Forest industry in north-western Canada has cooperated with Alberta Energy and Natural Resources in providing funds to assist the Faculty of Agriculture and Forestry through sponsorship of outside speakers.

During the 1976-77 term a seminar course was developed, taught by Desmond I. Crossley and Maxwell T. MacLaggan. The contribution of these two noted Canadian foresters was much appreciated.

In the fall of 1977 C. Ross Silversides was brought in for a week to visit with students and staff. During this visit he gave several talks to students, and made one major address. We are pleased to be able to make this major address widely available through this printing.

We would like to take this opportunity to express our thanks again to the sponsors of this program—we appreciate very much their support.
In the beginning, I would like to explain why the adjective industrial has been used in the title of this paper. It is simply to indicate that I will be discussing forest management from the standpoint of the production of wood for industrial purposes rather than from that related to wildlife or recreation.

Forest management has almost always been product-oriented. The various management systems have evolved around different products such as charcoal, sawdust, pulpwood, piling, etc. The systems may be coppice, coppice with standards, large tree over long rotations, even-aged stands of monocultures of pulpwood size, and so forth.

The silvicultural systems developed in Europe were transferred to North American forestry schools via teachers and textbooks of European origin. There was little or no interest in adapting those systems to actual conditions in North America, and as a result, in the light of existing forests and prevailing social and economic conditions, little so-called forest management was practiced. Basically, there was no place for forest management systems, all of which were based upon a shortage of a land where there was a great surplus into the indefinite future. Today, 75 years later, in some regions, shortages are beginning to appear. They may be in species, in specifications, or absolute shortages in volume. Shortages produce concern, concern produces calls for effective management.

Chief, Forest Management Technology Program, Forest Management Institute, Environment Canada.
Forest management is a term which can mean all things to all people or the opposite. Sometimes the terms "extensive" and "intensive" forest management are used, but they are subjective and cannot be defined specifically. Canada to date I would say have been trying, against considerable odds, to promote the concepts of sustained or increased yield and applied silviculture with minimal success. If successful, we would then be the inheritors of 28.3 million hectares (283,000 square kilometers) of burned-over and cut-over forest lands in Canada.

John Walters, Director of the University of British Columbia Forest at Haney, B.C. In the 1965 issue of the Forestry Chronicle, Walters published a paper entitled "The Uncertainty of the Future in Canadian Forestry." I personally feel that this paper should be made compulsory reading for all forestry students in Canada. In this paper he points out a number of things which are known, but have not been accepted. Our forestry practices, inherited from Europe, were developed when the need for them was not obvious. It is now clear that, with the rapid change and the forester rightly questions the reality of the future market assured by traditional or successful past practices because it will not then be necessary to use models as the Monongahela decision which forbade the cutting of any but diseased or dead trees in national parks and forest serves. By old legislation modern forest lands were outlawed.

Stability is the classic goal of forestry. Sustained yield and the normal forest management have been dominant themes which have guided the development of forestry since the theoretical ideas of forest management first began to emerge in Germany several hundred years ago (Zivnu).

However, the problems facing foresters in Canada have been well expressed. If one thinks back, the aim of the German and Scandinavian forest management, and still is, in many instances, to produce very high quality large trees as a source of lumber and other sawn products. At that time in history, and this is for a period of several hundred years, this was the only conversion of wood. Pulp and other fibre products came much later. In France, for example, they are still growing oak on a two hundred year rotation. The forests of Canada existed to supply timber to the French Navy but today go mainly into logs for the furniture industry. The conversion has changed but the forestry practices haven't. To quote from Walters: "We used as models grew and matured while time stood still. Today, forests grow at traditional rates to mature in a strange market under non-traditional conditions of continuous and accelerated change and the forester rightly questions the reality of the future market assured by traditional models.

Change is now measured in geometric progressions. New principles, techniques, and industries give birth to new industries which become giants before tree seedlings become saplings.
Constant change is now inevitable and normal. To state that forestry th its long
exception is an exercise in restraint. As foresters, with its purposes always in the
not only accept more change, but we must anticipate it. We must get into the
technological progress and re-examine the principle of intensifying forestry practice in
the Golden Age. Only good could come from studying the past and only disaster
there'.

In my short lifetime I have seen the Canadian pulp and paper industry range
both in its logging practices and in the species utilized. For (example, when Abitibi
Paper Ltd. started operations in Iroquois Falls in 1912 the pulpwood was produced
because the woods workers came from timbering operations, mainly in the
wood is being delivered to mills in tree lengths, in full tree, and even in the form
which Include bark and foliage. Most transport of wood to sills today is by land
ly by truck. The pulp and paper industry initially located its mills on rivers, at a
downstream from the woodshed ributary to the mill. Today with Intrprovincial
al power grids, with and transport taking over from water, many mills are poorly
must live with the inheritance from an earlier technology.

Here, originally, was the only wood acceptable by the mills. As spruce regionally
supply it was reluctantly established that balsam fir could make acceptable pulp.
reed a weed species until the kraft pulping process was introduced and it has if
a preferred species. As you all know, aspen is currently the cinderella species.
conversion process to a new end use to give it value In our economy. and to
at how best to manage it.

Particle or wafer boards are a post World War II phenomenon and some Impact on the utilization of aspen but the requirement is small compared to the resource.

To continue from Walters, "the forester becomes uncertain of the wise
action, less because of a lack of knowledge of silviculture than because of his
visualize the fruition of traditional practice In terms of the bewildering and ever
speed of social and Industrial change. Regardless of a natural reluctance of
honored on European conditions, to desert the Golden Age of forestry, he would be
if he failed to acknowledge that his plantation (forest) will be harvested, utilized,
very different ways to very different standards, from those now prevailing. For
somewhat unique with respect to the time period with which he must deal. The use
forestry purposes imposes a large measure of inflexibility in management due to
the time between successive crops." Under such circumstances where decisions have
reaching far into the future, it is vital that these decisions be the best for what
industry is capable. The forester of the Golden Age had the immense advantage
of biological change was not perceptibly outpaced by the rate of technology.
Walters goes on to analyze this situation at greater length but I think you get the nu

An element of the change taking place in Canadian forestry, is the
consideration of forest biomass as a source of energy. The concept of the total
forest biomass has already raised a substantial resistance by foresters in the
environmental damage, loss of soil nutrients, competition with conventional forest use.
As been stated that social systems resist change with an energy proportional to
the change that is threatened (Schon, 1971). It is not due to the stubborness
involved, such resistance is built in and is a function of the system itself.

Wood has been used as a source of energy since pre-history, and still is. "The most
of recovering energy from wood is to simply burn the material in an excess of
heat so produced. Of all the wood removed from the forests in the world today,
For many years statistics on the use of wood as a fuel have been used as an
level of industrialization of a country; the less developed a country, the greater its
wood as a fuel. For example, the use of wood as a fuel in the U.S. is 5%. In the
, it averages 50% and in developing countries it is as high as 80%. We may
the use of this indicator.

difference between the direct combustion of wood as a fuel and utilization of
energy is very great. The former is primitive and relatively inefficient; the latter
ated Industrial engineering: technology. Technology is the process of applying
practical purposes.

des direct combustion, forest biomass can be utilized through classification,
tion, hydrogasification, hydrolysis and the results can be in solid, liquid or
concepts of the utilization of Canadian forests as a source of large scale energy
volutionary implications for foresters. It will directly affect our ideas of forest
ued values and energy forms and distributions.

The use of the forest for energy will have an immediate effect on provinces devoid of fossil fuels, such as Ontario and Quebec. These provinces are
dependent on imports for fossil fuels, Ontario obtaining its coal from the U.S.
gas from Western Canada and Quebec being dependent upon imports from
countries for its oil. However, both these provinces have extensive forest resources
which they can call. The energy-producing patterns can be appreciably changed re
The form in which forest biomass can make its greatest contribution may be
Indications are that Canada has enormous reserves of coal and gas to carry on
21st century or further but all estimates indicate a short fall in oil by the mid 1980s.
one form of energy that forest biomass can supplement.

Studies made by the Department of Energy, Mines and Resources
indicate that in relative amounts forest biomass can make a relatively small contr
the total energy supply, perhaps only 5-6% of the total supply. However, in absol
the amount of biomass required will be very great.

One of the many factors which will affect forest management if the bi
used for energy will be in the units of measurement and the manner in which the
Itself is considered. (n considering biomass, species and volume are of little con
and oven-dry weight is the unit of importance. Another unit is the expression of one
BTUs or metric equivalents. Again our concepts of rotation age will be drastically
from 50 to 80 years to perhaps 5 to 25 years.
Recent estimate of Canada's energy demand shows that we use approximately 8 quadrillion BTUs and is usually designated as $1 \times 10^{15}$Q. The potential of our forest, based upon an estimate for the total biomass use in the country is approximately 2.06Q per year. However, it has been pointed out that energy users today can supply no more than probably 1096 of our energy needs by 2000. New technologies with few exceptions require very long introduction times to make a significant impact on society or the economy.

The latest estimate available to us for wood, as used by the conventional forest inventoried, such inventories are normally done to a predetermined minimum tree diameter, maximum stump height, minimum top diameter points, minimum volume per acre, etc., and these inventories are eventually converted into volume such as board feet, cubic feet, or more recently in cubic metres.

If forests are utilized for energy there is only a peripheral interest in volume but weight, and the tons of dry tons equivalent (DTE). There are no limitations or size, taper, back thickness, etc., as these factors are irrelevant to biomass.
10. Economic Accessibility Estimates for the Physical Timber Reserve (1 000 m³/a)

No Inventory of forest biomass, provincial or federal exists. This condition is under intense study at this time. It is estimated that in the normal course of conventional forest operations only some 40% of a tree is removed as sawtimber or pulpwood. In turn the utilization of this portion of the tree may again be 40-50%. The utilization of the forest stand itself will vary from perhaps 50-90% depending upon the nature of the stand, species utilized and the species left. One should remember that inventories give data on so-called merchantable stands but or nothing is recorded on the so-called unmerchantable stands or waste areas. The magnitude of these areas is shown in Table 3.

Table 3. Areas of conventionally unmerchantable stands

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardwood Reserve</td>
<td>* * This Includes barrens, muskeg rock and scrub and/or land with forest</td>
<td>519 105</td>
</tr>
<tr>
<td>Wildland</td>
<td>Description is substandard to the category forest land.</td>
<td></td>
</tr>
<tr>
<td>Provincial Lands</td>
<td>Areas suitable for harvest but unstocked to trees and areas unsuitable for</td>
<td>1 574 000</td>
</tr>
<tr>
<td></td>
<td>regular harvest.</td>
<td></td>
</tr>
<tr>
<td>Federal Lands</td>
<td>Areas suitable for harvest but unstocked to trees and areas suitable for</td>
<td></td>
</tr>
<tr>
<td></td>
<td>regular harvest.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>616 483</td>
</tr>
</tbody>
</table>

There is every indication that in most provinces there is a substantial amount of forest biomass remaining after all legitimate requirements of conventional forest-based industries are met. One important fact not available to present is the local distribution of this material and its physical relationship to population centres where, energy demands exist.
There are many skeptics regarding the use of forest biomass for energy. In the province of Alberta I'm sure this is true. Forests are a most diffuse source of compared with fossil fuels. In the latter case conversion plants can be erected at or wellhead while biomass will have to be transported over substantial distances to a conversion plant. Being a diffuse source of energy, the utilization of forest biomass becomes evident, in the manner of clear-cut forests. Such is not the case with oil wells and mining of coal.

Forest biomass will present problems in transport and in storage. It has been that, to date at least, commercial harvesting of biomass for energy alone is not yet possible. However, if combined with other uses of the forest such as sawtimber and pulp, it can be produced economically. This, however, greatly restricts the location of energy.

Three possible distinct phases of the use of biomass for energy are: (1) of logging and mill residues. This is immediately possible with a minimum of investment. Its effect on forest management practices would be to almost eliminate clear-cutting and to leave cutover sites in better condition for reforestation. (2) The utilization of biomass taken in from logging operations at the mill would include currently small and deformed trees not up to current merchantable standards. The utilization of stumpwood for energy purposes by mills is under active consideration. This stage in development would capitalize on the infrastructure resulting from conventional logging operations. (3) The third phase would be the development of an energy industry quite independent of present woodusing mills, distributed across the country to supply energy to the areas to which they are located.

The subject of this paper is "Industrial Forestry in Changing Canada." A good deal of time has been spent discussing energy from forest biomass. This is because any move to this end will have important implications, good and bad that will change concepts of forest management completely. It has already been stated that stability is the classic goal of forestry and that sustained yield and the normal forest have been the dominant themes of our forestry philosophy.

Now we have a compelling use for forests which is not concerned with degree with tree quality, tree species, tree size but primarily with the site's capacity to maximize its conversion of solar energy through photosynthesis into cellulosic material. The product required has no particular specification, unlike sawtimber, pulpwood, pole and other forest products. The product may be chipped, hogged, crushed, pulped, however for use, the form depending upon the manner in which the energy is to be extracted.

It may soon be possible to state that there is no noncommercial forest, none of areas or tree components - all of the material will have value. This will require the retuning of many of our forest practices.

Forest biomass, as a perennial, has many advantages over agricultural residues as a feedstock for energy. As a crop it can be harvested at any time of the year over a period of years. It has characteristics that make it possible to convert it into energy in a solid, liquid or gaseous state. It therefore has a potential for wide use in one or other of the various forms in which energy is used in Canada.
Distribution of Energy Use in Canada Today (Hart, 1977)

<table>
<thead>
<tr>
<th>Energy Use</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>25%</td>
</tr>
<tr>
<td>Transportation</td>
<td>25%</td>
</tr>
<tr>
<td>Equipment</td>
<td>4%</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
</tr>
</tbody>
</table>

It was mentioned earlier that harvesting of forest biomass for energy may have environmental impacts which are undesirable. One point that might be mentioned concerning environmental damage is that the environmental impact on miniculture would be to agriculture rather than to forestry and should generate a minimum response from the concern concerning environmental damage.

One of the problems faced by our conventional forest management is that the industries are subject to wild fluctuations in demand whether it be for lumber or for pulp and paper. Forest management to a degree has suffered as a result of these fluctuations. It may well be that if forest biomass is utilized for energy it will generate a very stable, slightly increasing level of forest consumption which will have very few, if any fluctuations. This could serve as a solid base upon which to develop new management practices.

The above indicates, I think, the fact that our forest management practices are faced with challenges that never existed in the past. In the next decade we will be rewriting the textbooks on this subject and I hope we will be applying new concepts and techniques in the forest to meet the country's needs in the not too distant future.

With hybrids of *Populus*, *Salix* and *Alnus* it is possible to produce 22.5 t/hectare per year. This will work out to approximately 50kW-h/(m 2.a) energy equivalent.
REFERENCES


