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# Heating and Carbon Dioxide Enrichment From Biomass

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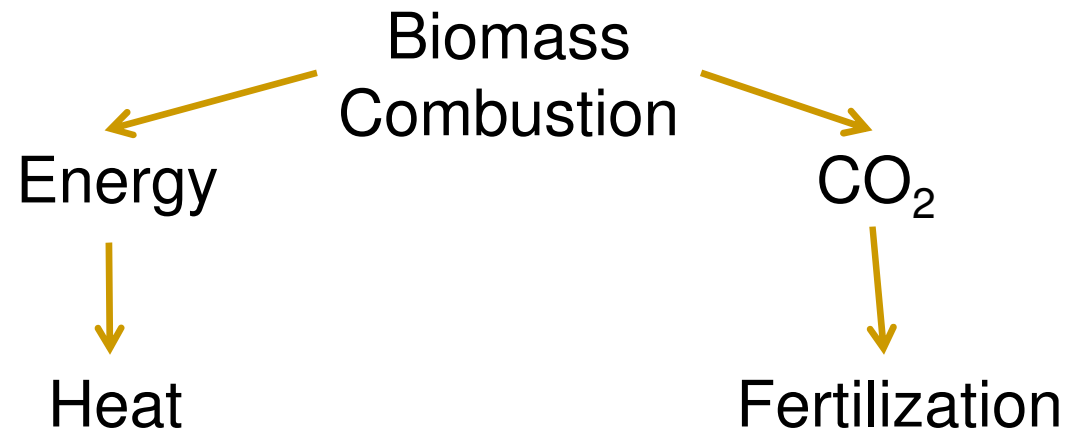
# Biomass Heating

- Using biomass to
  - Provide heat
  - Enrich with carbon dioxide



# Direct Combustion Biomass Heating

- Greenhouse Wood Pellet Heating Project
- M. Lefsrud, V. Orsat, P. Thomassin, D. Smith, L. Dion



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# Feedstock

- **Pellets**
- Blend different feedstock to tailor composition of pellet
  - Bulk density of 500-700 kg/m<sup>3</sup>
  - Wood pellets with 5% moisture and less than 0.2% ash.



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# Greenhouse

- Double Poly Greenhouse



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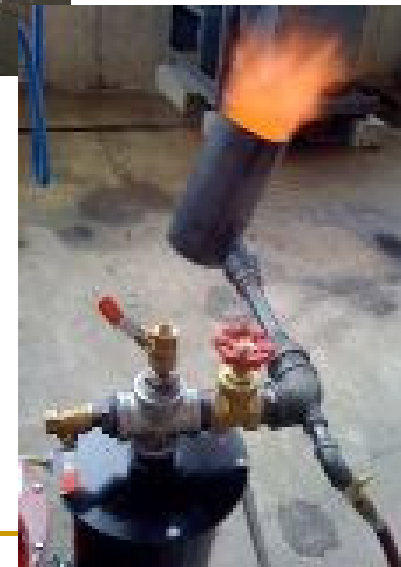
# Plants

- Tomato
- Lettuce



# Gasification System

- Gasification is a process of combustion with a lack of oxygen.
- Results in gases CO and H<sub>2</sub>, known as syngas
- Combust this Syngas at a separate burner for final combustion



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# Gasifier

- Advantages

- Separation of combustion from solid feedstock results in clean exhaust.
- Particle levels below 100mg/m<sup>3</sup>.
- Can control combustion process.
- Reduced VOC production
- Use any biomass source





# Wood Pellets

Type of Biomass			
	Units	Wood Pellets	Wood Chips
Moisture Content	%	8-12	10-60
Density	t/m <sup>3</sup>	0,56-0,75	0,18-0,35
Energy	GJ/t	17-18	10-11
Price	\$ CAN/t	133	70



[www.meec.com](http://www.meec.com)



[www.alternativeenergysource.org](http://www.alternativeenergysource.org)

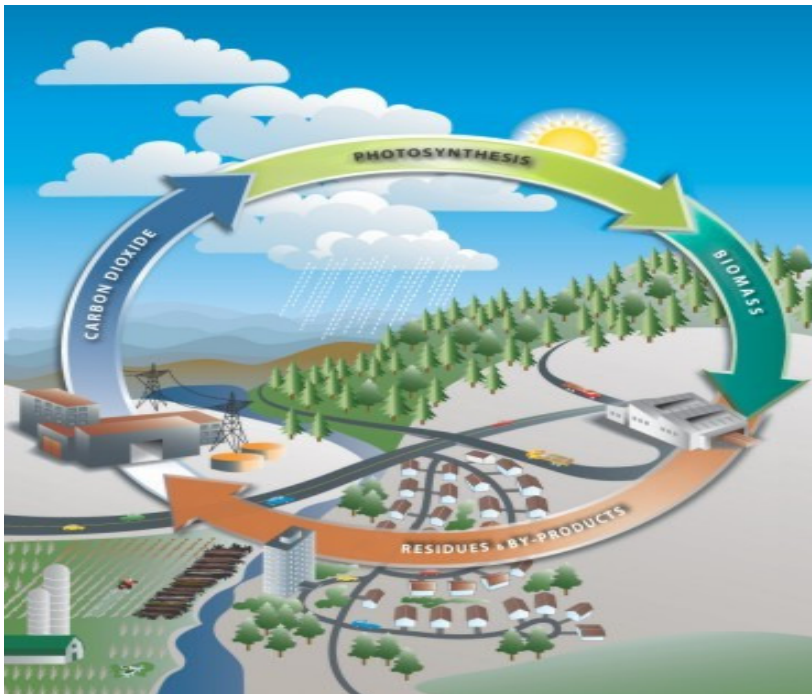
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# Energy Efficiency

- Biofuels touted as reducing carbon emissions and increase energy
  - Energy ratio based on Energy in verse Energy out.
    - Normalized as  $E_{\text{out}} : E_{\text{in}}$
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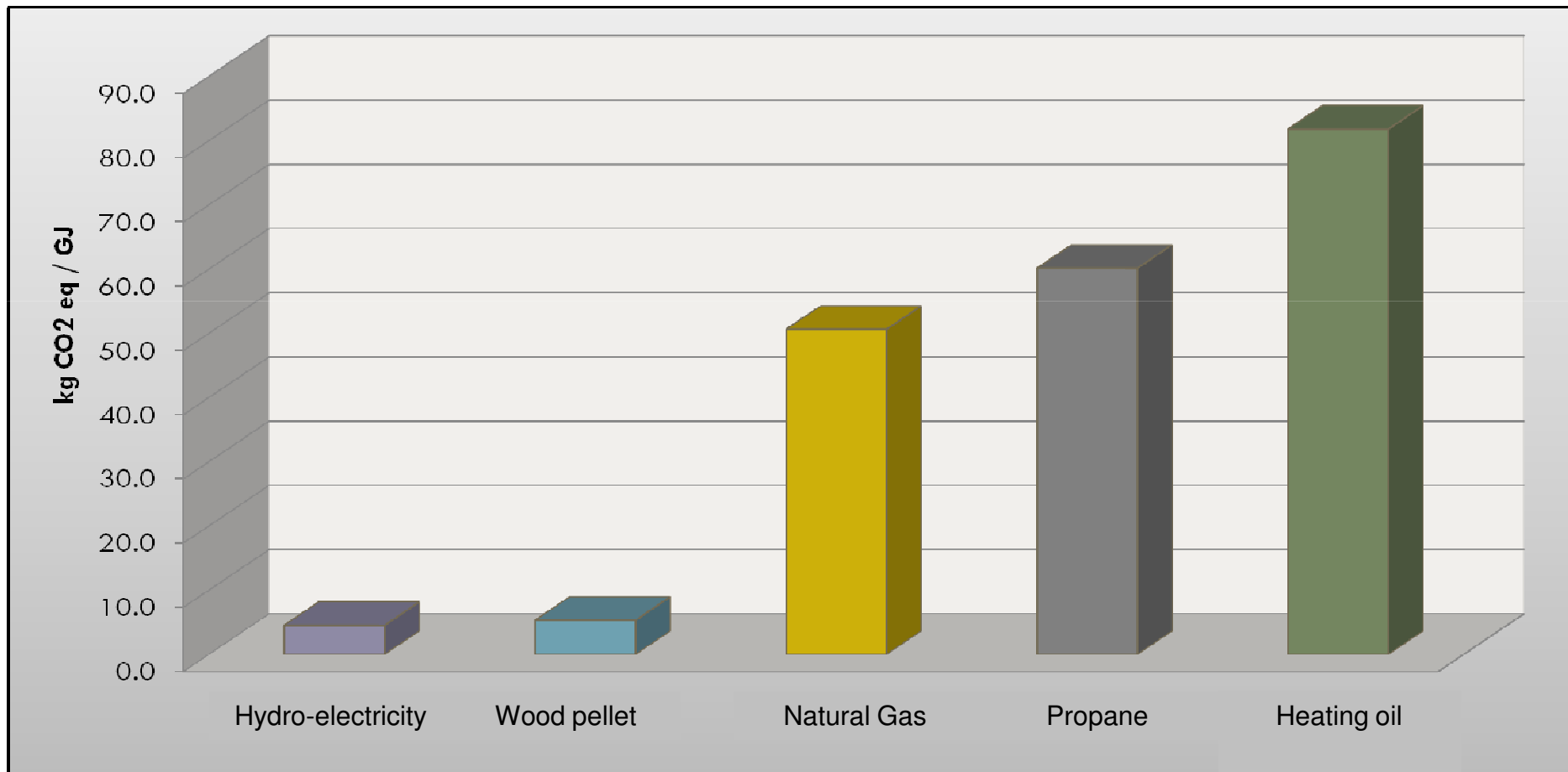
# Biomass Advantages

- Advantages bio-based energy system
  - “cycle time” is very short as compared to petroleum / coal
  - carbon neutral, if grown in a well managed system.



This means that the carbon dioxide that is emitted by burning these fuels will be reabsorbed quite soon by other plants.

# Carbon Dioxide Advantage



# Emissions

- Heat Value
  - Combustion
  - Gasification
- Objective:  
Production of CO<sub>2</sub>

ASHREA Standards		
Quality of interior air		
Acrolein	C3H4O	0.02 ppm
Formaldehyde	CH2O	0.10 ppm
Carbon dioxide	CO2	3500 ppm
Carbon monoxide	CO	11 ppm (8h) 25 ppm (1h)
Nitrogen dioxide	NO2	0.05 ppm 0.25 ppm (1h)
Particles		40 µg/m <sup>3</sup> (8h) 100 µg/m <sup>3</sup> (1h)
Sulfur dioxide	SO2	0.019 ppm 0.38 ppm (5min)
COV		0.05 ppm
N2O		
Dioxins		
Furans		

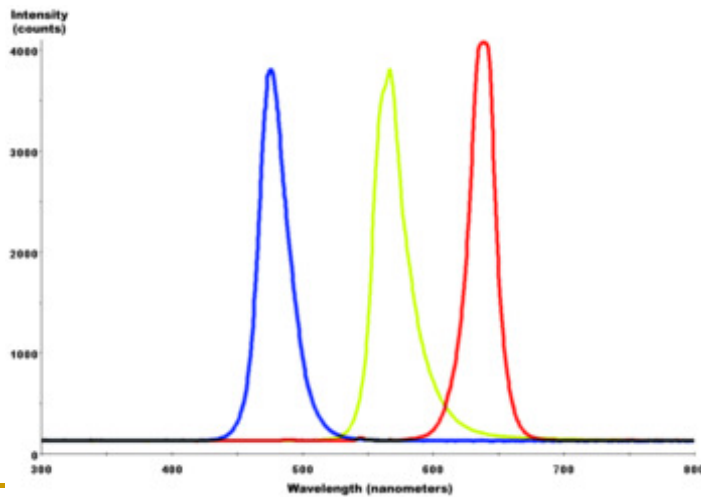
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# Solid Biomass Utilization

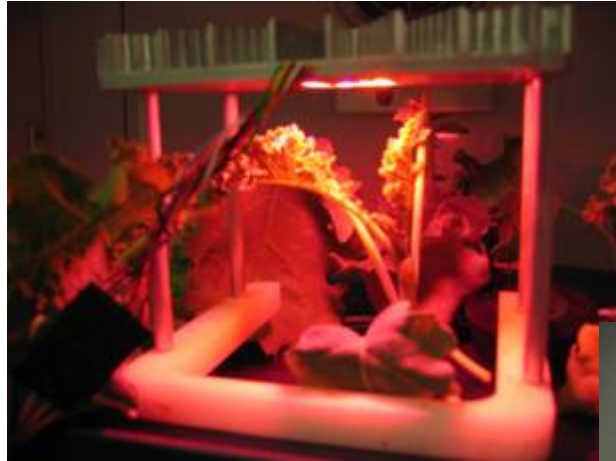
- Public Demands / Government Regulation
    - Montreal Particle emissions
      - Wood burning systems
        - Existing renovations at  $<100 \text{ mg/m}^3$
        - New at  $<70 \text{ mg/m}^3$
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# Light Emitting Diodes

- **A light-emitting diode (LED)**
  - **semiconductor diode that emits narrow-spectrum light when electrically biased in the forward direction of the p-n junction**



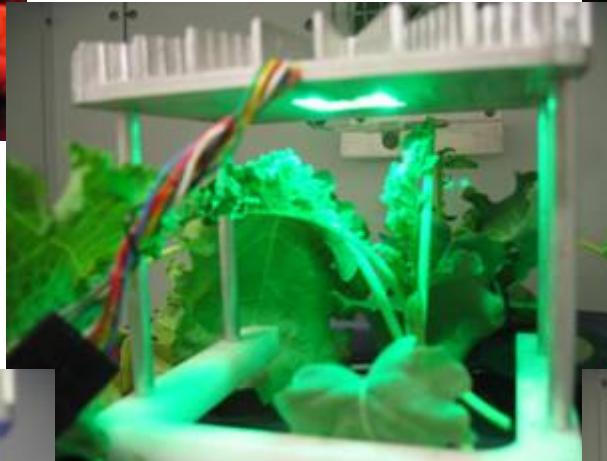
# Wavelength



**730 nm**



**640 nm**



**525 nm**



**440 nm**



**400 nm**



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# Questions

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