Design and implementation of bio-energy strategies into forest management scenarios for Crown land in NB

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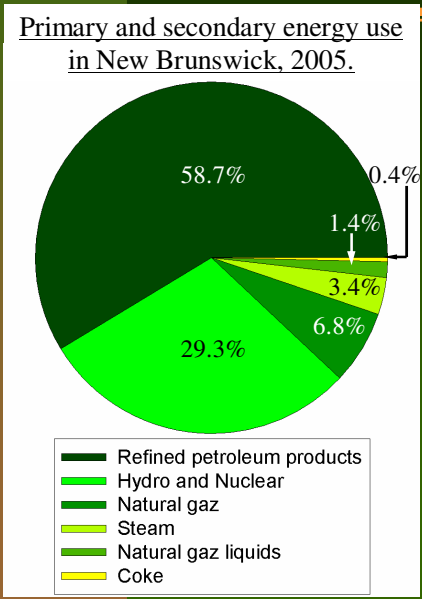
February 24th 2009

BACKGROUND



- Reducing net emissions of greenhouse gazes
- High energy cost
- Uncertainty in long term supplies of fossil fuels
- Mill closures – Job lost

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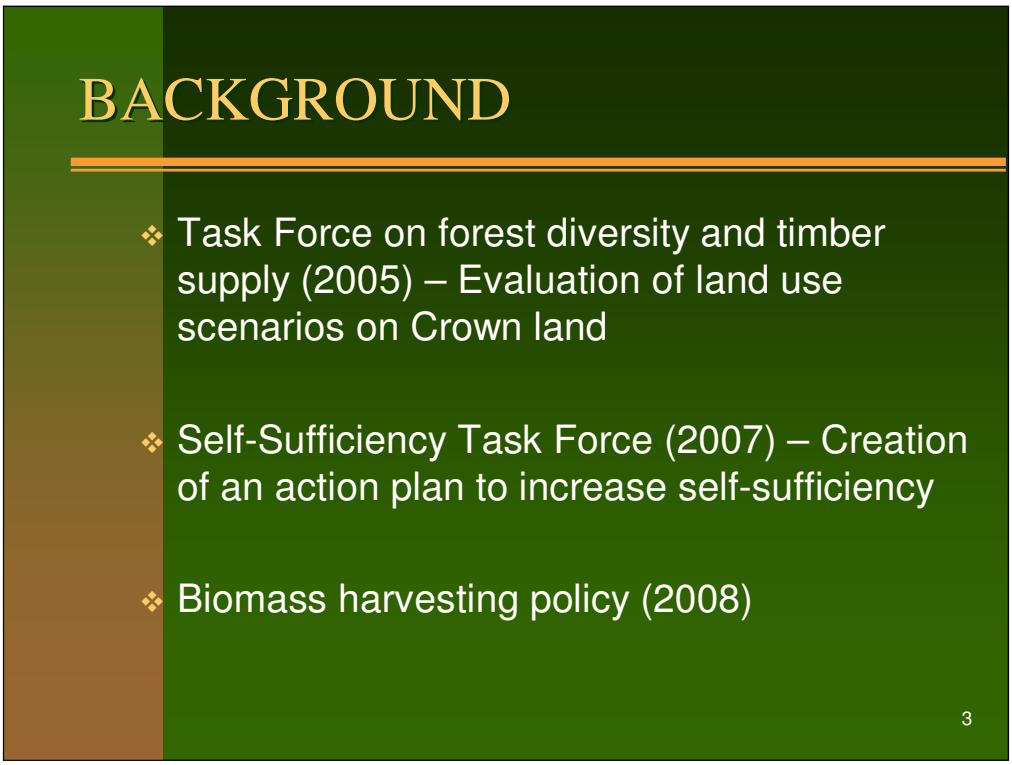
New Brunswick greenhouse gas emissions (GHG) are about 3% of total Canada's GHG emissions, and if we look at this figure here, we can see that our energy consumption is mainly coming from fossil fuel. More specifically, from refined petroleum products, natural gaze and natural gaze liquids for a total of about 70% of total energy consumption in the province. In the last couple years, we have seen an increasing public recognition of the importance of **reducing net emissions of greenhouse gazes, lately we have seen a high increase of energy cost coupled with an uncertainty in long term supplies of fossil fuels**. In addition to these energy problems is a forest industry facing many challenges with many mill closures and job lost. So, these are some of the reasons why I decided to start this project on bio-energy production, and we can see that there is definitely a need to consider other type of production such as bioenergy production.



The government of NB commissioned **two provincial Task Forces**. One to evaluate different land use scenarios on Crown land (2005), and the other one to build an action plan to increase self-sufficiency in the province (2007). In general, their mandate was to develop alternatives that promote healthy wood supply, conservation of natural resources, and the use of renewable sources of energy. Plus, last fall there has been a new biomass harvesting policy released for NB. So, there is definitely an interest and a need in developing new management alternatives that include bioenergy production.

Therefore, in this study, I used and adapted a timber supply model that has been created by one of these Task forces to explore the feasibility and the benefits of biomass and bio-energy production under various management scenarios for all 3.3 million hectares of Crown land in NB. To my knowledge, previous work has not analyzed an integrated approach to forecast bioenergy from willow plantations and forest biomass, at the forest level using forest estate modeling and linear programming (LP) optimization.

RESEARCH OBJECTIVES

1) To develop an integrated approach that includes forest bio-energy and timber production into a forest estate model

2) To identify optimum management strategies to maximize forest-sector energy production on 3.3 million hectares of Crown land in NB over a 100 year planning horizon

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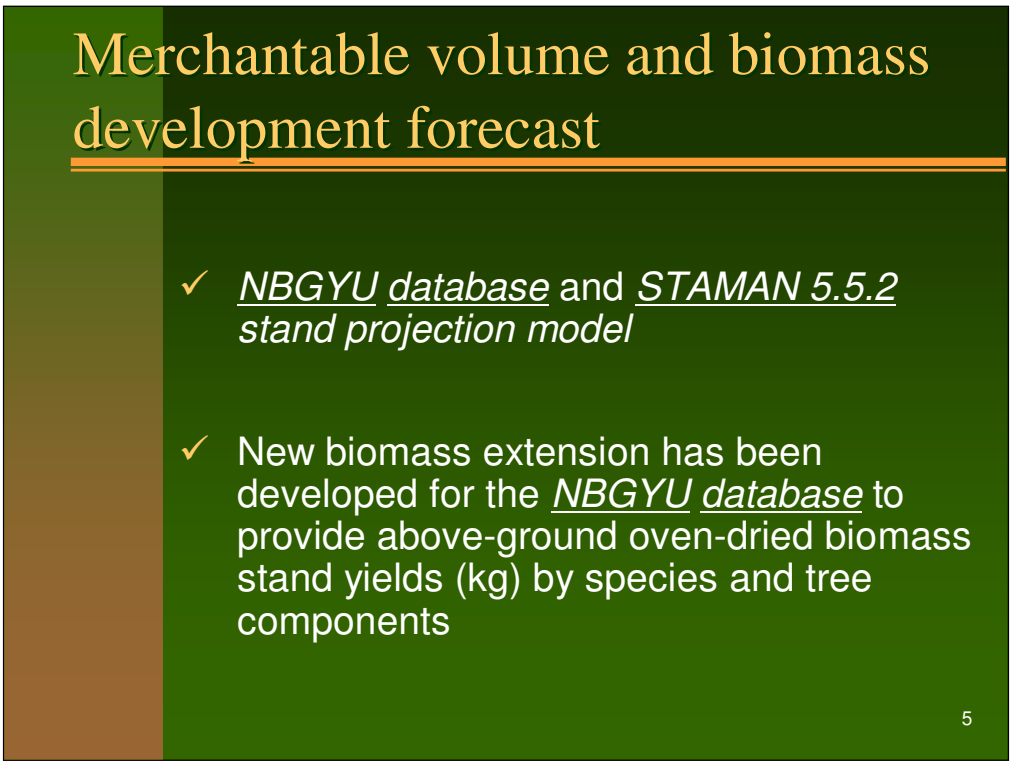
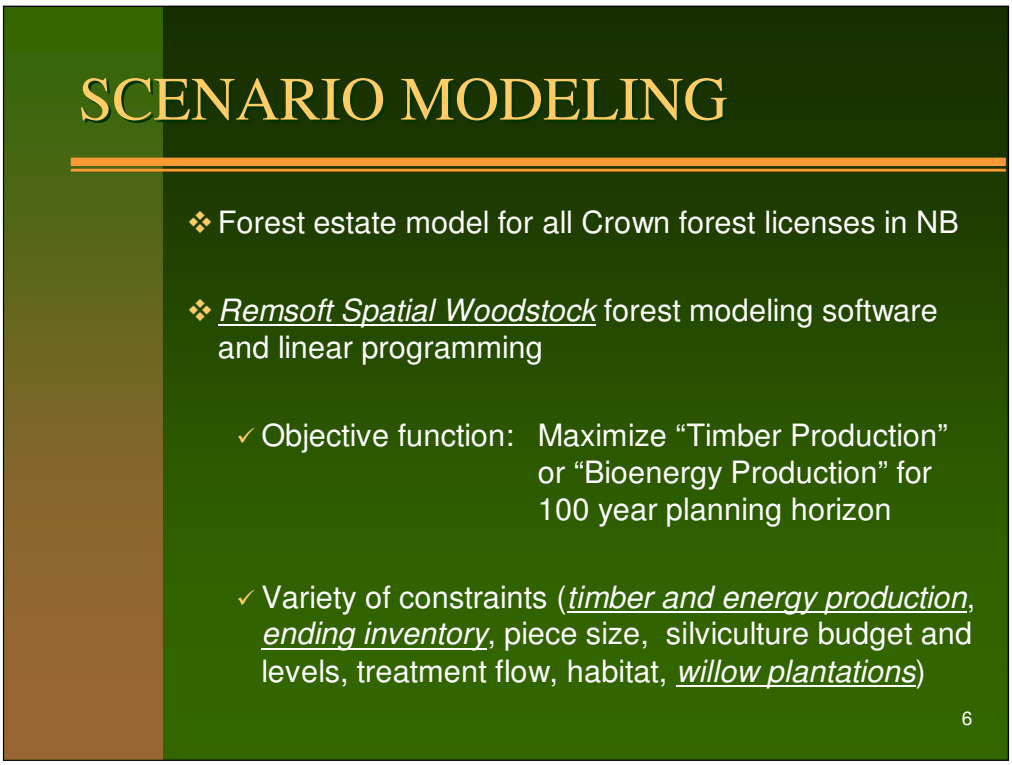


The first step of my project was to create the stand development or the yield curves needed for my model.

The Provincial Task Force has used the latest version of *STAMAN 5.5.2* to construct stand development forecasts to be used in the forest-level Woodstock model. However, this model has been primarily built for forecasting merchantable volume growth and yield by products and species (Norfolk 2006), but not for biomass growth and yield forecasts. Therefore, a new biomass extension was developed for the *NBGYU database* as a tool to quantify above-ground live biomass stand yields by species and tree components (foliage, branch, tops, stemwood and merchantable products).



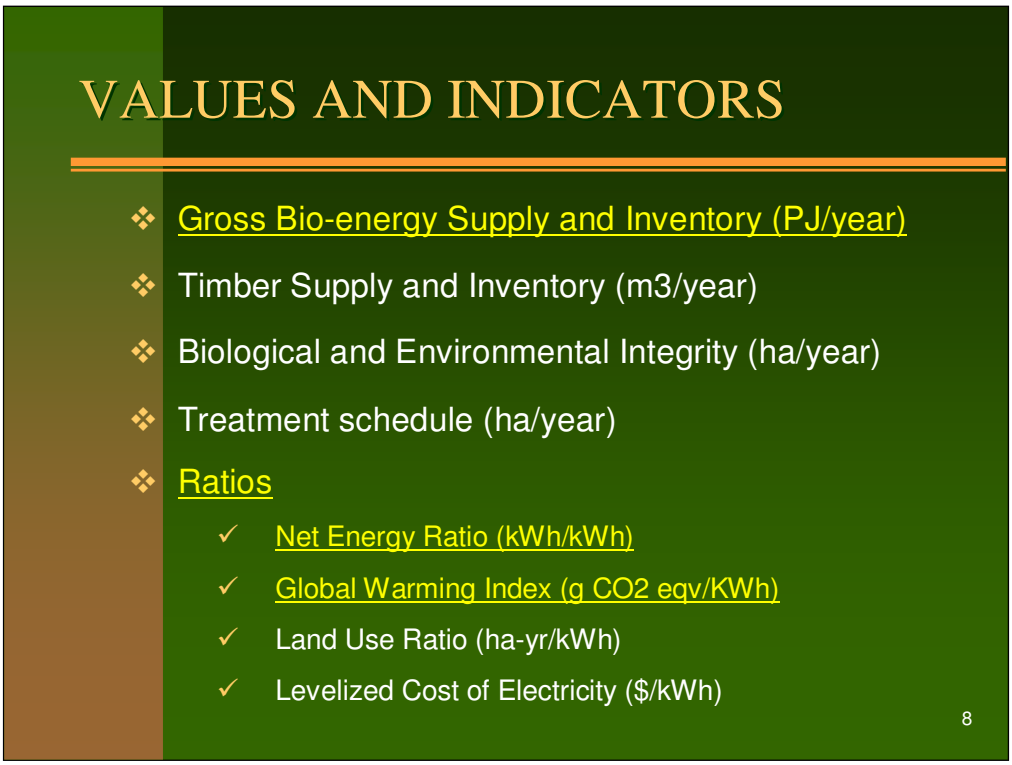
We used a forest estate model for all 3.3 million hectare of Crown land in NB and the Remsoft Spatial Woodstock forest modeling software to forecast forest development overtime and linear programming to solve single forest levels objective functions subject to various constraints.

SCENARIO ANALYSIS

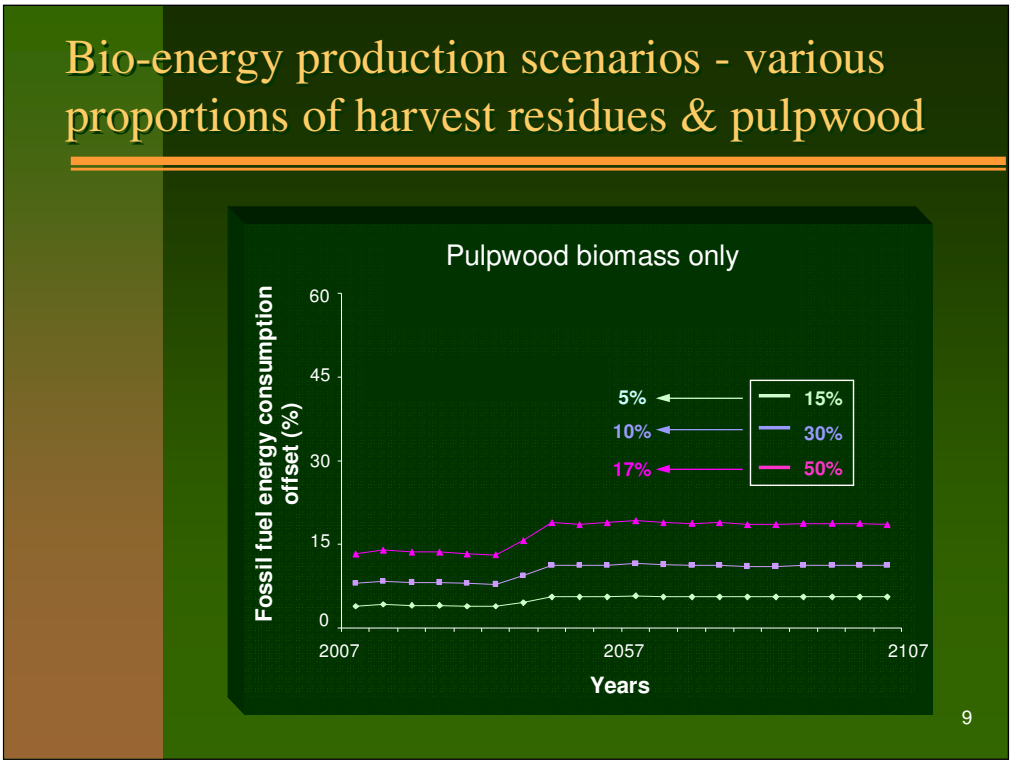
- Status Quo (1) – Max Timber harvested (m3)
- Timber Scenarios (2) – Max Timber harvested (m3)
- Bio-energy Scenarios (9) – Max Energy harvested (GJ)

Objective maximized	Discount factors (%)		
	0	4	8
Timber	1	2	3
Harvest residues	4	5	6
Harvest residues & pulp	7	8	9
Residues, pulp & willow plantations	10	11	12

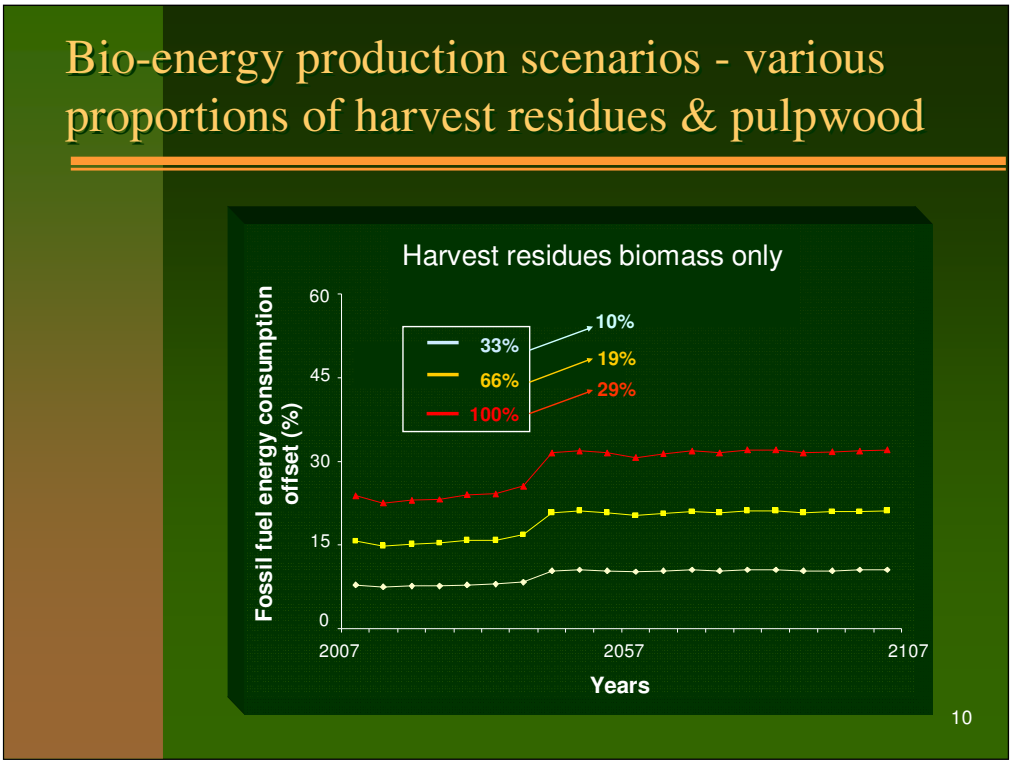
We evaluated 3 timber oriented scenarios and 9 bioenergy oriented scenarios. Three discount factors applied to the objective functions were also tested to evaluate the influence on harvest timing of timber or energy.



Here, this is just to give an overview of all values and indicators that were evaluated in this project. However, results shown in this presentation will only focus on gross bio-energy supply, net energy ratio and the global warming index.



This figure show the fossil fuel energy consumption offset with thermal energy of various proportions of pulpwood biomass harvested on Crown land in NB. This scenario maximized energy harvested for harvest residues and pulpwood biomass.



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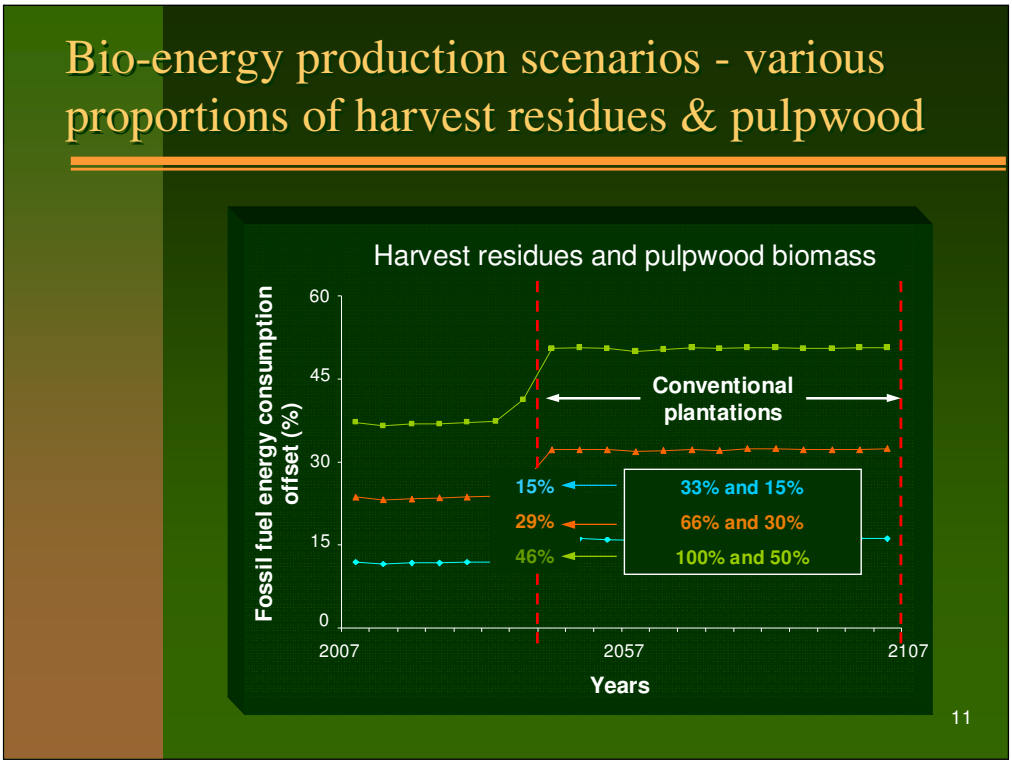
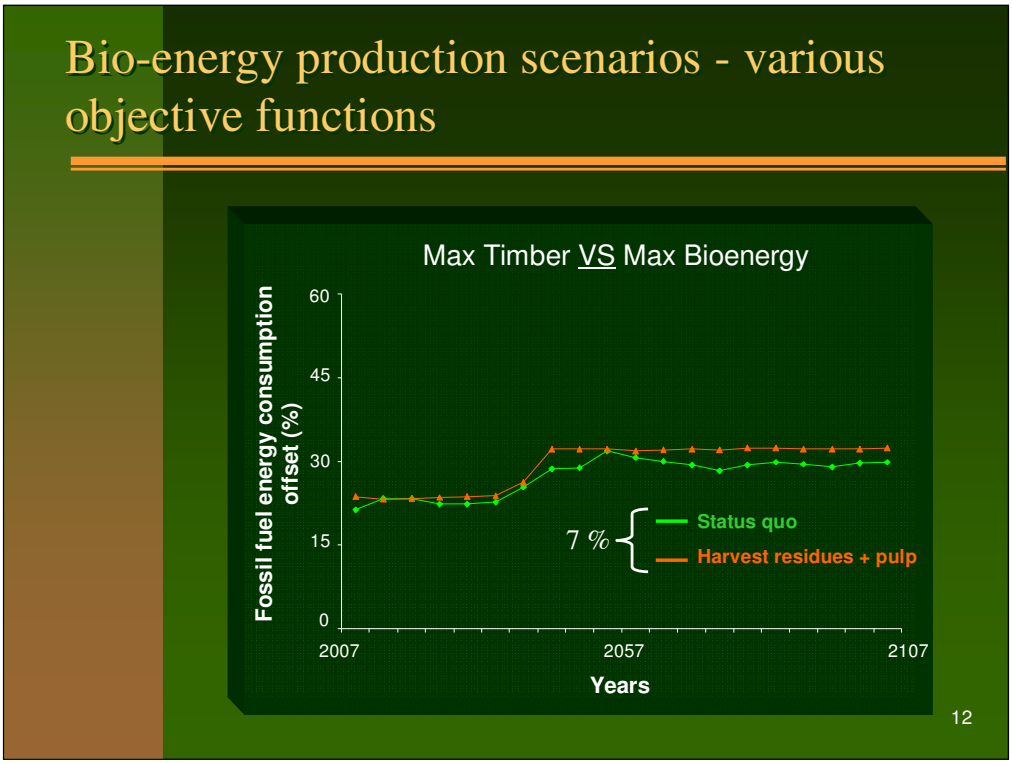
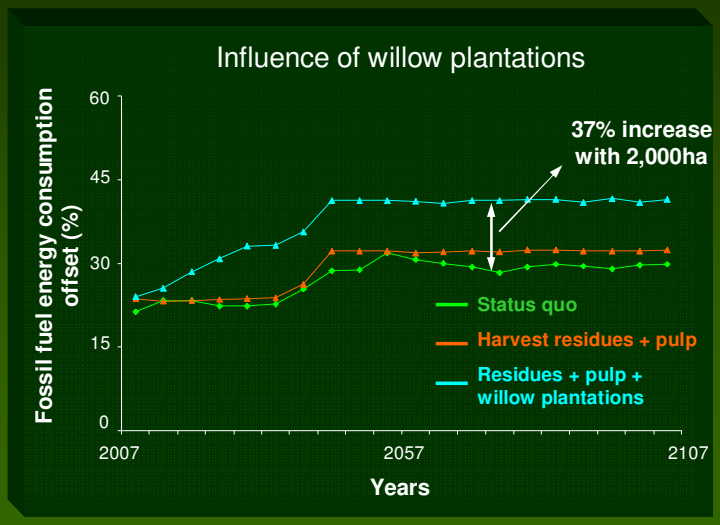


This figure show the fossil fuel energy consumption offset with thermal energy of various proportions of harvest residues and pulpwood biomass harvested on Crown land in NB. This scenario maximized energy harvested for harvest residues and pulpwood biomass. The increased in energy production from year 2040 to 2107 is due to softwood plantations that become operable for harvest. Therefore, an increased in growth and utilization rates of biomass resulted in an increase in energy production.



Maximizing for timber or energy harvest resulted in different results. Results are shown with 66% of harvest residues and 30% of pulpwood biomass available for energy production. Maximizing for energy harvest increased the energy production by 7% when compared to the status quo scenario in which timber harvest was maximized.

Bio-energy production scenarios - various objective functions



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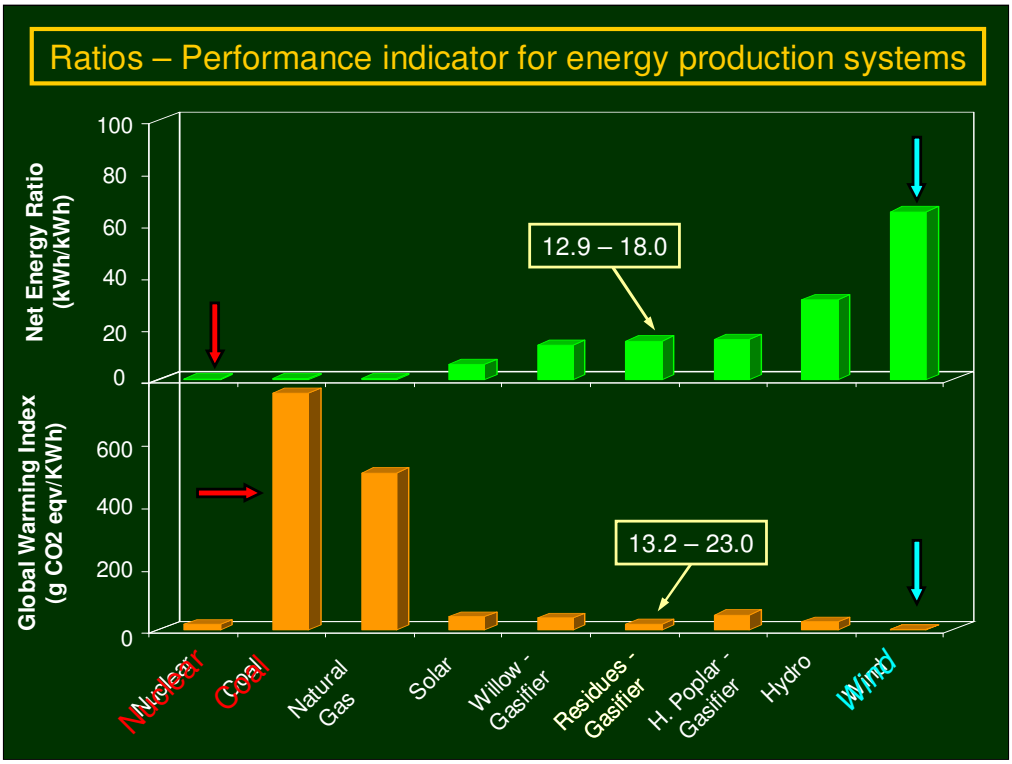
When only 2000 hectares of willow plantations were allowed to be planted per year with a maximum inventory of 40,000 hectares on Crown land converted to willow plantations, we created the greatest increased in energy production. Therefore, when maximizing energy harvest from harvest residues, pulpwood, and willow plantations, the energy production has increased by 37% when compared to the status quo scenario.



Results are showed for the Net Energy Ratio (NER) and the Global Warming Index (GWI). These ratios are good indicators to compare various energy production system, and we created a scenario that convert forest biomass harvested on Crown land into electricity using a low pressure gasifier. The NER represent the number of unit of usable energy produced for electricity per unit of non-renewable energy consumed to produce the usable energy, so the higher it is better it is… The GWI is the weight of CO2 equivalent emitted in the atmosphere per unit of usable energy produced, so the lower it is better it is…. The best results for both indicators were for the Wind Power system, and the worst for Nuclear and Coal energy production for the NER and GWI respectively. The results we got when converting forest biomass into electricity using a gasifier were a good average between all energy production system.

CONCLUSION

- Changing Forest Industry
- Practical framework for sustainable forest bio-energy and timber supply
- Percentage of recovery of harvest residues is important for bioenergy production
- Harvest residues, pulpwood and willow plantations have a great potential for bioenergy production
- Willow plantations (<1% of Crown land) created the greatest increase in energy production
- Gasifier have great potential for bioenergy production

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ACKNOWLEDGMENTS

- Dr. Dave MacLean (Supervisor)
- Dr. Thom Erdle (Advisory Committee)
- Dr. Roger Roy (Advisory Committee)
- Chris Hennigar (PhD Candidate)
- Sustainable Forest Management Network (SFMN)
- FPInnovation - Division FERIC

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QUESTIONS ???

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