



Biological and Biotechnology Solutions to Climate Change

David B. Layzell, Ph.D., FRSC

President and CEO, BIOCAP Canada Foundation

*Professor & Research Chair, Dept. Biology and Institute for Energy & Environmental Policy,
Queen's University, Kingston, Ontario*

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Capturing Canada's Green Advantage

www.biocap.ca



21st Century Challenges

Climate Change



We need sustainable solutions...



Energy Price & Security



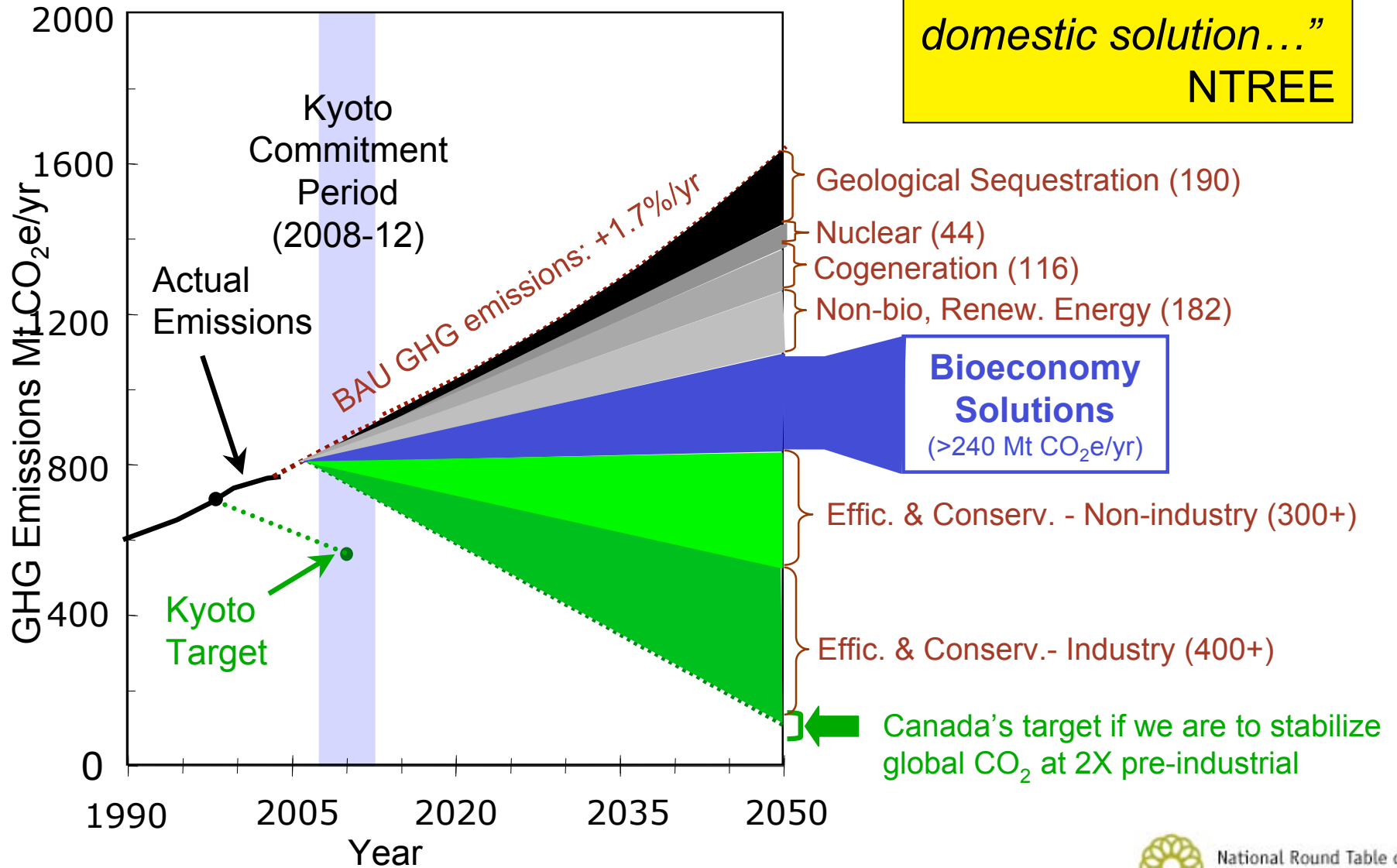
Iraq, Iran, Venezuela

Stabilization 'Wedges':

Modified from

National Round Table on the Environment & the Economy

"There can be a domestic solution..."
NTREE



* Modified from June 2006 "Advice on a long term strategy on Energy & Climate Change" NRTEE



Bioeconomy Solutions

Addressing Climate Change / Energy Priorities

Offsets

Agricultural carbon sinks:



30+ Mt/yr

- Low-tillage agriculture,
- Biochar into soils.

Forest carbon sinks



70+ Mt/yr

- Through improved mgmt and new technologies

Biosphere emission reductions



40 Mt/yr

From:

- Crop & animal production,
- Landfill sites,
- Managed aquatic systems.

Renewable Energy

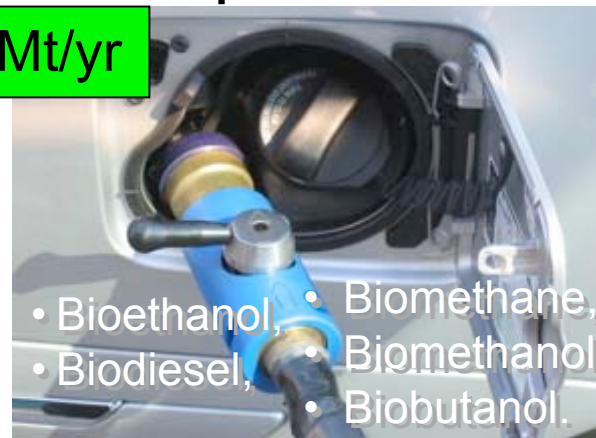
Heat and power



100+ Mt/yr

- Solid Fuels (e.g. wood or straw pellets)

Transportation fuels



- Bioethanol,
- Biodiesel,
- Biomethane,
- Biomethanol,
- Biobutanol.

By 2050, Canada's biosphere solutions could be as important as geological sequestration in reducing GHG emissions.

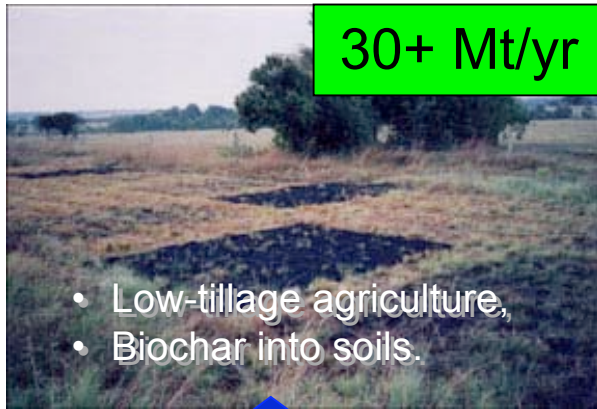
...with significant benefits to energy security & the rural economy

Bioeconomy Solutions

Addressing Climate Change / Energy Priorities

Offsets

Agricultural carbon sinks:



Forest carbon sinks



Biosphere emission reductions



(Bio)Technology Opportunities:

- Crops or soil microbes that build soil carbon;
- Bio-Charcoal into soils for fertility and carbon sink benefit.

- Tree genotypes optimized for future climate;
- Pest / disease resistance or control;
- Measurement / monitoring technologies.

- Waste to energy technologies (microbial & thermo-chemical);
- Management practices;
- Measurement / monitoring technologies.

...@ \$15-\$30/t CO₂e, market potential of \$2 - \$4B per year within Canada

Bioeconomy Solutions

Addressing Climate Change / Energy Priorities

Energy Comparison



1 tonne dry biomass = ~3 barrels oil
(\$50 to \$100) (over \$200)

Renewable Energy

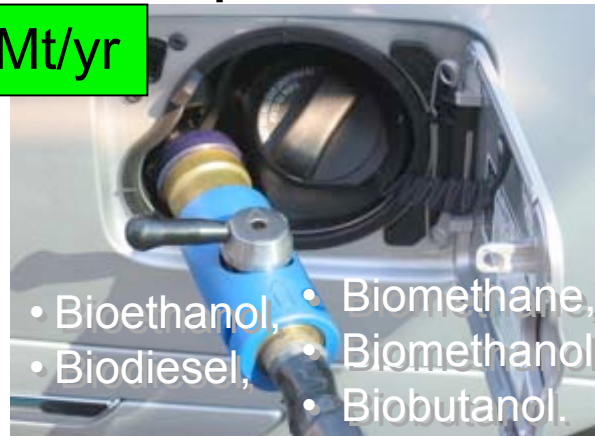
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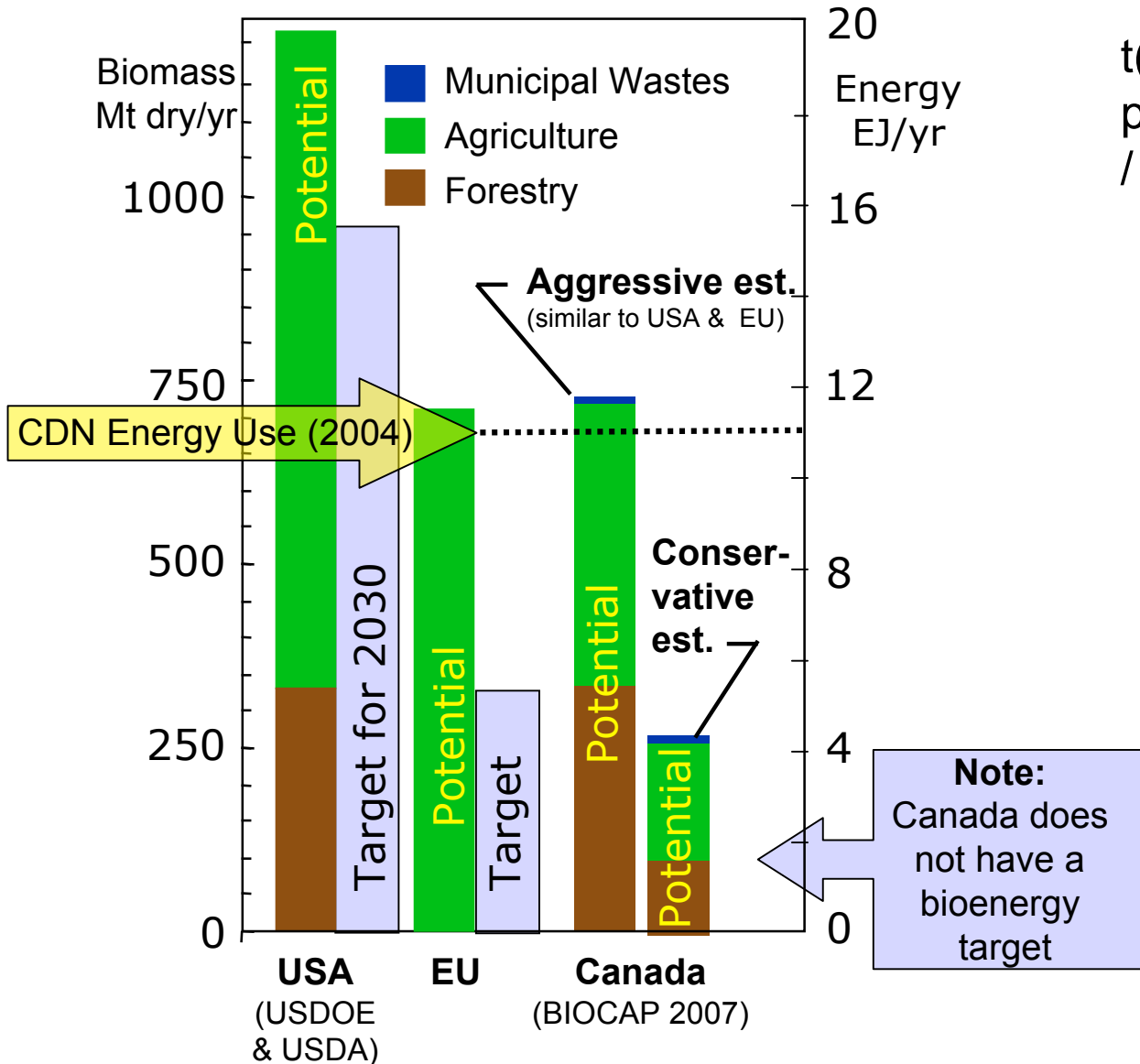


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- Biomethane
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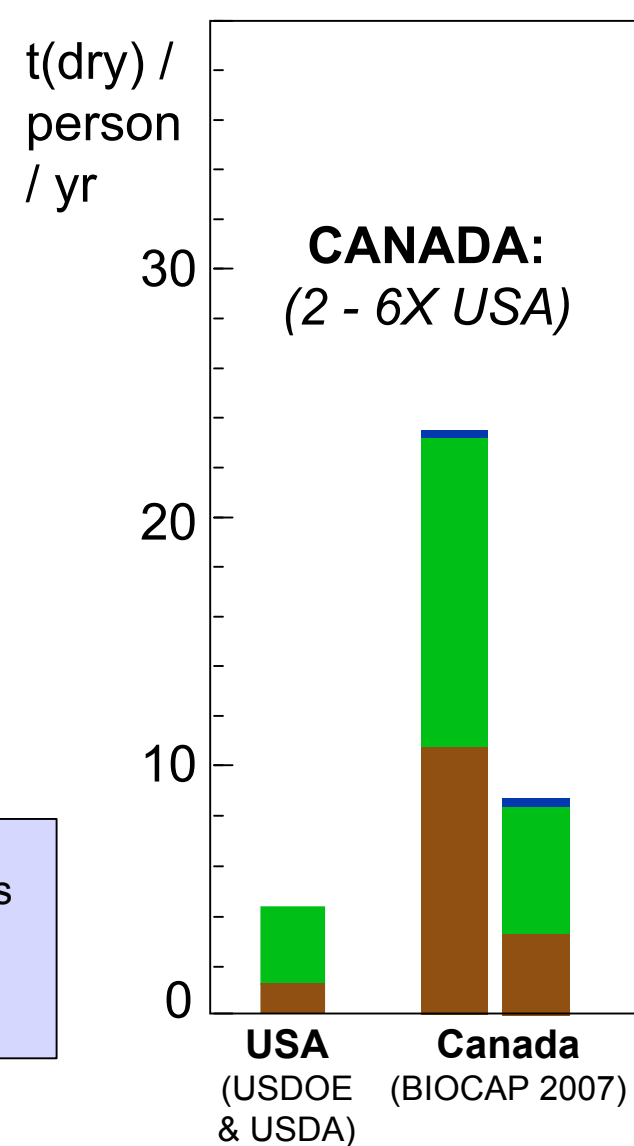
What is Canada's Bioenergy Potential?

Bioenergy Potentials & Targets

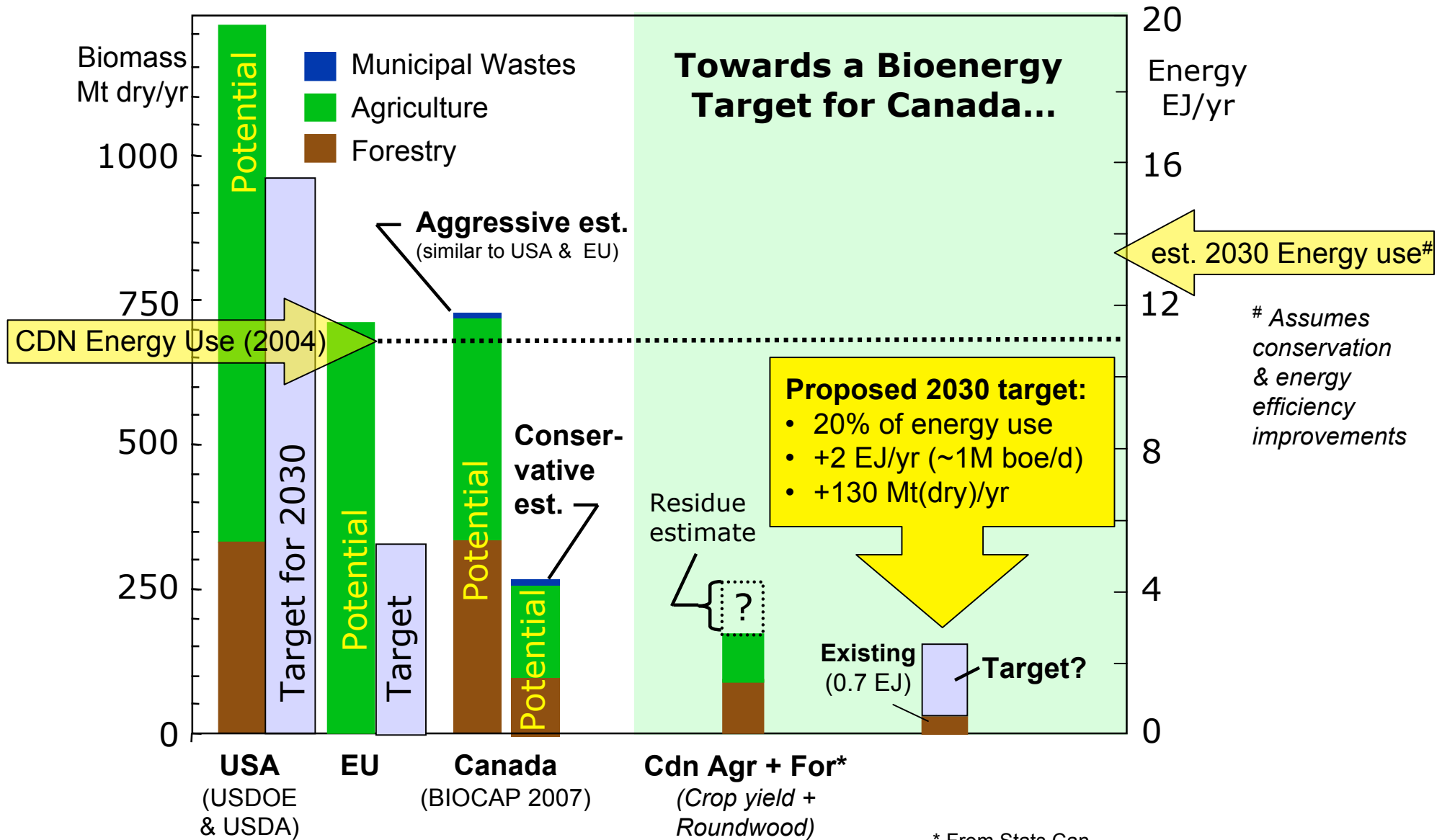
TOTAL



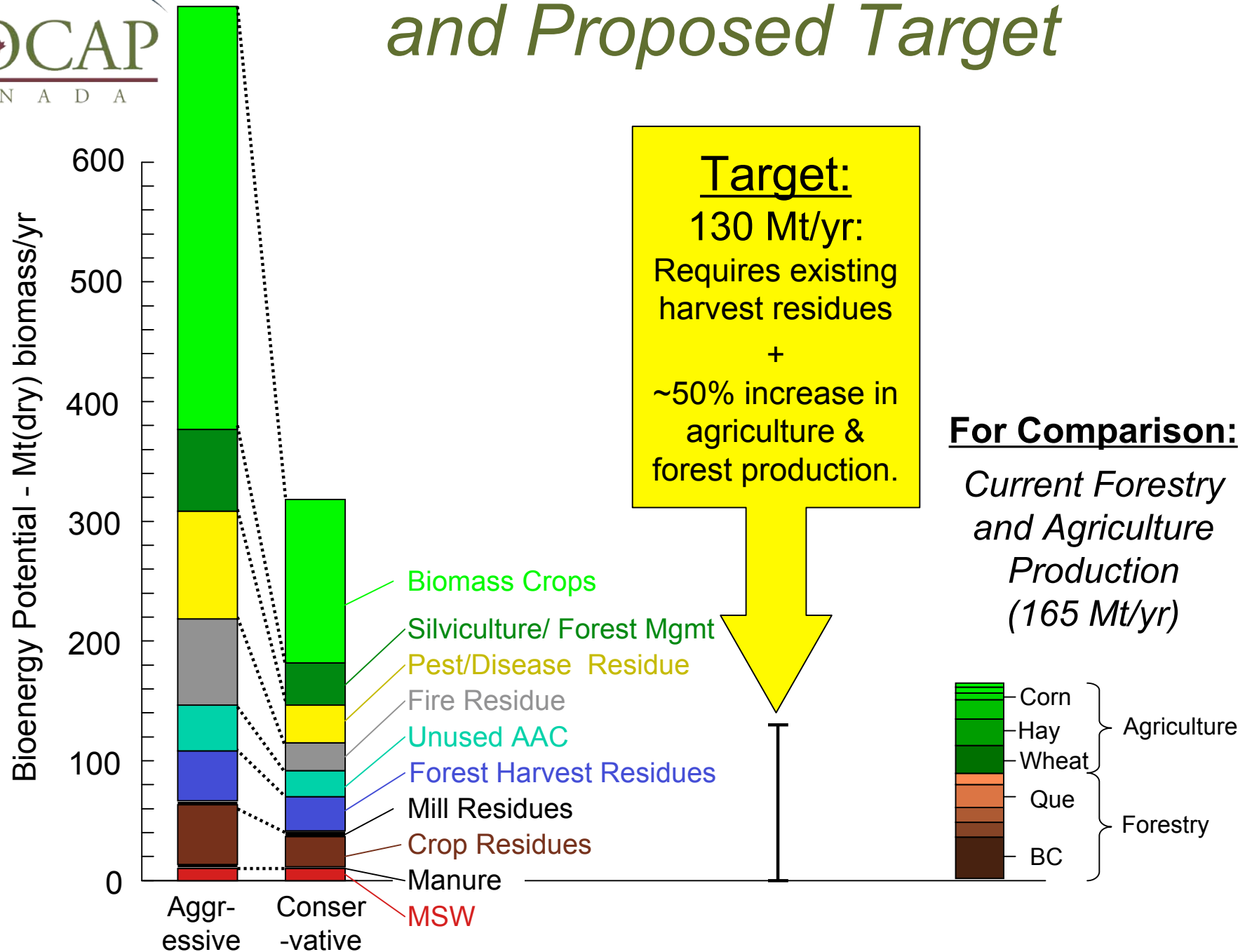
PER CAPITA



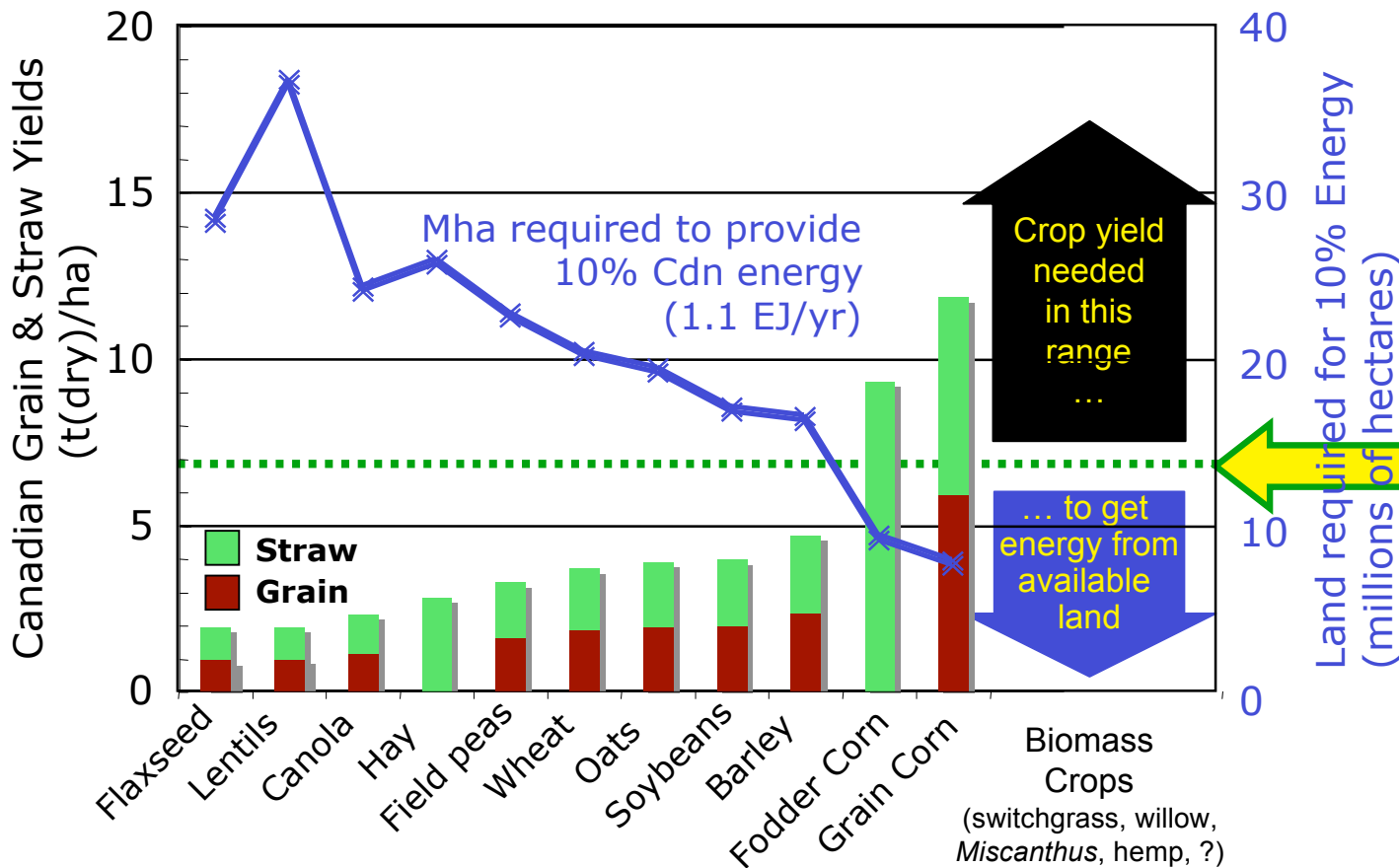
Bioenergy Potentials & Targets



Canada's Bioenergy Potential and Proposed Target



For large scale bioenergy, most food/feed crops don't make the grade



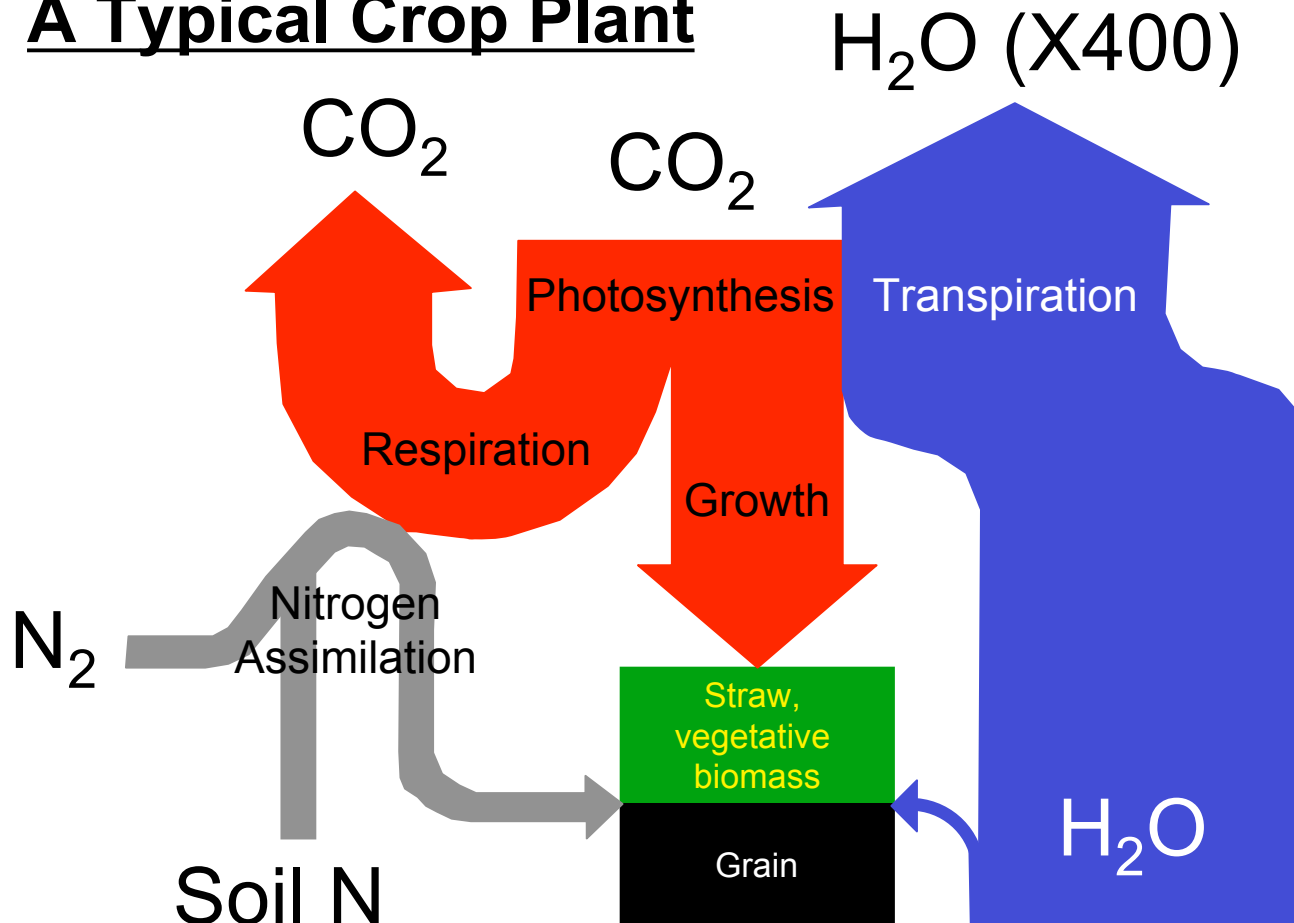
For biomass crops to provide 10% of Canada's energy demand (1.1 EJ/yr) on 10 Mha, the average yield will need to be ~6.8 t(dry)/ha

Source: Yield data from Stats Canada, assumes 1:1 straw:grain ratio; energy content: ligno-cellulose (16 GJ/t), oil (40 GJ/t); Oilseed content: Flax (45%), Canola (43%) soybean (20%)

Canadian agriculture needs new biomass crops

Building a Bioenergy Crop

A Typical Crop Plant



Crop Plant Limitations

Physiological:

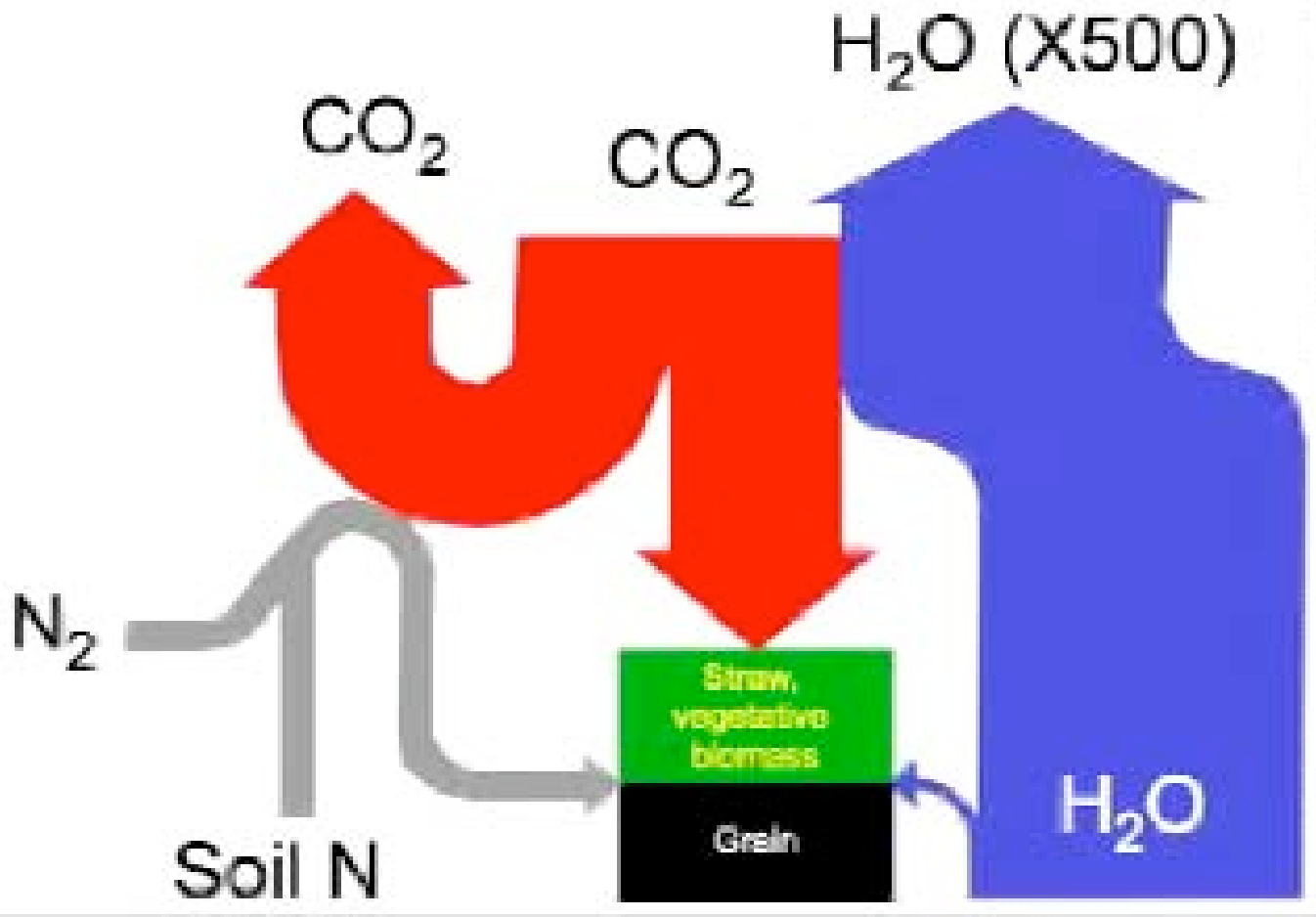
- Low Transpiration Efficiency;
 - 300-600 H_2O per 1 CO_2
- Half of C gain is lost in again;
 - Too much investment in N assimilation, etc.
- Not enough biomass/ha;
- Input costs too high;
- Straw biomass not optimized for energy use:
 - Need higher thermal energy content, lower nutritional value (e.g. protein, min., etc);
 - Need optimization for cellulose fermentation.

Ethical & Environmental:

- Food vs. Fuel debate;
 - For crops & agric. lands
- Life Cycle Analysis;
 - e.g. corn ethanol
- Loss of biodiversity
 - Need to get more on less land

Building a Bioenergy Crop

Characteristics of a Bioenergy crop



Physiological

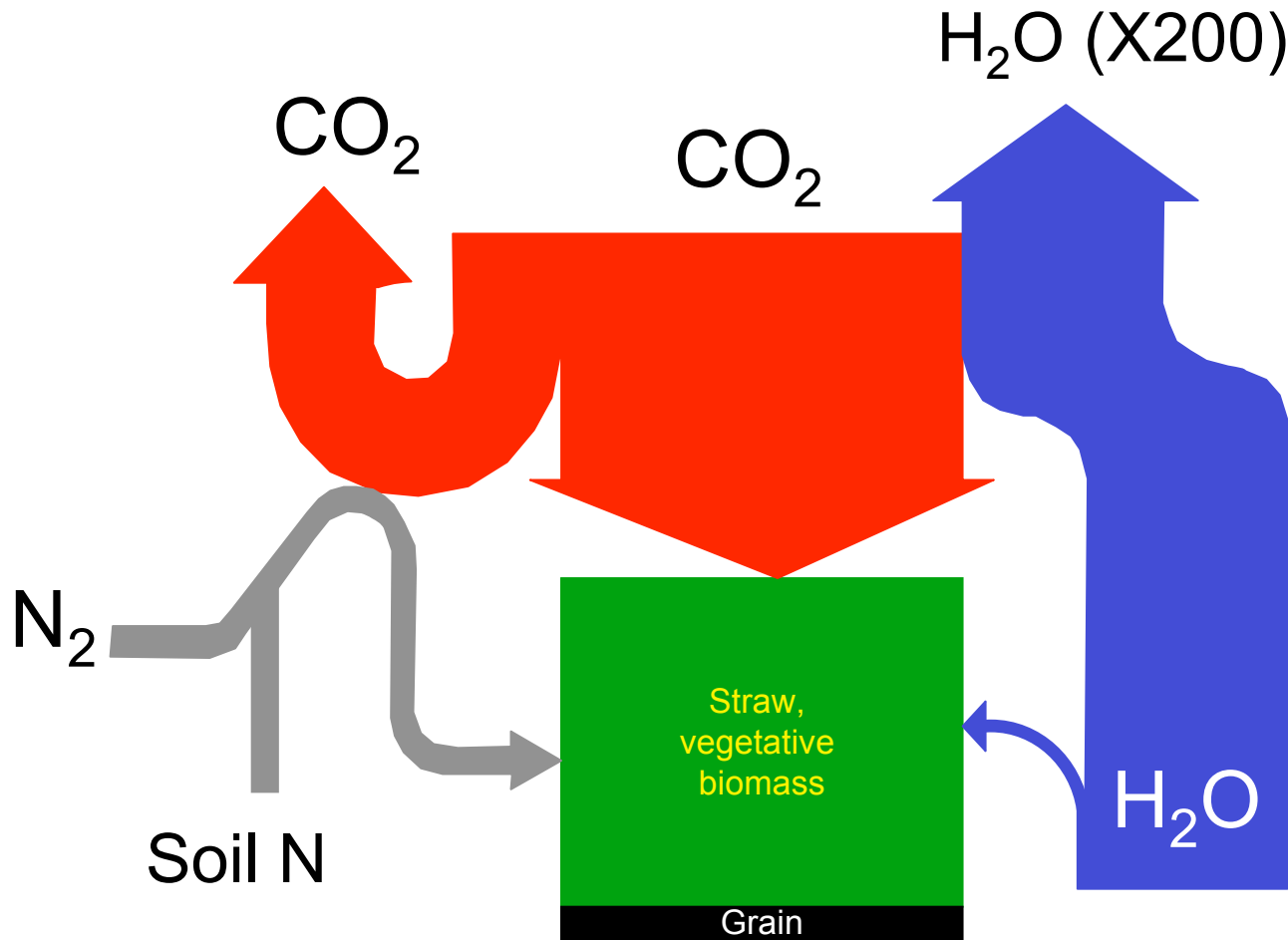
- ✓ Higher Photosynthesis rate;
- ✓ Better transpiration efficiency (100-200 H₂O/CO₂);
- ✓ Lower respiration;
- ✓ Lower Nitrogen demand;
 - ✓ Low tissue N
 - ✓ More stem/straw, less grain
- ✓ Fast Growth Rate

Agricultural

- ✓ Low Input
- ✓ Can grow on marginal lands;
- ✓ Perennial
 - ✓ At least root system
 - ✓ Pos. harvest every 3-4 yrs
- ✓ Poss. year around harvest

Building a Bioenergy Crop

Characteristics of a Bioenergy Crop



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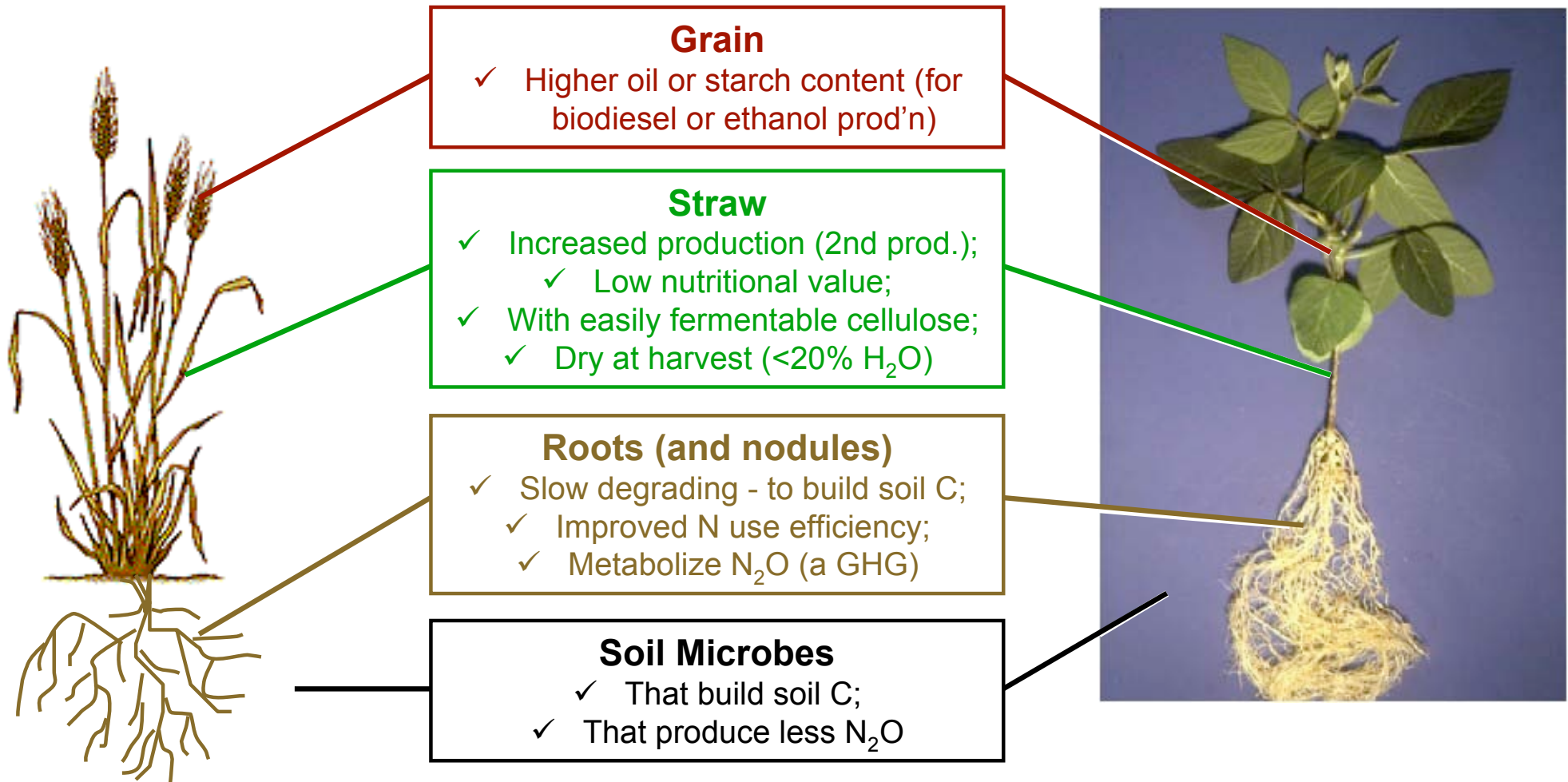
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But how can our existing crops be selected or engineered to contribute to an energy / climate change 'bioeconomy'?

Food & Feed Crops for an Energy / Climate Change Bioeconomy





Thank you:

David Layzell Ph.D., FRSC
President and CEO, BIOCAP

Queen's University Research Chair, Institute for Energy & Environmental Policy

Web Site: www.biocap.ca

Queen's University,
156 Barrie Street,
Kingston, Ontario K7L 3N6

Tel: (613) 542-0025
Fax: (613) 542-0045
Email: info@biocap.ca

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