchment
- Lakes, reservoirs
- Lake sediments
- Rivers
- River sediments
- Oceans
Land: 1.9 Pg/y

Sediment storage: 0.23 Pg/y

Oceans: 0.9 Pg/y

CO₂ evasion: 0.75 Pg/y

Inland waters

What happens when a reservoir is created?
Do these arrows change?
Tucuruí before impoundment

1979
Tucuruí before impoundment

Tucuruí after impoundment
Pre impoundment GHG balance

- CO₂
- CH₄/CO₂
- CH₄

Forest
River
Wetlands

from Yves Prairie
Post impoundment GHG balance

Forest

River

Wetlands

from Yves Prairie
Net emissions concept

Before reservoir construction

Divided into components
1. River basin
2. Downstream river reach
Net emissions concept

After reservoir construction

Divided into components
1. River basin with reservoir
2. Reservoir
3. River reach between dam and power plant outlet
4. River reach downstream power plant outlet
Main processes

Catchment

Oceans

Sediments

Oxic ?
Anoxic ?

Flux through macrophytes

CO₂, CH₄ diffusion

Reservoir

DAM

CO₂, CH₄ degassing

Diffusion and bubbling

DOWNSTREAM EMISSIONS

1
3

2

3
Main processes in the reservoir

1) Net emissions = sum of all arrows
2) Net carbon balance = sum of all arrows

after Huttunen
Conceptual Model - CH4

Oxidation of CH4 to CO2 by methanotrophs
Diffusion to atmosphere

Organic matter $\rightarrow$ CO2 + CH4

Expansive shallow systems

Deep systems

Stream

from B. Sherman
Net emissions =

After impoundment

Before impoundment

Excluding unrelated anthropogenic sources

From Julie Bastien

From Joel Goldenfum
Spatial and temporal resolution

Conditions & factors

Seasons & operation

Method

Practical
Comparision of *gross* emissions

Nam Leuk, Laos:  
78 g CO$_2$/kWh

Nam Ngum, Laos:  
-60 g CO$_2$/kWh

Petit Saut, French Guyane:  
970 g CO$_2$/kWh

Follsjø, Norway  
2 g CO$_2$/kWh
Source to biased conclusions – reported high **gross** reservoir emissions from Brazil

- Petit Saut, French Guyane: 970 g CO$_2$/kWh
- Nam Leuk, Laos: 78 g CO$_2$/kWh
- Nam Ngum, Laos: -60 g CO$_2$/kWh
....takk for oppmerksomheten!