The sustainability of bioenergy: Some questions in search of answers

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Outline

What is current context: food crops?

Unintended consequences: do they matter?

C&I and certification?

What is current context: forestry?

How can we be proactive?

Approach

“One person’s view of sport” by highlighting questions

Why bioenergy?

- Energy security (home-grown crops)
- International policy (Middle East)
- Farm income (better price for farmers)
- Rural development (new industry)
- Subsidize forestry sector (co-generation)
- New forestry product (diversify market)
- GHG reduction (renewable C)

Is bioenergy renewable?

- Global GHG issues are immediate (Kyoto)
- C renewal rate for agricultural crops
  - 1 year
  - annual, perennial
- C renewal rate for forests
  - “forest estate” perspective
    - lumpers
    - immediate
  - “forest site” perspective
    - splitters
    - over full rotation

What is energy balance?

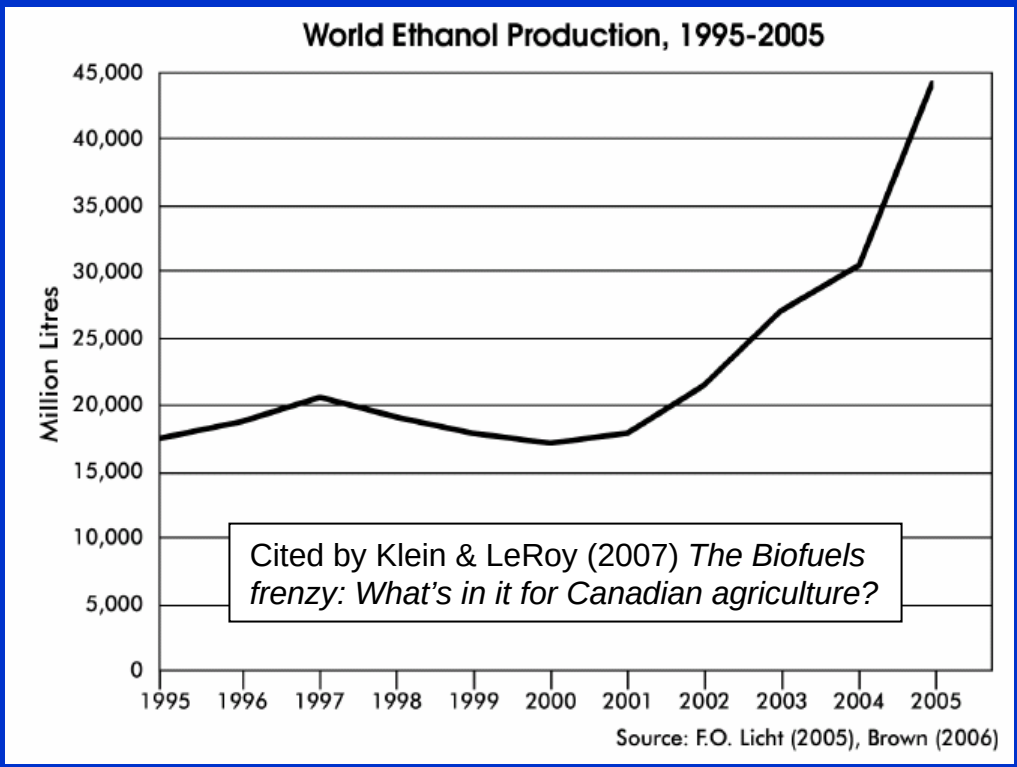
(LCA: energy to produce 1 megajoule)

Gasoline, petrodiesel	1.1 to 1.4 mj
Tar sands oil	~2 mj
Grain ethanol	0.8 mj
Biodiesel	0.3 mj
Cellulosic ethanol	0.1 mj
Wood	0.05 mj

0.046 tonnes GHG/MWH for wood (including 780 km trucking) cf. 1.02 for coal (for cogeneration in northern Alberta) = ~5% (Stennes & McBeath 2006)

Where are we going in agriculture?

- Europe & Brazil ahead of North America
- 2006-07 a “tipping point” for North America:
  - 5% liquid biofuels in Canada = 18% of crops (5% in gasoline by 2010; 2% in diesel and heating oil by 2012)
  - 12% ethanol & 6% biodiesel in US = *all* corn & soy
    - US targets = 3x to 5x US corn production



Achim Steiner, Executive Director, UN Environment Program (UNEP)

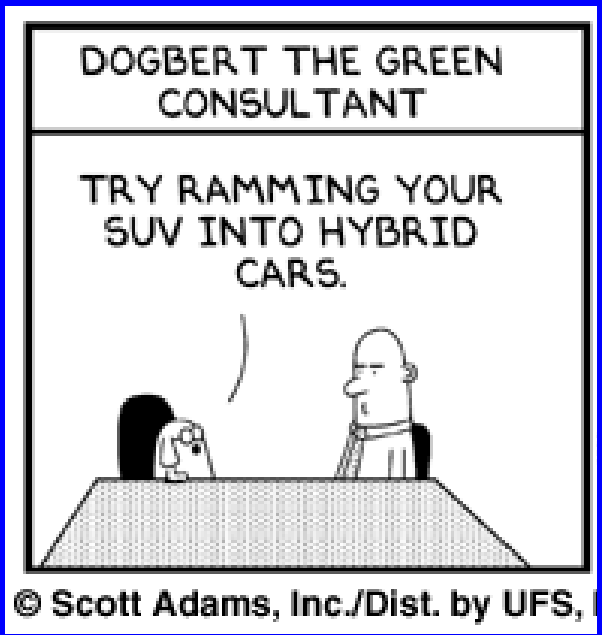
"A new breed of "prospectors" have set off a rush to claim their stakes in the green gold [rush] of biodiesel and ethanol…

"[We] need to remember the law of unintended consequences…

"The path to sustainable development is paved with well-intentioned but failed projects…"

Baltimore Sun, February 13, 2007, http://www.uneptie.org/energy/act/bio/op-ed.htm

Who pays for unintended consequences?



What is effect on grain prices?

(Increases March 2006 to March 2007)

Corn[1]	86%
Soybeans[1]	32%
Oats[1]	39%
Feed barley[2]	54%
Feed wheat[2]	59%

From Klein & LeRoy (2007) *The Biofuels frenzy: What's in it for Canadian agriculture?*

1. Chicago Board of Trade; 2. Winnipeg Commodity Exchange

What is effect on food prices?

(Increases over past year)

Eggs	125%
Chicken breasts	90%
Corn	53%
Butter	24%
Bacon	17%
Beef	16%

Source: U.S. Department of Labor and
Stephens Inc. report of May 15, 2007

Where are we going in agriculture?

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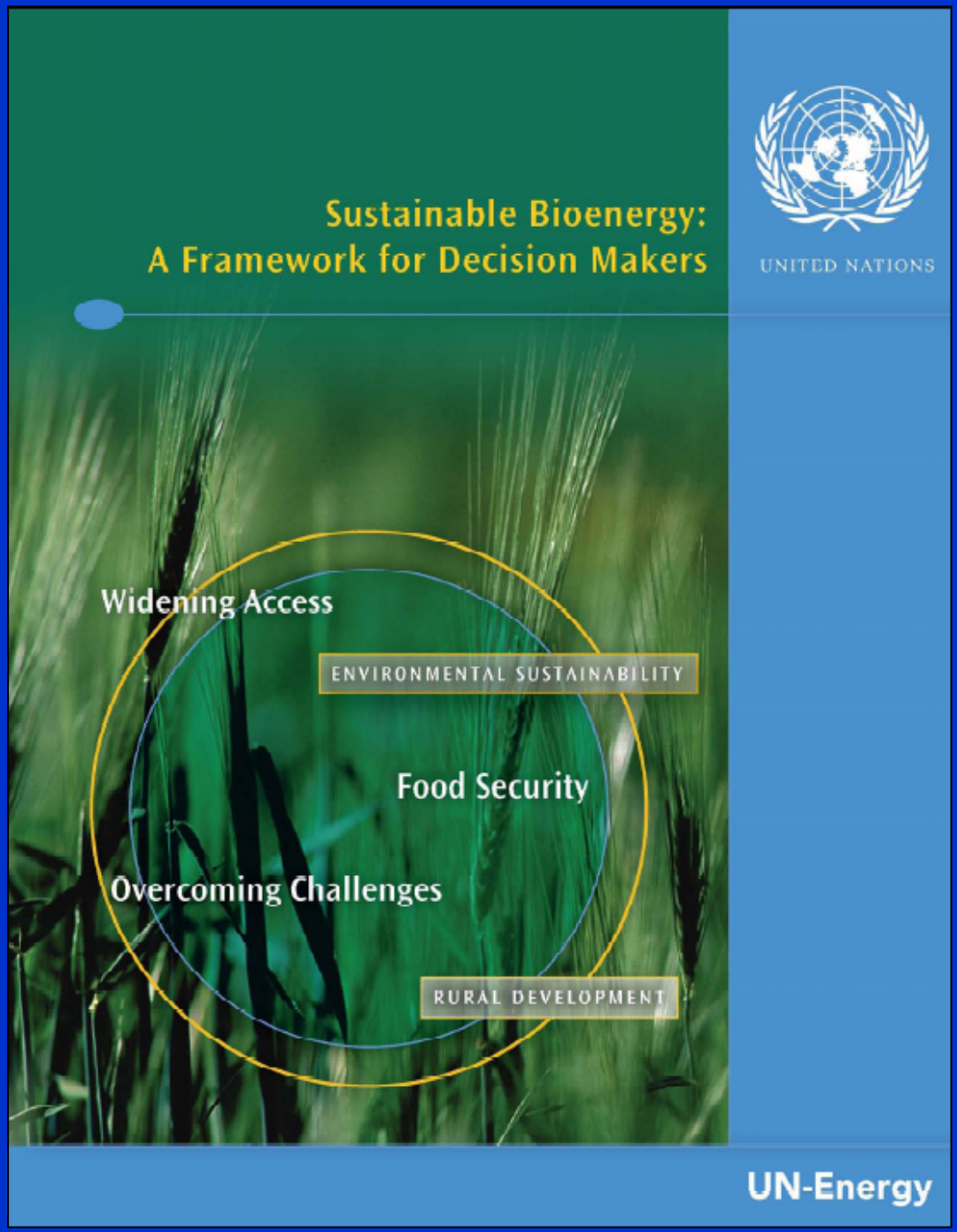
- 2006-07 a “tipping point” for North America:
  - 5% liquid biofuels in Canada = 18% of crops
    - 5% in gasoline by 2010; 2% in diesel and heating oil by 2012
  - 12% ethanol & 6% biodiesel in US = *all* corn & soy
    - US targets = 3x to 5x US corn production
- Global demand → increases in crop prices:
  - ***Corn:*** 75,000+ people in “tortilla riots” in Mexico
  - ***Oil palm:*** deforestation in Malaysia & wetlands in Indonesia = large C release
  - ***Soy:*** 100,000 ha/yr deforestation in Bolivia (& indigenous peoples); paved road in Amazon to export soy → illegal deforestation
  - ***Knock-on effect:*** crop conversion → price inflation for non-biofuel crops

Are liquid biofuels sustainable?

- ***Local protest:*** biodiesel plant using palm oil cancelled in UK
- ***Global protest:*** increasing number of petitions against developed countries
- **UN** grappling with *unintended consequences* and *sustainability* (social, ecological, economic)



UN report (April 2007)

"*Bioenergy requires a multidiciplinary and global approach if it is to play the key role expected by… the energy, agricultural and environment sectors*"

What does UN Report say about Sustainable Bioenergy?

Along with knowledge generation, compilation, & transfer (North to South):

- C&I to be mainstreamed into projects and programs
- Establish internationally agreed standards and certification models

Are C&I the answer?

- Dutch government's Cramer Commission
  (reported July 2006; refinements to C&I late 2006; 1st step 2007, 2nd step 2011)
  - "*to formulate a set of sustainability criteria for the production and conversion of biomass for energy, fuels and chemistry*"
  - "*no distinction… between imported biomass and biomass that is produced in the Netherlands*"
  - "*An internationally watertight monitoring and registration system will be needed*"
  - C&I "*must integrate into … policy frameworks at the national, European & global level*"

Cramer C&I the new "standard"?

6 themes, each with C&I

(#2-6 range from "*insight*" to "*no negative*" between 2007 & 2011)

1. lifecycle GHG balance (>30% reduction from fossil fuel reference for 2007; 50% for 2011)
2. Competition with food, local energy supply, medicines and building materials
3. Biodiversity
4. Economic prosperity
5. Social well-being
6. Environment

Cramer Commission (2006) *Criteria for sustainable biomass production*, 14 July 2006, the Netherlands.

http://www.forum-ue.de/bioenergy/txtpdf/project_group_netherlands_criteria_for_biomass_production_102006bonn.pdf

Cramer Environment Indicator?

Criteria: No negative effects on local environment

Indicators *(that could also relate to forestry)*:

- Local guidelines and legislation
- Erosion
- Steep soils, marginal or vulnerable soils
- Nutrient balance

Are N. Am. consumers familiar with certification?

Are consumers ready for certified bioenergy?


PEFC
100% FROM A CERTIFIED FOREST
FSC
SFI IMPLEMENTATION COMMITTEE
The mark of sustainable forestry in California
FORCERT
Forest Management & Product Certification Service

Summary so far…

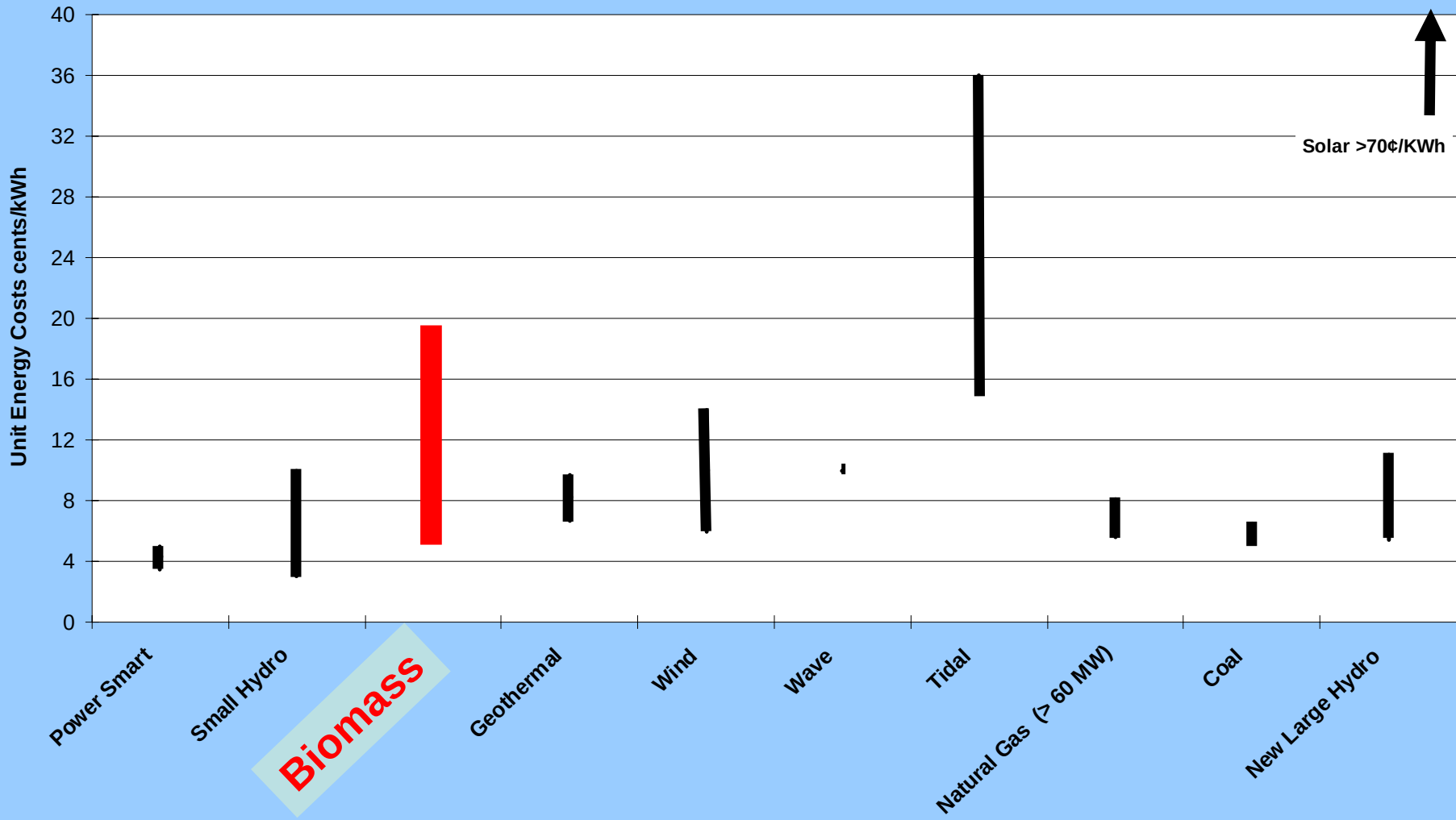
- Agricultural biofuels are not a panacea
- Unintended consequences (& Canada is not immune)
- Calls for C&I and certification
- Dutch have implemented C&I process
- Are North American public open to the concept of global certification?

Where are we going in forestry?

- ***Sweden and Finland:*** 20% from forests
- ***Canada:*** 6% from forests (wood waste)
  - half of this generated BC
  - cf. 76% potential for Canada (Wetezel et al. 2006)
  - 30% potential for BC (cf. total BC energy; Ralevic & Layzell)
- Why so little in Canada?
  - *Hydro:* QC, MB and BC have 3 cheapest electricity prices in North America
  - *Economics:* wood is high volume/mass and low value = tough market to compete in…

Levelized Unit Energy Costs

(BC Hydro, 2003)



Where are we going in forestry?

- "1st generation" (ethanol, biodiesel) → "2nd generation":
  - syngas
  - cellulosic ethanol (Iogen, Lignol, UBC)
  - bio-oil (pyrolysis)
- Cellulosic ethanol from stover (→ loss of SOM?) & perennial grasses; forests = huge feedstock supply
- Technological advances in forestry, notably:

John Deere 1490D Slash Bundler

One bundle contains
1 MWh of energy

Stumps for biomass

6000 ha/year pulled in Finland; Sweden now doing operational trials

"Build and they will come"

Once committed to bioenergy, can we end up with "unintended consequences", as with food crops?

Advanced BioRefinery Inc. (ABRI), Ottawa

Portable (flat bed trucks) 50 Dry Ton Per Day (DTPD) conversion plant

What about BC?

- New BC Energy Plan (27 Feb. 2007)
  - zero net GHG emissions from all new projects
  - BC to be self-sufficient in electricity by 2016
- Call for Proposals by BC Hydro (with EMPR, MOFR, forestry & energy sectors; projects by end of 2007)
- Specific Bioenergy Strategy TBA (soon!)
- Will P&P and lumber give way to bioenergy? (Craig Campbell, PWC, 10 May 2007)

Are we ready?

Low-hanging fruit = “underutilized wood residue”

Sawmill residue

1.2 x 10^6 BDt burned in beehives = good use of resource

Courtesy of Alec McBeath

Roadside logging residue

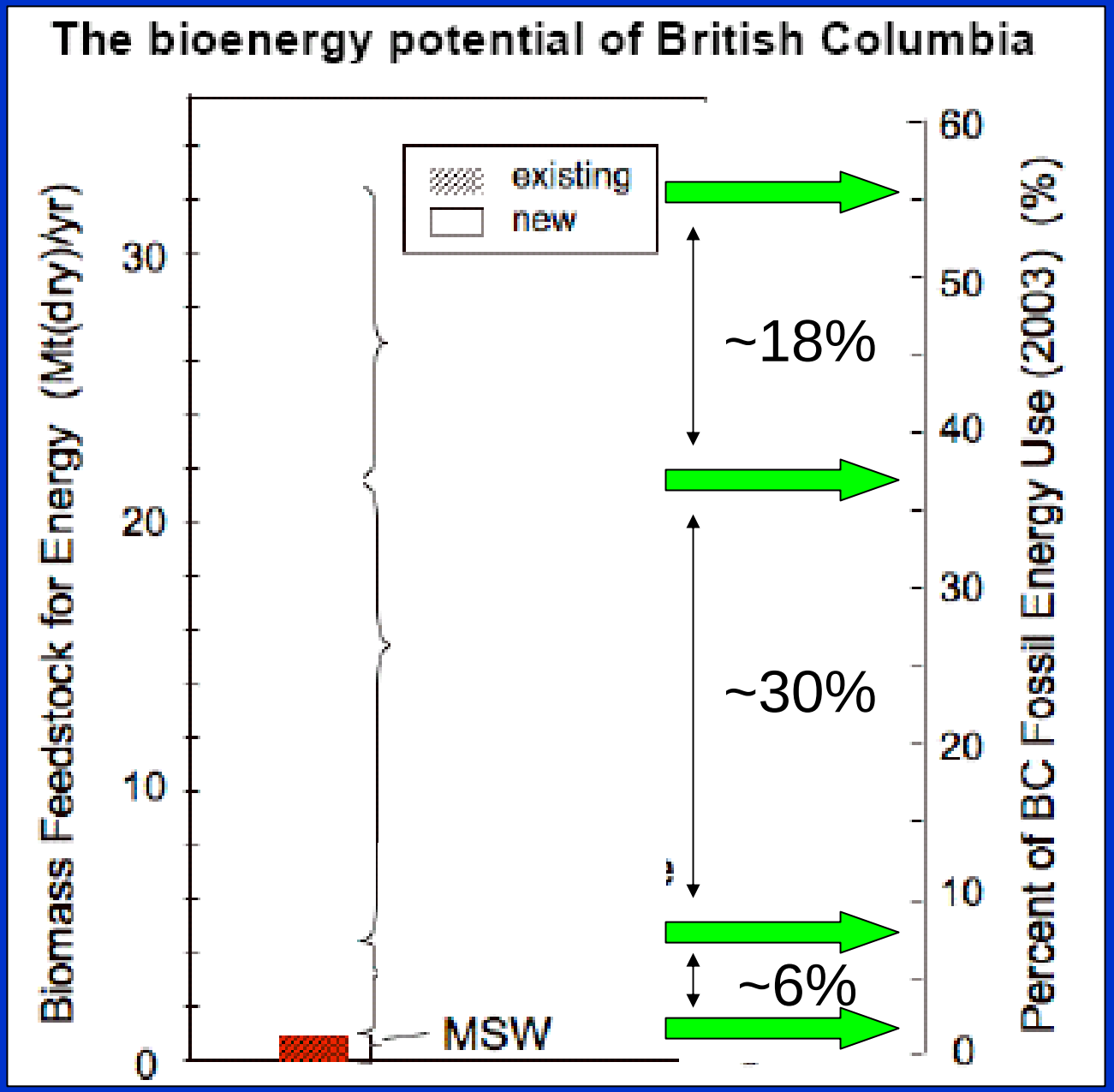
- 7 x 10^6 BDt in Central Interior
- *Maritimes:* opposition to full-length to roadside
- *Quebec:* documentary highlighted slash piles; public concern
- *Ontario:* public input to biorefining; boreal controversy
- Even though

Courtesy of Art Shortreid

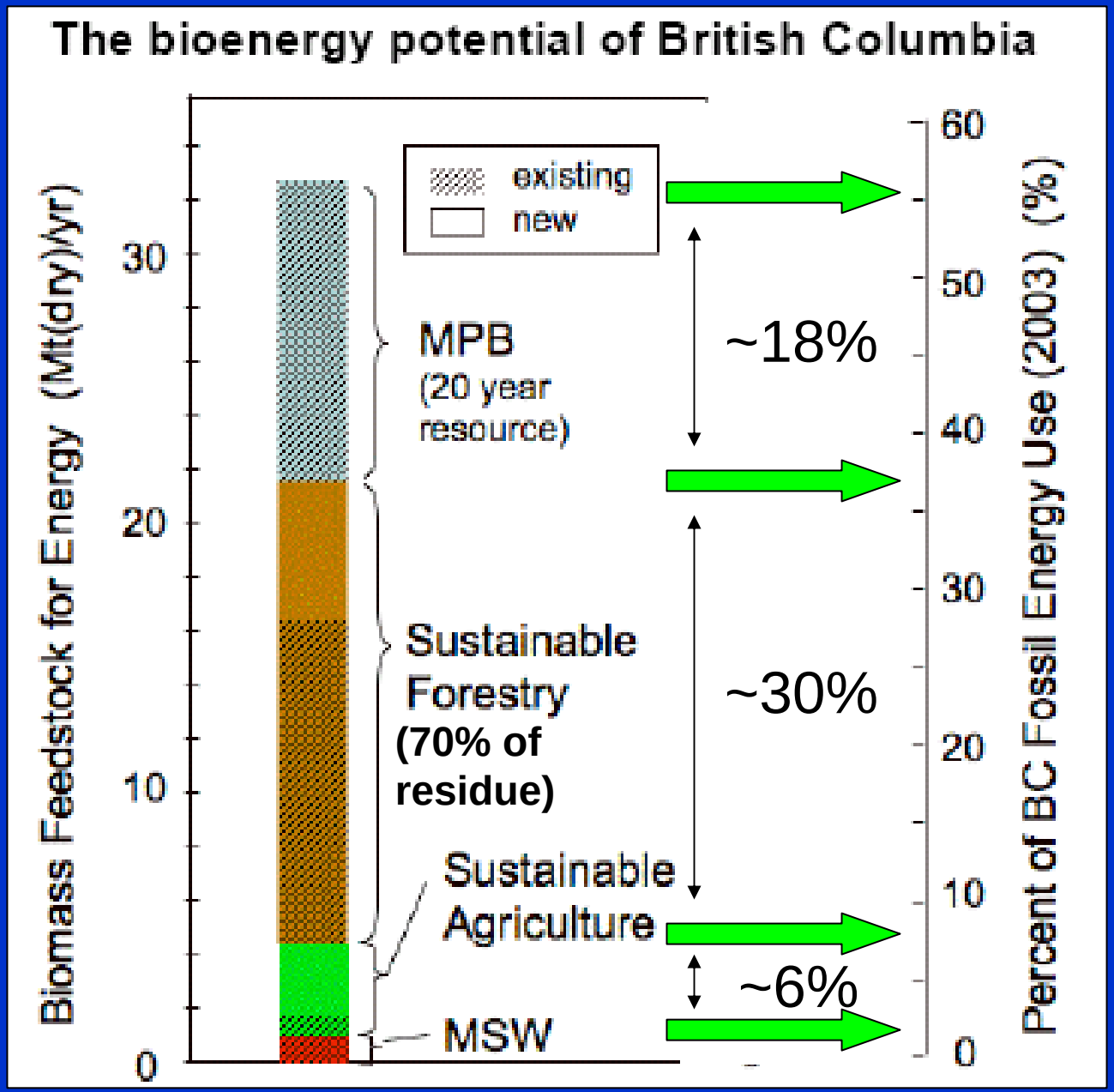
MPB-killed wood

- 400 x 10^6 to 1 billion BDt non-recoverable for timber
- MPB is limited resource
- Stop gap: “see us over the hump”?

Stagnant stand 20 years after MPB in SE BC (Courtesy of Alec McBeath)



From Ralevic, P. & Layzell, D.B. 2006. *An Inventory of the Bioenergy Potential of British Columbia*, BIOCAP Canada Foundation
http://www.biocap.ca/images/pdfs/BC_Inventory_Final-06Nov15.pdf



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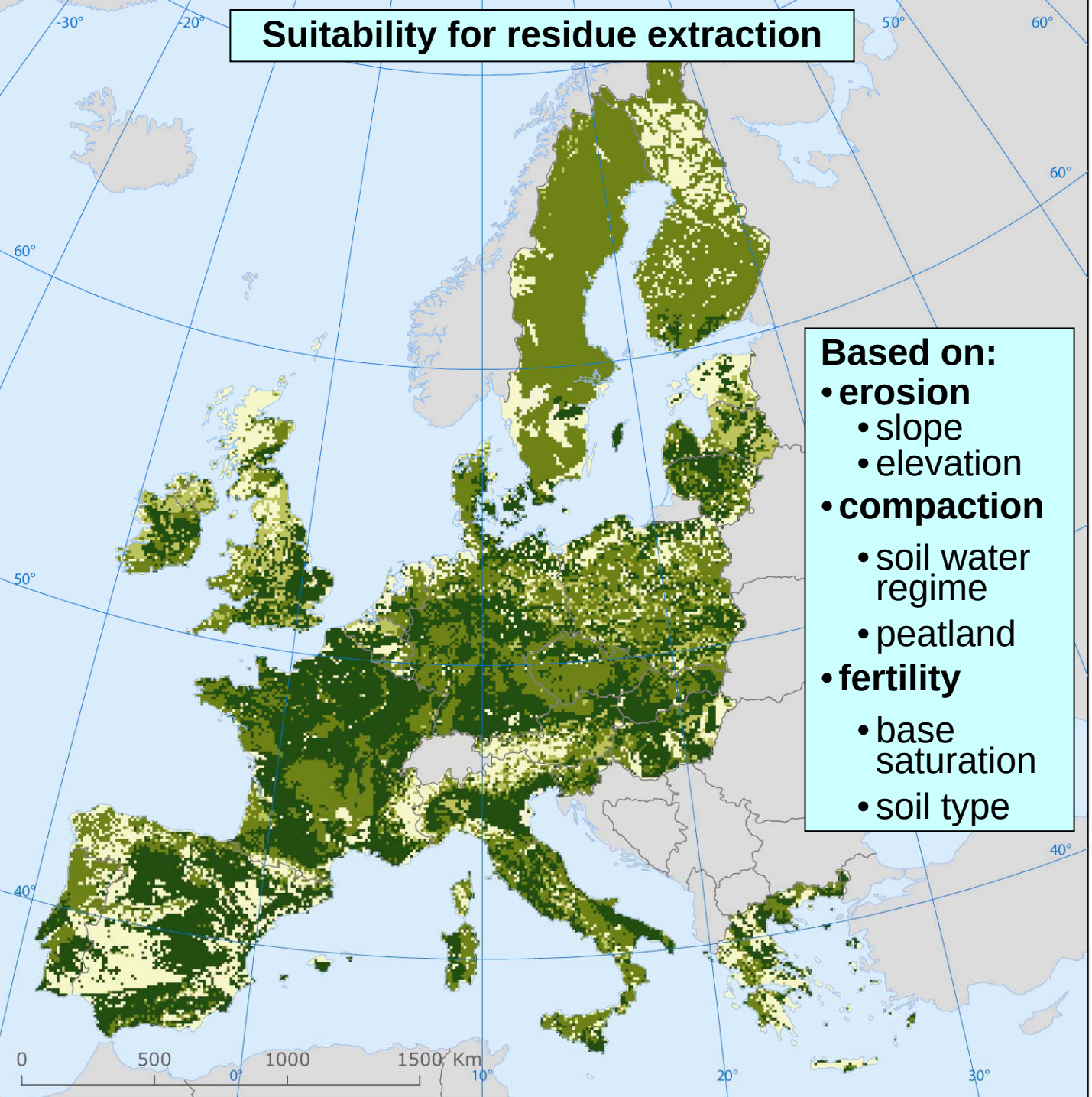
http://www.biocap.ca/images/pdfs/BC_Inventory_Final-06Nov15.pdf

Suitability for residue extraction



Based on:

- **erosion**
  - slope
  - elevation
- **compaction**
  - soil water regime
  - peatland
- **fertility**
  - base saturation
  - soil type

Suitability for residue extraction according to environmental criteria

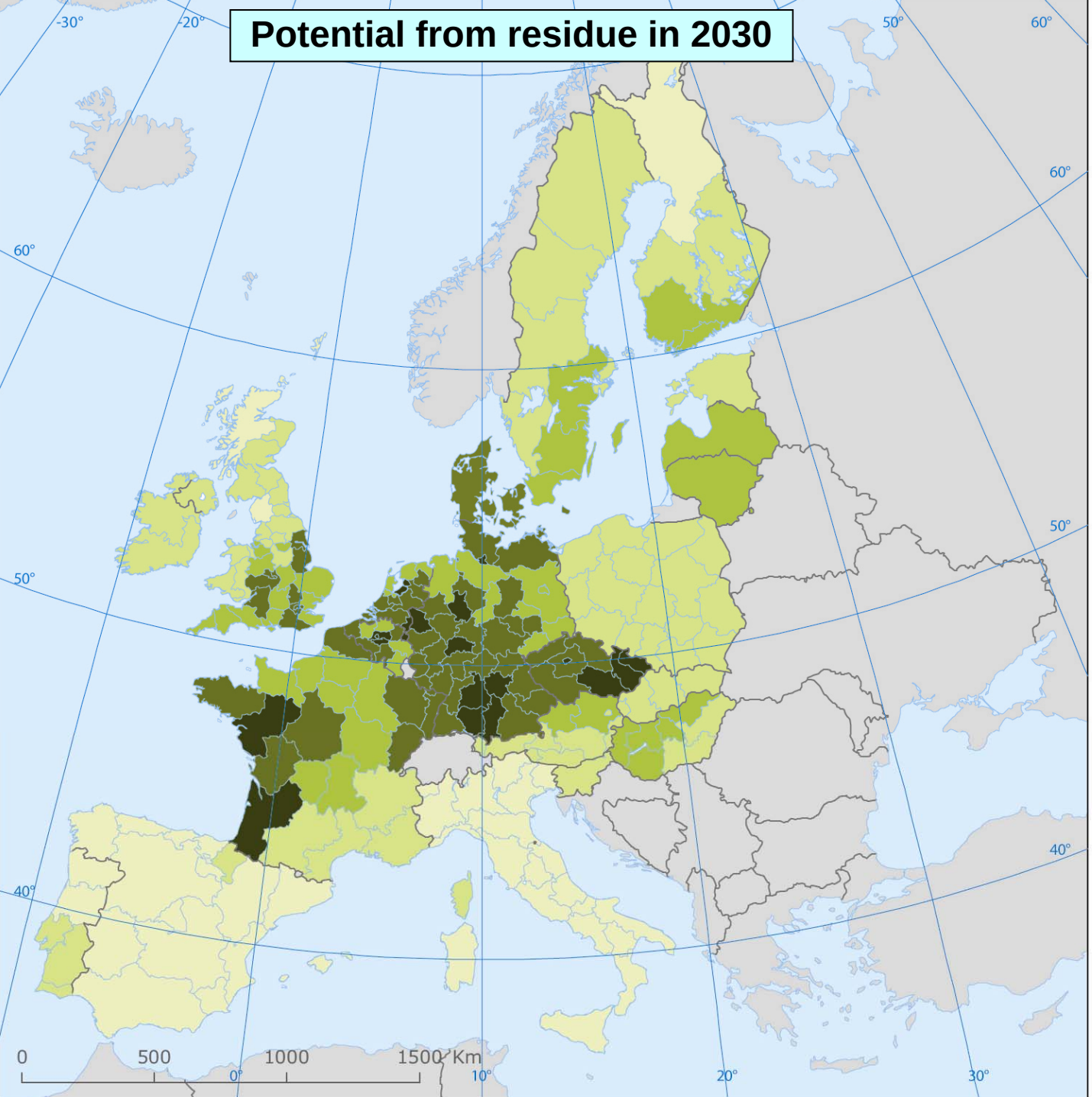
- Highly suitable
- Moderately suitable
- Marginally suitable
- Unsuitable
- Outside data coverage

High: 75% (=60%)
Moderate: 50% (=40%)
Marginal: 15% (=12%)

From: European Environment Agency. 2006. ***How much bioenergy can Europe produce without harming the environment?*** EEA Report No 7/2006. 67 pp.

http://reports.eea.europa.eu/eea_report_2006_7/en/eea_report_7_2006.pdf

Potential from residue in 2030



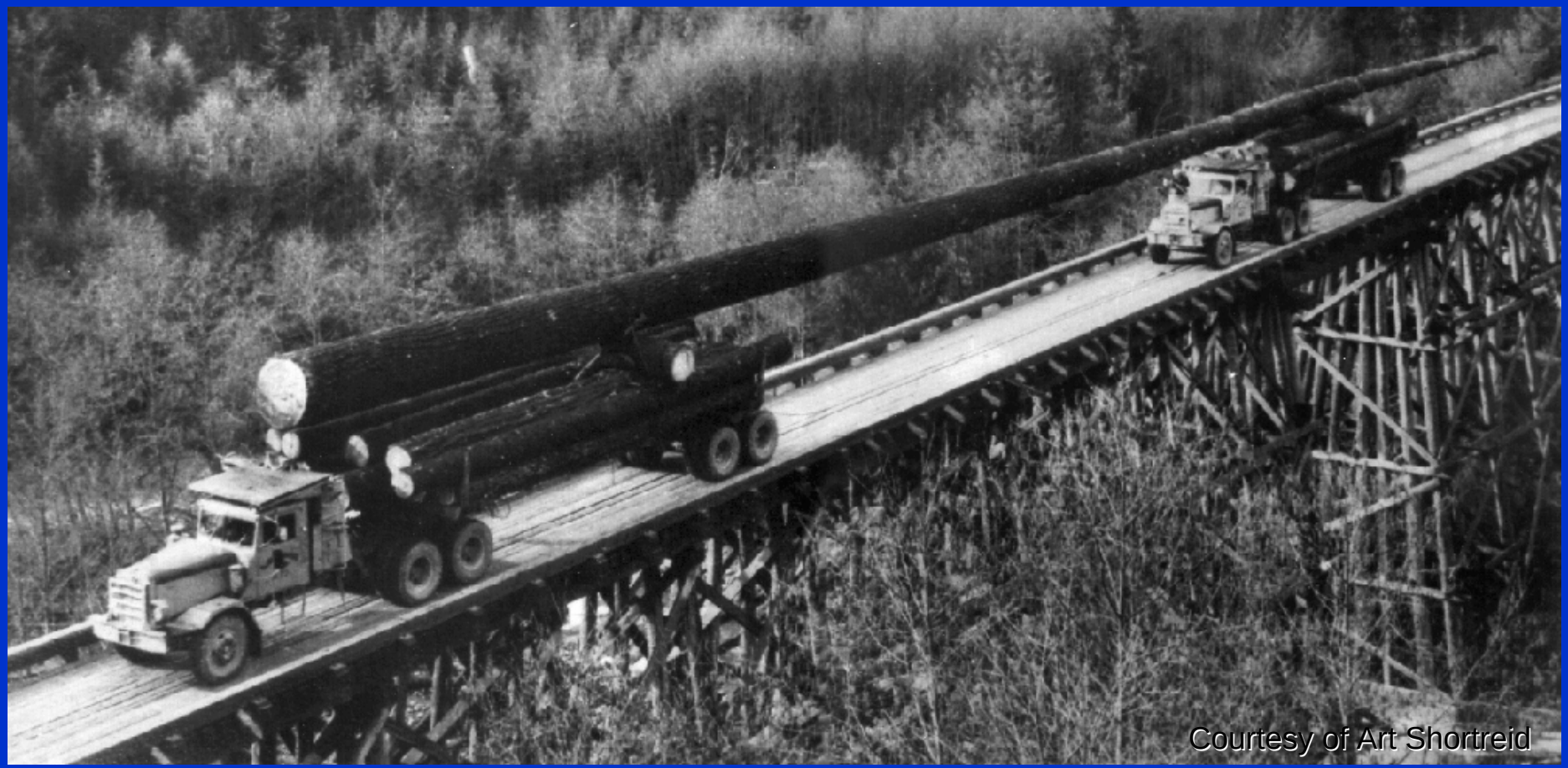
tOE per km² forest area

- 0–5
- 5–15
- 15–25
- 25–35
- > 35
- Outside data coverage

From: European Environment Agency. 2006. ***How much bioenergy can Europe produce without harming the environment?*** EEA Report No 7/2006. 67 pp.

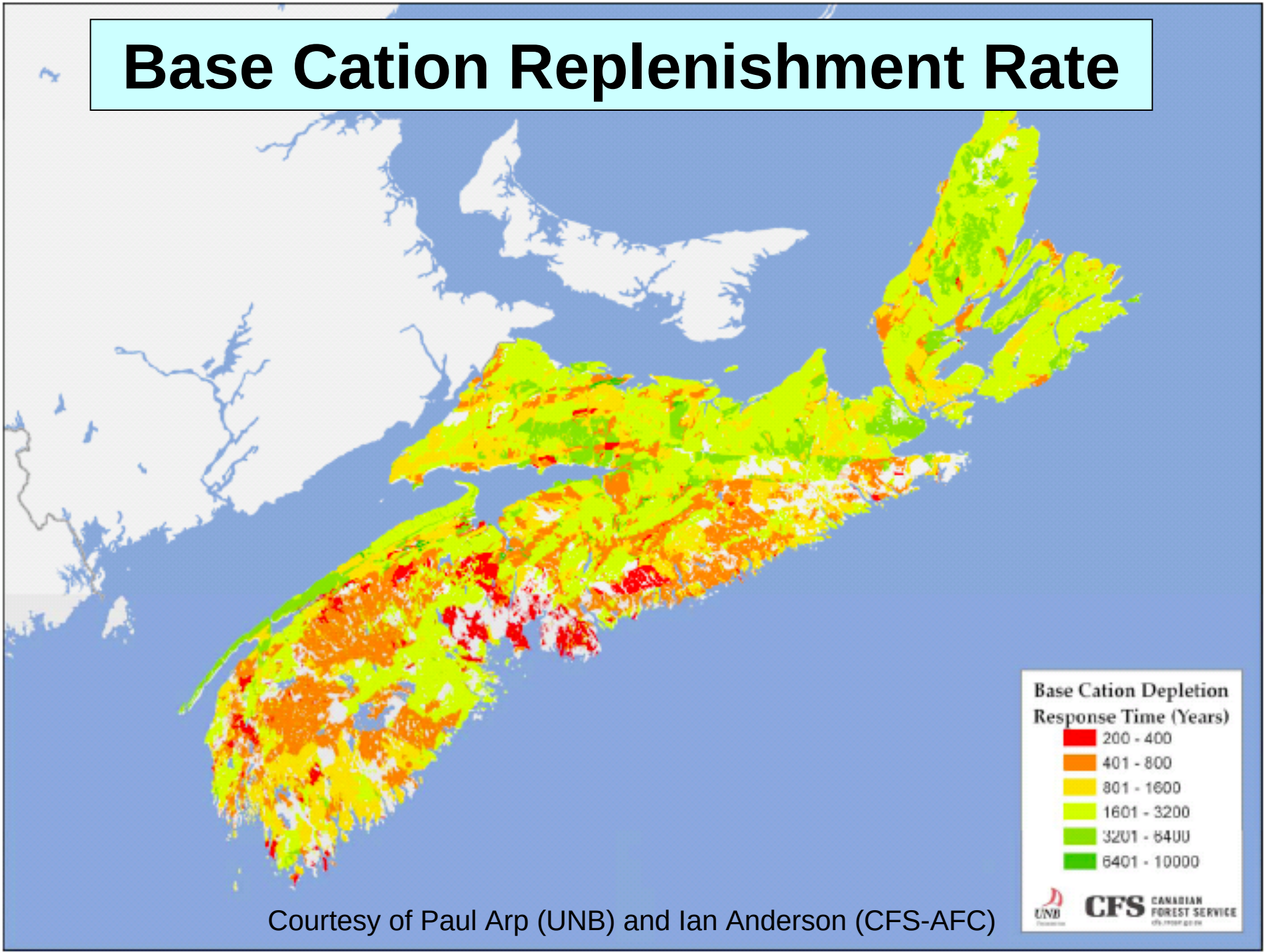
http://reports.eea.europa.eu/eea_report_2006_7/en/eea_report_7_2006.pdf

What happens if we remove more than just logs?



370-yr-old, 275-ft (84-m) Douglas-fir log (1958)

Base Cation Replenishment Rate



Courtesy of Paul Arp (UNB) and Ian Anderson (CFS-AFC)

Ca in PNW
(Oregon Coast Range)

Ca inputs (kg/ha) in young Douglas-fir stands

Wet deposition	0.90
Cloud deposition	0.60
Weathering	0.05
Total	1.55

Pool or flux	STO	WTH
Years of available Ca supply	402	54

Perakis, S.S. et al. 2006. Coupled nitrogen and calcium cycles in forests of the Oregon Coast Range. Ecosystems 9: 63-74.

What might we do?

- “Low hanging fruit”, but need to address thinning and slash removal questions now (cannot buy time…)
- Consolidate knowledge and make it easily accessible (provincially, nationally, globally)
  - Current WTH field trials a good starting point
  - Compile data on other relevant trials/research
  - Gap analyses and syntheses
  - Weathering rates, base cations, Ca/Al, PROFILE
  - Compile relevant spatial layers and maps
  - Address scaling questions to relate point-data to spatial units (scaling up)

What might we do?

- Concentric layers of research intensity (based on costs & need for knowledge)
  - Intensive research trials on selected, key sites
  - Extensive but less intensive “legacy” trials (establish now; only measure in future if needed)
  - Monitoring (e.g., BC Soils remote sensing study)
- Environmentally-sensitive biomass inventory
- Work towards guidelines
- Work towards C&I, certification (level playing field with agriculture)
- Adaptive management will be essential
- Where to process models fit in?

What might we do?

- Clarify terminology at outset:
  - “biofuels”, or “biomass”?
  - “logging waste”, or “slash”, “residue”?
  - “C neutral”, or “C lean”?
- Collegial collaboration (research strategies depend more on this, and serendipity, than on top-down planning)
- Inter-provincial networks and working groups, to share knowledge and minimize duplication
- Time is of the essence (can never have enough good, long-term field trials)


END

Are we ready?

- Guidelines for biomass removals need nutrient & site data & knowledge
  - ***Denmark:*** leave all slash till foliage drops
  - ***Sweden:*** leave most of foliage, or else need compensatory fertilization
  - ***Finland:*** depends on site type; greatest removal is 70% of slash or equivalent removal of nutrients on richest sites

Are we ready?

Low-hanging fruit = “underutilized wood residue”

- Sawmill residue
  - 1.2 x 10^6 BDt burned in beehives = good use of resource
- Logging residue
  - 7 x 10^6 BDt in Central Interior
  - *Quebec:* documentary highlighted slash piles; public concern
  - *Maritimes:* opposition to full-length to roadside
  - *Ontario:* public input to biorefining; boreal controversy
  - Even though presently burnt, will public approve when they find out?
- MPB-killed wood
  - 400 x 10^6 to 1 billion BDt non-recoverable for timber
  - MPB is limited resource
  - Stop gap: “see us over the hump”?