Fuelwood, the Environment and the 21st Century

A discussion paper prepared by the Ontario Woodlot Association
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1.0 Executive Summary

Rural Ontarians have a long history of using fuelwood for home heating and could be considered one of the early leaders in the movement towards reducing our reliance on fossil fuels by using a renewable green energy source.

With advancing technology, woodburning appliances now available within the marketplace far exceed the US Environmental Protection Agency's (EPA) smoke emission standards. Fine particulate emissions from newer wood stoves and fireplace inserts are up to 90% less than previous generations, while burning 1/3 less wood to generate the same amount of heat.

Wood used as energy is renewable, need not result in major scars to the landscape, and still leaves a forest to filter water, sequester carbon and produce oxygen as well as support wildlife and humankind. Fuelwood obtained from sustainably managed forests is considered carbon neutral.

With well thought-out strategic planning, the use of fuelwood for home heating can continue to play a key role in the green energy strategy for the 21st century and assist our need to reduce fossil fuel dependency.

The Ontario Woodlot Association believes that by managing our forests sustainably, we can help the environment, increase carbon sequestration and improve our forests while continuing to provide accessible renewable green energy to Ontario's rural population.

As the provincial government moves towards developing new clean and renewable energy initiatives the Ontario Woodlot Association recommends and supports the development of the following initiatives:

- The application of EPA standards on all woodburning appliances sold in Ontario;
- Enhanced subsidies to assist homeowners to switch to high efficiency woodburning appliances;
- The reinstatement and enhancement of public awareness campaigns about good wood burning practices (e.g., Burn It Smart Program);
- Legislation and policy language which specifically names fuelwood as a renewable energy;
- The development of new incentives for private woodlot owners to manage their forested properties sustainably; and
- Develop provincial policy to reduce the use of fossil fuels and increase the use of sustainably sourced fuelwood (forest biomass) as a renewable energy source.

Implementation of these recommendations would result in cleaner air for all Ontarians, reduce our carbon footprint and work towards building a stronger green economy.

2.0 Introduction

The Ontario Woodlot Association believes that by managing our forests sustainably, we can help the environment, increase carbon sequestration and improve our forests while providing accessible renewable energy to a significant portion of our citizens.

In 2006, one million Ontario families burned wood at home or cottage.

Here are some facts:

66% of Ontario is forested including approximately 7 million hectares of private forests, representing 169,000 woodlot owners.[1]

In 2006, one million Ontario families burned wood at home or cottage.[2]

In 2006, Ontarians burned about 1.8 million cords of wood.[3] With the renewed interest in wood heat, it is estimated that in 2008 fuelwood was worth half a billion dollars to the rural economy.[4]

It is estimated that wood using Ontarians saved 1.2 million litres of home heating oil in 2008.[5]

If electric heat were used instead of wood, we would consume 6 trillion Kwh[6] and that doesn't take into account the energy loss over the transmission lines. More than this amount would actually have to be generated.

Table 1: Heating Equivalents

Depending on the species one cord (128 cubic feet) of dry firewood is the equivalent of:

- 450 to 900 litres of No. 2 fuel oil;
- 100 to 200 therms of natural gas; or
- 2,000 to 4,000 Kwh of electricity

If coal were used to generate this electricity, we can equate our annual fuelwood consumption with that of 6 trillion pounds of coal.[7]

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[1] *Forestry Facts*, Forestry Canada, 1991
[2] *TNS Canadian Facts for Environment Canada, Residential Fuelwood Combustion in Canada, Volume 1 – Report*, April 2006.
[3] *The Argument in Favour of Wood Heating*; John Gulland; www.woodheat.org/why/theargument.htm
[4] Estimate: 2 million cords x $250 per cord
[5] Estimate: 2 million cords x 600 litres of No. 2 fuel oil
[6] Estimate: 2 million cords x 3,000 Kwh
[7] Using the data provided by the National Energy Foundation, http://www.coaleducation.org/lessons/twe/ctele.htm "it takes about one pound of coal to generate one kilowatt hour (Kwh) of electricity".

3.0 The Culture of Fuelwood

From the original clearing of the land for settlement to the present generation, wood has been a focal point in the lives of many rural Ontarians.

Fuelwood creates a sense of satisfaction and self reliance unequaled by almost any other activity. Heating your home yourself while the snow piles up outside seems to be inherently Canadian. Like those who came before, we are repeating a time-honoured tradition.

"The whole family enjoyed bringing in the wood; everyone took part." P. VanOrder, Lennox and Addington County farmer.

Rural Ontario neighbourhoods have always pooled labour to accomplish large tasks. Well into the 20th century, after barn raisings and threshing bees were a rarity, fuelwood bees were still common. Many a young person came of age working alongside adult neighbours in this annual ritual of cutting and storing wood for the winter.

During the Great Depression, farmers often brought loads of fuelwood into the neighouring towns. If they could find no buyers, they would trade it for foodstuffs at the local store. Fuelwood became a currency for people who had no coin.

Today, fuelwood has largely been replaced by other fuels, but there are instances when it has become popular again. It seems that, for many people, wood is Plan B when times get tough.

In the 1970's, when the price of oil skyrocketed, a new generation "discovered" wood heat.

During the 1998 ice storm, those Ontario homes able to heat with wood were better able to cope. Once again, fuelwood was the answer in a crisis.

Similarly, when the price of oil began climbing again in 2007, people returned to wood as a means of heating their houses economically.

Now, with a global recession, wood will continue to be the fuel of choice for many Ontarians. For some, just as in the Great Depression, it may be the sole source of income.

This culture of fuelwood is deeply engrained in the rural population. Many homeowners are sixth and seventh generation wood heaters, tracing their roots back to those original settlers

clearing the land. With good strategic planning, this tradition can continue to play a key role in our need to reduce fossil fuel dependency.

4.0 Woodburning Technology

How Wood Burns

Properly dried fuelwood has a moisture content of 15 to 20%. Higher moisture contents will result in incomplete combustion, excessive smoking and less heat generation.

As wood is ignited, water in the wood is boiled off and gases are driven out, some of which are consumed. At stage two, with the water driven out, the remaining gases form the majority of the heat produced by the burning.

Eventually, after the gases are consumed, the coals continue to burn producing the last of the heat.

Dry fuelwood is key to the success of the process. Properly dried fuelwood has a moisture content of 15 to 20%. Any amount greater than this results in incomplete combustion, excessive smoking and less heat generation.

Secondly, combustion is dependent on sufficient air supply, particularly in the early stages when the water vapour is being driven out. Once stage two is reached, there is less potential for smoke and air can be adjusted to ensure efficient burning of the remaining gases.

Original Technology

The advent of cast iron woodstoves marked a huge leap forward in woodburning. Prior to that, fireplaces were the most common method of cooking and heating.

Fireplaces were notoriously inefficient, since much of the heat generated went up the chimney. Cooking over the open fire was difficult and dirty.

Cast iron stoves provided a better control of the burn and used wood more efficiently. By today's standard however, they were still a relatively crude method of heating a home.

Once heating oil became available, homeowners eagerly switched to this more convenient fuel.

The advent of cast iron woodstoves marked a huge leap forward in woodburning.

"Airtight" Technology

During the energy crisis of the 1970's, when the price of oil skyrocketed, many Canadians returned to fuelwood.

New "airtight" designs improved dramatically the efficiency of woodburning compared to the old cast iron stoves. This was achieved by building stoves with sealed joints and more sophisticated air controls.

These stoves could control air flow to the fire much better than the leaky cast iron antiques and the burn could be extended. Unfortunately, this smothering of the fire also meant that the burn was incomplete and there was a lot of smoke created. This smoke went up the chimney creating air pollution and creosote, the main cause of chimney fires.

New "airtight" designs improved dramatically the efficiency of woodburning compared to the old cast iron stoves.

Advanced Combustion Technology

In the late 1980's, the USA Environmental Protection Agency (EPA) established smoke emission standards for wood stoves and fireplace inserts at 7.5 grams of smoke per hour. Today there are stoves available with emissions in the 1 to 4 g/hr range. This represents up to a 90% reduction in particulate matter when compared with the previous generation of stoves.

These new, advanced combustion stoves employ NASA-developed glass and insulation, and use about one-third less wood to get the same heat.

Also, because these EPA rated designs do not employ a "smothered fire", creosote buildup is significantly reduced with less chance of chimney fires.

Ironically, Ontario, the home of the first advanced combustion stove still allows old technology stoves to be sold.

New, advanced combustion stoves employ NASA-developed glass and insulation, and use about one-third less wood to get the same heat.

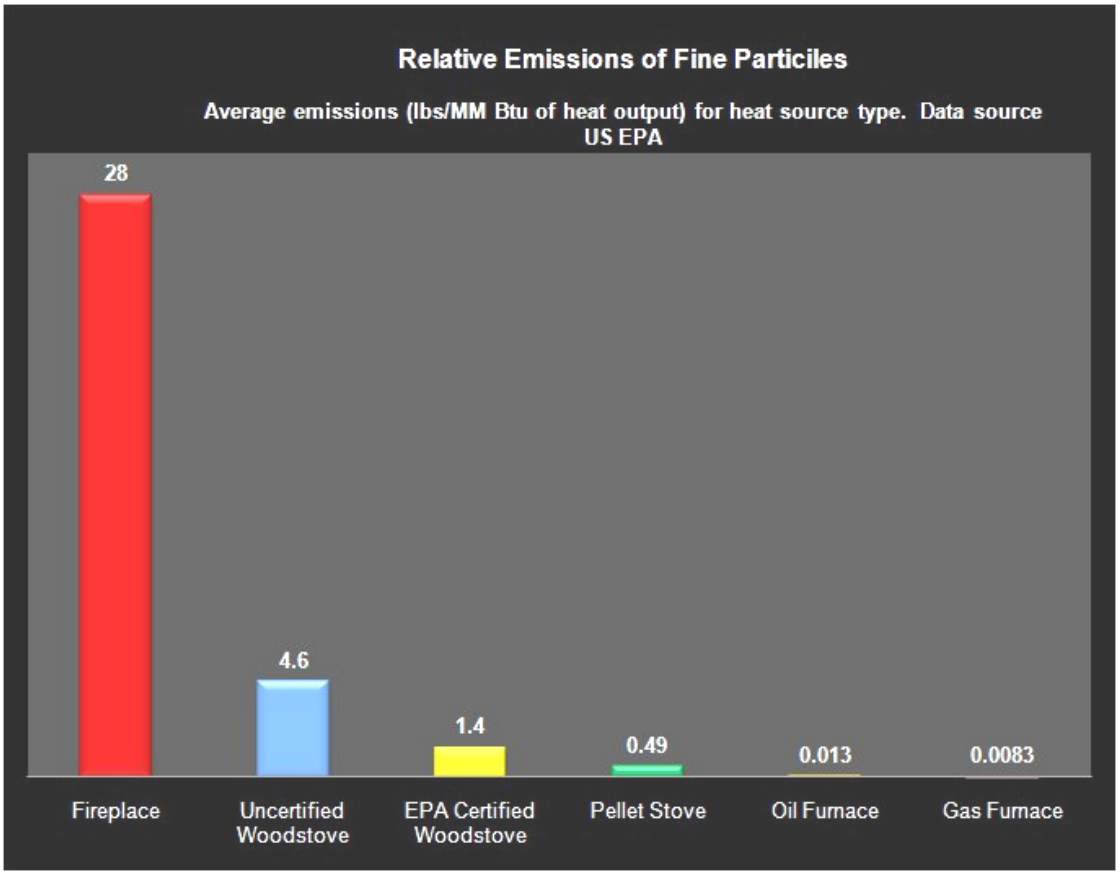


Figure 1: Today there are stoves available with emissions in the 1 to 4 g/hr range. This represents up to a 90% reduction in particulate matter when compared with the previous generation of stoves.

5.0 Sustainable Forestry

What Trees Do

Trees are one of the most remarkable plants on earth. They contribute to our well being in a myriad of ways. By sequestering carbon and producing oxygen, trees are the lungs of the planet. Trees support wildlife, hold and improve soil and water, and produce food and forest products.

Sustainable Forestry Practices

The Ontario Woodlot Association has always advocated the wise use of our forests. This includes using sustainable forestry practices. This means ensuring a continuing supply of forest products while maintaining the ecological functions of the forest, including protecting and/or maintaining forest health and other forest values and features such as wildlife habitat, wetlands, streams and other environmentally sensitive areas.

Why Sustainable Forestry?

There is less impact on the forest when harvesting is done sustainably. By implementing good forestry practices (e.g., selecting individual stems for removal in tolerant hardwoods), continuous tree cover is ensured for the flora and fauna in that ecosystem.

Jim Birkemeier, a Wisconsin forest owner (www.timbergreenforestry.com) has managed his woodlot sustainably for over 30 years keeping detailed records. His forest adds volume at a much faster rate than neighbouring properties that have not had regular thinnings or have been overharvested by commercial logging.

He states "If a forest is not thinned, it becomes overcrowded and stagnates. Steady thinning keeps room to grow around the good trees."

Marking trees for a fuelwood harvest. "A forest is like a garden; you thin the carrots to grow a good crop." Anon.

Starting with the original volume of standing wood, Birkmeier has removed those trees that are diseased, poorly formed or crowded leaving the healthy, well-formed specimens and improving the future genetics of the forest.

In thirty years, his forest has seen a fourfold increase in volume in spite of having the same amount of wood removed through thinnings.

Current growth rates are four times the regional average for saw timber and cordwood.

In addition, subsequent generations of trees will come from the best in the forest rather than the worst.

"Working a woods is mostly common sense"
Wm. Sexsmith, (1915 – 2005) Hastings County farmer.

Forest Bio-diversity

If Ontario's hardwood forests are left untouched, over time certain tree species, those preferring shady conditions, would perform best. Only natural events such as fire or storm would create openings in the canopy to allow other species a chance.

Sustainable management practices can emulate natural disturbances and assist the bio-diversity of the forest by creating more sunlight in those areas where sun loving species are sprouting. Red oak, for instance, a valuable timber and food source for wildlife can be assisted this way.

Forest Health

Removal of trees that are falling prey to disease and pests also help ensure the future health of Ontario's forests. Recent invasions, such as Asian longhorn beetle or emerald ash borer, have increased the likelihood of premature death for many trees.

Removal of trees that are falling prey to disease and pests also help ensure the future health of Ontario's forests.

This problem is quite visible with the pine mountain beetle in British Columbia. The environment is hit twice, losing the sequestering ability of the affected trees at the same time as they release their carbon.

By actively monitoring our forests and removing affected trees immediately, we help to preserve this vital resource.

The Role of Fuelwood

Managing a woodlot is hard work with few government programs to assist the owner. Many woodlots are young and overcrowded and their owners are attempting to restore them to good health and production. The cost of implementing good forestry practices to restore these forest types can be a challenge.

A healthy fuelwood market is key to a sustainable forestry plan. Landowners are more likely to remove low value trees knowing the wood will be used to heat their or their neighbours' homes.

Ensuring there is a healthy fuelwood market is key to a sustainable forestry plan. Landowners have more incentive to remove low value trees and manage their forests sustainably knowing there is a market for this low value material (e.g., used to heat their or their neighbours' homes).

As well, when suppressed, diseased and dying trees are removed for fuelwood, the remaining healthy trees can continue to grow, add value for the landowner and help the environment.

6.0 Fuelwood and the Environment

"Carbon sequestration is the process by which atmospheric carbon dioxide is absorbed by trees." United States Department of Agriculture, Forest Service http://www.fs.fed.us/ecosystemservices/carbon.shtml

"….landowners should be able to manage their forests, including periodic harvests, while increasing sequestered carbon." *Carbon Sequestration and its Impacts on Forest Management in the Northeast*. Developed for the North East State Foresters Association, December 19, 2002 http://www.nefainfo.org/publications/carbonsequestration.pdf.

Forests and Carbon Sequestration

Trees are an essential part of efforts to reduce our carbon footprint. Some believe that we should leave our forests untouched to continue sequestering carbon into the future.

However, as trees mature, their ability to sequester carbon slows. When they die and decay, the stored carbon is released back into the environment.

In the sustainably managed forest, trees in decline, or of poor quality, are removed first leaving room for the better stems to grow. The removed trees are often past their carbon sequestering days or are performing poorly and will never sequester very well.

The remaining trees grow faster and sequester carbon better.

Hardwood Growth in Ontario

"The removal of companion trees that are competing for the same growing space will provide opportunity for growth acceleration depending on the physical attributes of the tree and the silvicultural characteristics of the species. Hard maple is an "elastic" species, capable of adjusting its growth rate to available growing space. Even badly suppressed trees can respond quickly to release, both in height and diameter." *A Tree-marking Guide for the Tolerant Hardwoods Working Group in Ontario*; Anderson and Rice 1993, Forest Resources Branch,

Bark vigour characteristics – indicative of low, medium and high vigour (left to right) based on 20-year diameter at breast height growth. (Photo: A Tree-marking Guide for the Tolerant Hardwoods Working Group in Ontario*; Ontario Ministry of Natural Resources)*

Ontario Ministry of Natural Resources.

In the publication noted above, the Ontario Ministry of Natural Resources illustrates growth rate ranges in hardwoods species depending on, among other things, the amount of room the trees have to grow.

In the case of hard (sugar) maple, the growth rate can range between 2.5 cm (1") and 12.5 cm (5") in 20 years.

An 18 cm (7") diameter maple, as shown above, could, in 20 years, have a volume increase of as little as 30% or as much as 187% depending on the conditions under which the tree grew.

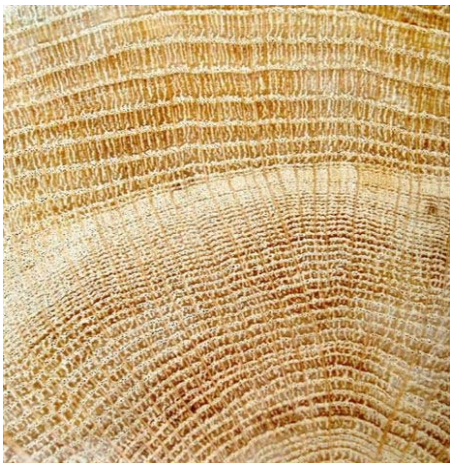
The basal area (cross-sectional area of the stem) of red oak and sugar maple from a forest in eastern Ontario.

The photo on the right shows the cross-sectional area of the stem of a red oak and sugar maple from a forest in eastern Ontario where the site has more trees than it can support. Both stems are approximately 8 cm (3") in diameter and are over 50 years old. This equates to an annual diameter growth of 1.5 mm (1/16").

With this growth rate, in another 50 years a similar tree in this forest, if it survives, would be 16 cm (6") in diameter, a mere fourfold increase in volume growth.

If, through selective thinning, this tree were able to grow instead, at 6 mm (1/4") in diameter per year, it would have 23 times more volume growth in another 50 years.

Wood is 50% carbon by weight. Therefore, the faster the growth and the greater the volume, the more carbon is sequestered.



"A red oak in our forest was 80 years old and 6" [15 cm] diameter…With sunshine and room to grow …It grew with ¼" [6mm] growth rings." Jim Birkemeier

The Carbon Cycle

"…trees recycle CO_2. As a tree grows, it uses CO_2 from the air as a source of carbon to build its structure. This carbon makes up about half the weight of wood. When wood is burned, it decomposes rapidly, and CO_2 is released into the atmosphere again. A similar amount of CO_2 would be slowly released if the tree died and was left to rot on the forest floor." *A Guide to Residential Wood Heating*; Natural Resources Canada 2002.

When wood is used as lumber in the building industry, the carbon is trapped for the life of the structure. When it is used as a heating fuel, the carbon is released, but not before the energy is used to replace fossil fuels.

As trees will eventually die and release their carbon, burning wood from sustainably managed forests is considered carbon neutral. The carbon cycle may be accelerated but is offset by increased carbon sequestering of the managed forest and by the reduction in fossil fuel consumption.

Paul Grogan, a Queen's University biology professor and climate change expert has reported a 60% reduction in his home heating carbon footprint by using wood to reduce the amount of natural gas to heat his house.[8]

It is this carbon neutrality that makes wood such an attractive fuel for electrical generation when compared with other fuels.[9]

When wood is burned, it decomposes rapidly, and CO_2 is released into the atmosphere again. A similar amount of CO_2 would be slowly released if the tree died and was left to rot on the forest floor.

The Energy Cost of Energy

If one were to determine the environmental cost of heating with wood versus fossil fuels by monitoring chimney output only, fuelwood would be at a disadvantage.

However, this only looks at the environmental implications at the user end. To base decisions on only chimney particulate levels means we want our pristine neighbourhood without consideration that someone else's landscape is being torn up, used as a toxic dumping ground or polluted by heavy industry.

Table 2: Carbon Emissions for Fuel Combustion

Fuel	lbs carbon per million BTU
Biomass (wood)	0
Hydro	0
Solar	0
Wind	0
Coal	55
Residential Oil	47
Propane	38
Natural Gas	32

To properly evaluate the cost of using these various fuels, we must consider the complete environmental footprint.

[8] "*Don't knock wood*, …"; J. Pritchett; Kingston Whig Standard; Jan 31, 2009

[9] *Carbon Sequestration and its Impacts on Forest Management in the Northeast*. Developed for the North East *State* Foresters Association, December 19, 2002. http://www.nefainfo.org/publications/carbonsequestration.pdf

One way is to consider the energy return on energy invested (EROEI). This ratio is an estimate of the energy expended to create energy; the larger the ratio, the better the return.

The value for fuelwood assumes an average distance from woods to stove and adds energy consumption for cutting, hauling and splitting. The result is an EROEI of 32:1. For each unit of energy invested in fuelwood production, 32 units of energy are created.[10]

Figure 2 below (Energy Return on Energy Invested) demonstrates how this compares with EROEI estimates of other sources of energy.[11]

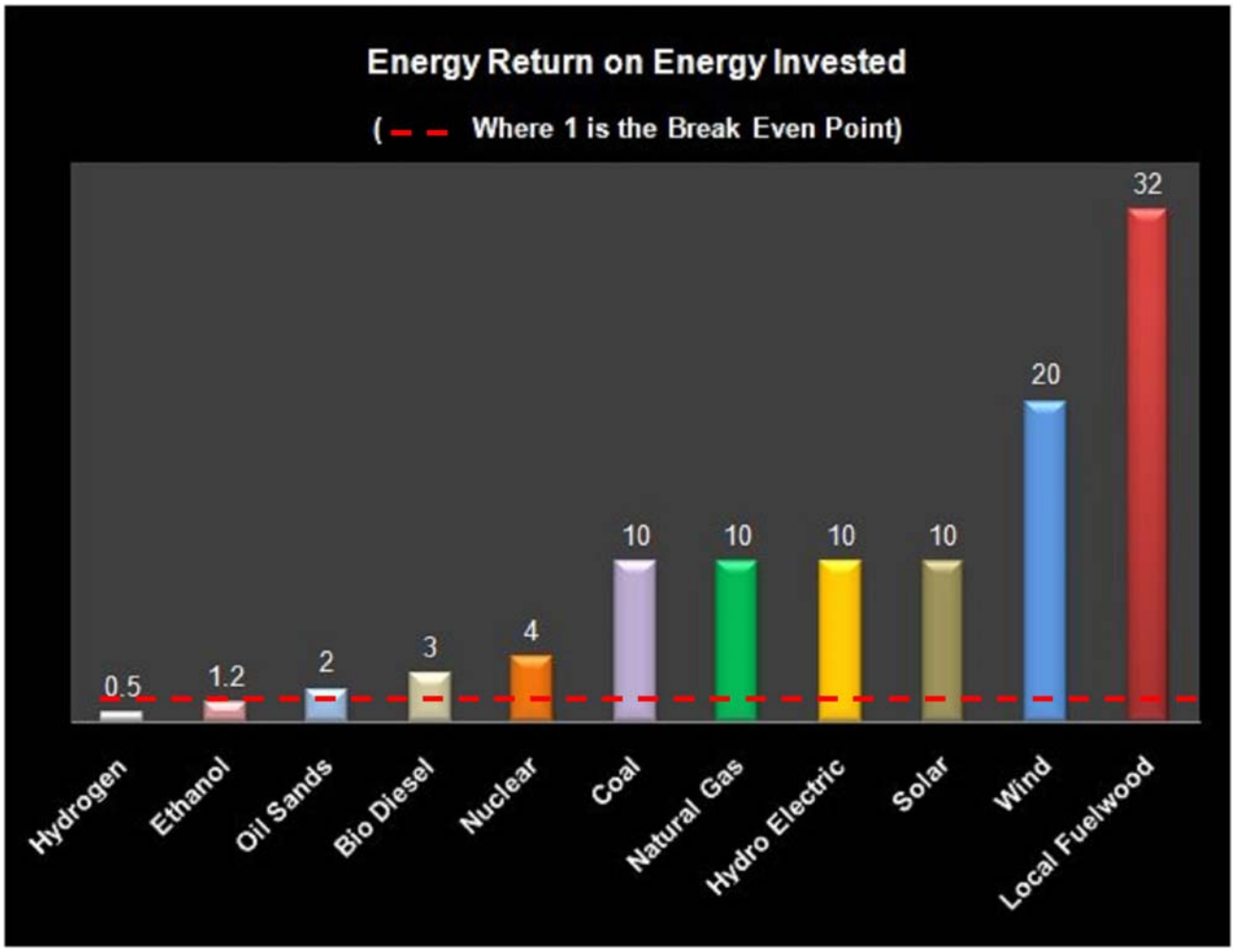


Figure 2: Due to the wide variations in factors affecting the EROEI for some energy sources, the chart shows the maximum. Actual ranges are: coal 1:1 to 10:1; natural gas 1:1 to 10:1; solar 1:1 to 10:1; and wind 3:1 to 20:1. All values except for local fuelwood[9] were obtained from www.energybulletin.net/14745.html[10].

[10] *The Argument in Favour of Wood Heating*; John Gulland; www.woodheat.org/why/theargument.htm
[11] EROEI for various fuels; Dana Visalle, 2006. http://www.energybulletin.net/14745.html

Additional environmental costs should also be taken into account when comparing energy types. Hydroelectric dams *flood* large areas of land, gas and oil pipelines subdivide the landscape and refining processes result in waste materials requiring disposal.

Not only does the tar sands industry consume huge quantities of energy to capture their oil, the process removes unsustainable amounts of water from the Athabaska River system and creates tailings lakes of staggering size. By 2006, Syncrude had dam systems in the tar sands which were second only to Three Gorges in China.[12]

By comparison, wood used as energy is renewable, need not result in major scars to the landscape, and still leaves a forest to filter water, sequester carbon and produce oxygen as well as support wildlife and humankind. Extracting and processing of the raw material into useable energy is relatively benign compared to sour gas wells, oil refineries and hydroelectric dams.

Recognizing fuelwood as the original biomass and encouraging its sustainable management would create an opportunity for individual citizens to be a partner in Ontario's new Green Energy strategy.

Fuelwood and Government Policy

"Since 1990 in Sweden we have managed to increase renewable energy to almost 40%, reduce greenhouse gas emissions by 9% and grow our GDP by 44%. Bioenergy for us is no longer an alternative energy but a major part of our energy supply system." Ms. Maude Olofsson Minister for Enterprise and Energy, Deputy Prime Minister Sweden opening address to the World Bioenergy Conference (Jönköping Sweden, May 27, 2008).

In certain parts of the globe, governments have recognized that wood is a logical way to reduce dependence on fossil fuels with their greenhouse gas emissions while improving the domestic economy. In particular, Scandinavian countries have pursued policies to increase the use of biomass from farm and forestry operations.

In Finland, small scale "heat entrepreneurs" play an important role. "In addition to the larger forest chip producers, in 2002 there were 172 small heat entrepreneurs operating in Finland. This number has since expanded to be over 400 in 2008. These are either single farmers, co-

[12] *Stupid to the Last Drop*; William Marsden; Vintage Canada http://www.randomhouse.ca

operatives or syndicates, or limited liability companies that are responsible for fuel supply and heating of rural buildings like schools".[13]

In Canada's north, replacing heating oil with wood pellets is catching on. The North Slave Correctional Facility in Yellowknife, Northwest Territories installed a wood pellet boiler system that, in 2007, reduced their greenhouse gas emissions by 1,554 tonnes and displaced 568,903 litres of heating fuel.[14]

The City of Yellowknife has also been adopting wood pellet technology to heat in a more environmentally responsible way. The community arena is being retrofitted and other major buildings are planned.

Wood used as energy is renewable, need not result in major scars to the landscape, and still leaves a forest to filter water, sequester carbon and produce oxygen as well as support wildlife and humankind.

In Ontario, the *Green Energy Act* will "spark growth in clean and renewable sources of energy such as wind, solar, hydro, biomass and biogas".[15]

Governments and private industry are now recognizing the role of biomass in fighting climate change and building a green economy. For example, Ontario Power Generation is currently examining the possibility of switching its Nanticoke generation facility from coal to being fueled with biomass.[16]

Recognizing fuelwood as the original forest biomass[17] and encouraging its sustainable management would create an opportunity for individual citizens to be a partner in this new Green Energy strategy.

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[13] *Energy from Wood – Policies, Logistics and Economics of Bioenergy in Nordic Countries*; Andrew Lang; 2008 Gottstein Fellowship Report. http://www.gottsteintrust.org/media/alang.pdf

[14] "Biomass Heating System Wood Pellet Boilers", 2007. Northwest Territories Public Works and Services http://www.pws.gov.nt.ca/pdf/publications/Biomass.pdf

[15] Ontario's Proposed *Green Energy Act* http://www.mei.gov.on.ca.wsd6.korax.net/english/energy/gea/

[16] "Ontario Power Generation holds Biomass Workshop". The Working Forest, February 5, 2009.

[17] Forest biomass includes harvest residues such as tops, limbs, unmerchantable and unmarketable trees, cull, thinnings; mill products such as bark, sawdust and trim ends from wood processing industry.

7.0 Recommendations

The Ontario Woodlot Association recommends and supports:

1. The application of EPA standards on all woodburning appliances sold in Ontario;

2. Enhanced subsidies to assist homeowners to switch to high efficiency woodburning appliances; and

3. The reinstatement and enhancement of public awareness campaigns about good wood burning practices (e.g., Burn It Smart Program).

These recommendations would assist in reducing the numbers of "old technology" stoves and fireplaces currently in use in the province, encourage the purchase of cleaner burning wood burning appliances and work towards increasing the public's knowledge about proper wood burning practices.

The net result will be cleaner air for all Ontarians, a primary objective of *Ontario's Clean Air Action Plan: Protecting Environmental and Human Health in Ontario*.

The Ontario Woodlot Association recommends and supports:

4. Legislation and policy language which specifically names fuelwood as a renewable energy;

5. Additional incentives for private woodlot owners to manage their forested properties sustainably; and

6. Develop provincial policy to reduce the use of fossil fuels and increase the use of sustainably sourced fuelwood (forest biomass) as a renewable energy source.

These recommendations will provide recognition for fuelwood as part of the green energy strategy for the 21st century and assist landowners to improve their forests' health and carbon sequestration capabilities.

The net result will be a smaller carbon footprint and stronger green economy, two of the objectives of the *Green Energy Act, 2009*.