Wood Processing and Manufacturing

Science and Innovation Plan
Wood Processing and Manufacturing - Science and Innovation Plan

Purpose of this Document:

The forestry industry believes Research, Science & Technology is a fundamental driver to international competitiveness which in turn catalyses growth. It also welcomes the recent changes in Science Policy and the key recommendations from the recent review of Crown Research Institutes.

In conjunction with the Wood Council of New Zealand’s “Statement on Research Needs for the Forest Industry” released in July 2010, this “Wood Processing and Manufacturing Science and Innovation Plan” provides a clear statement as to the research priorities for the wood and fibre processing and remanufacturing sector. In addition to outlining research needs and the rationale, this document will contribute to improved linkages and dialogue with research providers and policy makers.

Contents:

1. Research Science and Technology for Economic Outcomes 3
2. Why invest in Wood Processing? 3
3. Industry Profile: 4
4. Industry Investment in RS&T in Wood Processing & Manufacturing 7
5. The Research Plan: 8
   5.1 Solid Wood Research 10
   5.2 Fibre Products and Bio-energy Research 18
6. Research Capability and Capacity 22
7. References and Sources: 23
1: Research Science and Technology for Economic Outcomes:

A recent comprehensive review of the Science System has underpinned the Government’s aim to boost economic growth particularly through exports.

“It’s my view that we need to put science at the heart of this National-led Government. If we don’t do that, we are simply not going to get the economic gains that New Zealand needs and we won’t have the standard of living that we deserve.” PM John Key

Government strategies include a focus on Primary sector productivity and higher value products and processes.

Forest based industries are a key part of New Zealand’s “biological economy” and recently revised Government policy settings are focused on:

- Accelerating the knowledge, capabilities and technologies needed to drive export growth in primary producing sectors.
- Promoting diversification of the sector by developing from New Zealand’s raw material base, new industries and firms producing higher margin products and processes for niche global markets.

2: Why Invest in Wood and Fibre Processing?

Increased Research, Science and Technology investment in Wood Processing is vital in realising economic gain from increased export revenues, and improved manufacturing processes including raw material conversion and energy efficiencies. i.e. innovation generates quantitative improvements in products and processes, and through this it produces output and productivity growth.

New Zealand’s Wood Processing and Manufacturing sector purchases 60% of the current annual log harvest and adds $4 billion per year of value to those logs. From a total income of $5.3 billion, it currently generates $2.8 billion in export receipts and directly employs 11,000 New Zealanders.

Small percentage gains in market acceptance and process efficiencies will yield significant economic upside.

**Large and early returns on investment**

Revenue growth opportunities and productivity gains for the Wood processing sector are significant and are able to be realised well within the current 25 year rotation of our radiata resource. Relatively modest enhancements will provide annual gains of the order of $100 million pa.

<table>
<thead>
<tr>
<th>Improvement</th>
<th>Annual Gain</th>
<th>10 year cumulative gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export Revenue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$2.8 billion</td>
<td>2% growth per year</td>
<td>$56 million pa</td>
</tr>
<tr>
<td>Manufacturing process improvement</td>
<td>1% reduction in manufacturing cost per year through conversion efficiencies.</td>
<td>$ 47 million pa</td>
</tr>
</tbody>
</table>
In addition to providing an early economic impact, the flow on benefits from RS&T investment in processing includes:

- reduced dependence upon wood commodities through the development of a broader product mix
- improved understanding of end user requirements to drive further innovation and enhancement
- providing the proof of concepts needed to catalyse industry uptake, capital investment and employment growth
- more value capture from a large, sustainable resource
- formation of cluster specialisations

3: Industry Profile:

The $6.4 billion New Zealand forestry industry (covering growing/protection, processing/products, design/construction), contributes around 3% of New Zealand’s GDP and employs 17,000 workers directly and many more indirectly. At ~ $4.0 billion pa it is New Zealand’s third largest export earner and has a projected potential harvest increase of almost 70% by 2025.

The industry is characterised by a complex and interdependent supply chain. As with pastoral farming, major assets are located either “inside the forest gate” (forestry) or “outside the forest gate” – processing. A natural and interdependent tension exists between log sellers and log buyers.
New Zealand put significant effort in breeding, establishing and managing softwood forests, which has become a model for renewable, sustainable softwood plantations. This has culminated in establishing a vast resource of wood ready for harvest that carries the full costs associated with land, establishment and management, producing a high (relative to other nations) raw material cost. However, fast grown plantation forests create a challenge for processing - large diameter trees, a high juvenile wood content and enormous within- and between-tree material variability.
Just as we have established an international leadership position in creating this resource, we now must establish a leadership position in processing and manufacturing high-value products from this material for world markets. Research and development will be critical to this.

The solid wood sector is a key part of establishing the value of the tree. The pruned logs and sawlogs comprise 85% and 95% of the volume and value of the tree respectively whereas the industrial log comprises the balance. **It is the value of pruned logs & saw logs that underpins the whole New Zealand forestry industry.** The pulp log and sawmill residues are directed at products such as pulp, paper and wood composites or as a source of energy.

**Solid Wood is the value driver for NZ Forestry**

The trees harvested in the next 20 years already have their properties locked in – no amount of breeding, silviculture or forest management will change those properties. This is the raw material of the wood and fibre processing industry.

New Zealand is very good at growing plantation radiata, and sustainable plantation grown wood products are being demanded in sophisticated markets, provided they have the performance of traditional wood and competing products. This trend will continue. Consumers like wood and wood is, relative to other materials, easy to work with and very versatile.

Our Radiata resource presents a number of challenges for processors that requires innovation, technology and investment to address these. They include:

- Variable stiffness and strength.
- High wood quality variability within and between trees
- Increasing proportion of juvenile wood.
- Variability in tree and log form/shape
- Unpredictable presence of defects such as resin pockets, streaks, bark blemishes, intra-ring checking birds-eye, etc.
4: Industry Investment in RS&T in Wood Processing and Manufacturing

The Forestry and forest products industry supports investment in strategic research but in doing so demands that an assessment of the route to uptake by the NZ forest industry must be considered prior to undertaking such longer-term research and development. At present the balance of R&D being undertaken in NZ is skewed heavily toward high risk, future focussed research that the sector cannot relate to or utilise in its existing business. Also, for nearer term research a balance is required between research directed at totally new and novel products/processes and adapting offshore technology, and applying it in New Zealand.

In the absence of a commodity levy, major collaborative research investments by wood processing companies amount to approx. $2 m pa. These research programmes are directed by their respective shareholders /members and are supported by co-investment by MSI. In addition to cooperative investment a number of companies engage in their own specific research and development and this is estimated at $10-$15 million pa.

**Processing Industry Investment in Collaborative Research**

<table>
<thead>
<tr>
<th>Collaborative</th>
<th>Focus</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWI Research Consortia</td>
<td>$2 million pa - increase export of appearance wood products - More efficient manufacturing - Greater energy efficiency and reduced water use in wood drying</td>
<td>$140 million pa by 2013 Export growth $ 60 m pa Manufacturing $70 m pa Energy and Water Savings $ 17 m pa</td>
</tr>
<tr>
<td>STIC Research Consortia</td>
<td>$2 million pa - STIC's research aims to develop different timber engineering solutions involving innovative large-span timber building technologies primarily for use in non-residential buildings.</td>
<td>New export revenue of $100 m pa by 2013 and $500 m pa by 2020</td>
</tr>
</tbody>
</table>

The immediate, as well as longer-term goal of the forest sector is to be more profitable while continuing to be environmentally and socially responsible. The sector is striving to improve productivity through innovation and to develop new solutions to current issues and opportunities; thereby delivering greater benefit to NZ. The forest sector will invest in quality research that will provide a return to the industry. This research will be delivered via CRI’s, Research Consortia, Universities and other research providers.
5: The Research Plan:
The following integrated research plan is designed to show the growth opportunities for the wood processing sector and how these can be delivered. The ‘outside the forest gate’ RS&T plan is divided into two major areas; (1) Solid Wood, and (2) Fibre Products and Bio-energy research.

The Research Plan format draws from the comprehensive “Forest-Based Sector Technology Platform – 2006 developed by the EU forest and processing sectors.

(Note: This paper does not cover Forestry Research (inside the forest gate that includes genetic improvement, silviculture enhancements, harvesting, forest health and biosecurity), which is lead by the FOA (Forest Owners Assn ).

### Solid Wood Research

<table>
<thead>
<tr>
<th>Strategic Objectives</th>
<th>Projects</th>
</tr>
</thead>
</table>
| Enhance existing processing systems and develop new systems | Advanced primary breakdown technologies  
  Automation / robotics  
  Improved Drying and Treating processes  
  Sawing / planing /grading technologies  
  Stability and durability enhancement |
| New and enhanced products and building systems | Advanced prefabrication systems  
  Multi-material concepts and functionality  
  Advanced adhesive, treating and finishing  
  Revision of regulations and standards  
  Durable cladding systems |
| Advanced segregation and optimisation technologies | Scanning & sensor technologies  
  Optimisation and decision support systems |
| Reduce energy, waste and environmental impact | Low energy and faster wood drying processes  
  Recycling of wood  
  Disposal pathways for treated wood  
  Carbon foot printing – LCI and LCA |
| Improve occupational safety, health and ergonomics | Noise and dust reduction and control  
  Performance measurement & benchmarking |
In sections 5.1 and 5.2 more detailed information is provided on the specific nature of the projects and how these will deliver benefit to the sector.
5.1 Solid Wood Research

Market size:

<table>
<thead>
<tr>
<th>Product</th>
<th>Export</th>
<th>NZ consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sawn Timber</strong></td>
<td>1.9 m³</td>
<td>2.1 m³</td>
</tr>
<tr>
<td><strong>Plywood and LVL</strong></td>
<td>74,000 m³</td>
<td>261,000 m³</td>
</tr>
<tr>
<td><strong>Remanufacturing</strong></td>
<td>est $350 m³</td>
<td>est $100 m³</td>
</tr>
<tr>
<td><strong>NZ consumption</strong></td>
<td>$829 million</td>
<td>$118 million</td>
</tr>
</tbody>
</table>

(excl. imports)

Strategic Objective

Enhance existing processing systems and develop new systems

Rationale:

Primary wood processing (sawing, peeling, slicing) involves very diverse processes for the production of timber, plywood and LVL. Advanced sorting and grading systems for logs and advanced processing technologies lead to optimised material efficiency and more reliable production.

Radiata pine as a species has unique requirements for processing – frequently machinery and processes designed for other species are purchased for utilisation on radiata pine and it is suboptimal for this application creating a need to adapt or develop machinery and systems specifically for processing radiata pine. Material assessment and segregation technologies to ensure the right material is directed to the right process and product. Development of real time expert assessment systems is key to addressing the high variability of the wood and achieving international competitiveness.

Systems for use with radiata pine, such as coatings and adhesives – gluing is key to unlocking future high value product opportunities, and coatings allow radiata pine to mimic the appearance of traditional timbers. Radiata pine is amenable to manipulation into enhanced performance materials through modification - chemically, mechanically, biochemically and thermally to produce uniform, high performance material that still has the look and feel of real wood but are...
advanced biologically based materials; these create the opportunity to develop sophisticated new products.

- Technologies that take wood into exterior applications eg weatherboards
- Maintenance-free coating systems.
- Low environmental impact – fitness-for-purpose treatment systems.

Supporting Research Projects:

<table>
<thead>
<tr>
<th>Opportunities / Benefit / Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every 1% gain in conversion efficiency equates to an additional 80,000 m3 of sawn timber. Assuming the average export price $415 /m3 this equated to $33 million.</td>
</tr>
<tr>
<td>Identifying and not processing highly twist prone logs in structural lumber mills can save $150k per 100,000 m3 of sawn timber production.</td>
</tr>
<tr>
<td>Early segregation of the worst 5% of warp prone lumber can deliver savings of $250k per 100,000 m3 production through material not being dried, planed and graded which will be later rejected.</td>
</tr>
<tr>
<td>An increase in conversion efficiency of 1% can be worth $500k per 100,000 m3 production in an appearance mill.</td>
</tr>
<tr>
<td>50% reduction in final steaming time during kiln drying with reduced energy, water plus increased plant utilisation and less redries yields a saving of $230k per 100,000 m3 production</td>
</tr>
<tr>
<td>Development of solutions improving the durability and shape stability of wood (biological attack, fire resistance, shrinkage, distortion, etc.).</td>
</tr>
</tbody>
</table>

Wood drying is a key process in adding further value to the wood resource. As a key component of New Zealand’s forest industry, the demand for improved drying processes and standards is likely to increase rather than diminish. A number of factors will continue to give wood drying its fundamental importance.

Wood drying:

- allows exports of sawn timber into high value markets that require drying to achieve the desired appearance, finish and structural requirements;
- reduces transport costs and enhances the relative competitiveness of the New Zealand product;
- provides the lumber stability and strength needed as an input to other manufacturing processes;
- and allows wood sterilisation requirements of export markets to be met.
Constant improvements in drying technology are essential to obtaining the greatest value from our forest resource.

**Automation / robotics**

Lockwood predict a 10 fold increase in productivity from their recent investment in automation

<table>
<thead>
<tr>
<th>Research and development investment supports state-of-the-art technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment by the Foundation for Research, Science and Technology has helped Rotorua-based building manufacturers Lockwood develop state-of-the-art technology that will support export growth for the company.</td>
</tr>
<tr>
<td>Established in 1951, Lockwood specialises in building wooden homes using a patented system where the walls are locked, rather than nailed, together. In 2006, funding of $816,000 was provided by TechNZ, the business investment programme of the Foundation, to support development of a machine that automates processing of timber components for Lockwood homes.</td>
</tr>
<tr>
<td>The machine, dubbed ‘Apollo Mark III’ and being unveiled in Rotorua today (Friday 12th June), is a first for the New Zealand building industry. Designed by Auckland company Aspen Design, it works with a Computer Aided Drawing (CAD) system which produces a drawing of the structure and programmes exactly where planks need to be cut. The data is then sent to the machine which cuts the planks to size, straightens any bends and labels them so the builder knows where they fit.</td>
</tr>
<tr>
<td>The new machine is expected to result in a ten-fold increase in output says Lockwood’s Research and Development Manager Jeff Parker.</td>
</tr>
<tr>
<td>“Even six months ago we wouldn’t have been able to bid for jobs involving hundreds of houses because our manual systems were too slow. Now we could quite easily take on projects of that scale,” says Mr Parker.</td>
</tr>
</tbody>
</table>

### Strategic Objective

**Develop new and enhanced product and building systems**

<table>
<thead>
<tr>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>An increased share of wood-based materials in construction, family-houses and multi-story buildings leads to a more sustainable living environment and a better quality of life</td>
</tr>
<tr>
<td>Novel building concepts (e.g. sound and thermal insulation, fire protection, hazard safety) will increase the amount of wood used for the construction of single and multi-storey houses, dwellings and office buildings. In addition, wood will be widely used for cost-efficient erection of large-scale constructions with high quality and standards. Advanced building concepts incorporating protection by design will minimise the use of wood preservatives.</td>
</tr>
<tr>
<td>Modern construction methods (e.g. pre-fabrication, gluing or joining at the construction site, system solutions) will speed up the building process and help to reduce building costs. Multi-material solutions will lead to wood-based building products with improved properties in terms of strength, shape stability, durability.</td>
</tr>
<tr>
<td>Additional to extended wood use in building structures, clear opportunities exist for increased penetration of sustainable NZ pine into large traditional applications such as doors, windows, mouldings and furniture.</td>
</tr>
</tbody>
</table>
Supporting Research projects

<table>
<thead>
<tr>
<th>Opportunities / Benefit / Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certified Stable Timber- the value proposition is based upon regaining market share from steel and concrete and capturing a premium for performance ‘certified’ framing systems.</td>
</tr>
<tr>
<td>Upgrading low value wood by smart combinations of unstable material. Potential value increase could be $50/m³ or more. For a sawmill of 100,000 m³ pa this benefit could be $1m pa</td>
</tr>
<tr>
<td>Reducing resin bleed in exterior products – value is created by including material which is unlikely to exhibit resin bleed and reducing remediation costs due to resin bleed in service.</td>
</tr>
<tr>
<td>Revision of timber building performance requirements, regulations and standards based on research results</td>
</tr>
</tbody>
</table>

Established in 1957 McIntosh Timber Laminates Ltd is New Zealand's leading manufacturer and exporter of Glue Laminated Timber solutions. McIntosh work with Scion (formerly Forest Research Institute), Standards Association of New Zealand, Building Research of New Zealand and other regulatory bodies to assist in creating industry standards and associations such as AS/NZS1328, Structural Engineered Timber Manufacturers Association (SETMA) and New Zealand Timber Certification Board. The promotion and assistance of timber design has always been a priority for McIntosh. McIntosh see their function going beyond the manufacture of Glulam to provide assistance to designers who may wish to take advantage of the benefits of timber construction. Work with Auckland Engineering School, Canterbury University, FRI and consultancy practices has seen significant growth and a better understanding of the performance of Glulam. This has helped to push back the boundaries traditionally associated with timber structures and allowed McIntosh to achieve large and complex spans in Laminated Timber.
Development of multifunctional and low maintenance surface treatments and finishing systems

Advanced prefabrication systems for efficient, rapid and flexible building
- Minimises on-site work
- Reduces total construction time
- High dimensional accuracy achieved with structural components
- Reduced construction cost
- Reduced total building erection cost
- Can achieve a carbon neutral building (embodied energy)
- Building structure able to sustain a major earthquake (Richter scale 7.0 – 7.9) without structural damage and able to return to original position without permanent offset or tilt.

Structural Timber Innovation Company (STIC) is a research consortium developing and commercialising new technologies that will enable structural timber to compete more effectively in the building and construction market.

STIC is developing a portfolio of new pre-fabricated LVL (Laminated Veneer Lumber) and Glulam (Glue Laminated Timber) structural building systems that will enable multi-storey commercial and long-span industrial portal framed buildings to be easily designed and rapidly constructed using engineered timber products. Commercialisation of these new technologies will enable timber to effectively compete with structural concrete and steel, the two present materials of choice in these market segments. By 2023 STIC projects potential revenues of $750m in Australia and $150m in NZ based upon additional LVL sales -$2,000 /m3

Multi-material concepts and functionality
- Lockwood siding demonstrates how to capture the enhanced benefits from the combination of two or more materials
  - versatility and traditional strength of wood
  - aesthetics, durability and style of other materials
The Bodyguard product range distributed in the USA is a good example of NZ R&D and collaboration providing a competitive edge for trim boards, siding and moulding.

Bodyguard® is a range of treated timber products made from renewable New Zealand pine, protected with an innovative wood treatment system and double-coated for added durability.

The Bodyguard® product range is suitable for all non-structural applications where the product is not in direct ground contact. Examples of products in the Bodyguard® range include: trim boards, siding and moulding.

- **Defect free**
  Bodyguard® is a natural wood product manufactured from kiln-dried, finger-jointed and primed timber, with a paint-ready finish.

- **Durable**
  Bodyguard® is pressure treated, achieving total active penetration protection. The addition of waxes and resins into the formulation enhances its water protection properties. The active ingredients used in the treatment process are insoluble in water and will not be removed through leaching.

- **Pest | insect | termite resistant**
  One of the active protective ingredients in Bodyguard® is permethrin, a food-crop protection product that is proven effective against all known species of termite and other borer insects.

---

**Strategic Objective**

### Advanced segregation and optimisation technologies

**Rationale:**
Advanced sorting and grading systems for round-wood and advanced processing technologies lead to an optimised material efficiency and a more reliable production.

*In sawmilling – “An early decision is often the best decision”*
Supporting Research projects

<table>
<thead>
<tr>
<th>Scanning &amp; sensor technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimisation and decision support systems</td>
</tr>
</tbody>
</table>

**Opportunities / Benefit / Examples**

High speed mobile profile assessment to identify shape defects - $50k per line per shift.

Monitoring systems for glueline spread and joint conformation – reduction of rework, breakage and improved performance.

Maximise product recovery – random width v fixed width. Preliminary indications are that an 11% reduction in feedstock would occur for a typical range of NZ moulding profiles. This would result in savings of $550k per 10,000m³ of production.

Stability scanning technology to predict wood that distorts when ripped to smaller products (e.g. mouldings). Cost savings in not ripping material (2%) which will produce unuseable warped mouldings and diverting to fingerjoint. Saving in the order of $550k per 100,000 m³ production.

**Strategic Objective**

Reduce energy, waste and environmental impact

Rationale:

The speed of production would increase considerably and energy consumption could be reduced through the introduction of new techniques to make wood drying faster.

Recycling channels provide access to a new raw material resource based on used wood products. Deconstruction methods, logistics for the collection, sorting and cleaning of used wood materials Easily applicable identification and detection methods for chemical compounds in wood products are also needed.

Supporting Research projects

<table>
<thead>
<tr>
<th>Low energy and faster wood drying processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycling of wood</td>
</tr>
<tr>
<td>Disposal pathways for treated wood</td>
</tr>
<tr>
<td>Carbon foot printing – LCI and LCA</td>
</tr>
</tbody>
</table>
Opportunities / Benefit / Examples

Low energy and faster wood drying processes

5% reduction in drying time provides a saving of $1.30/m³ or $130k per 100,000 m³ production.

Recovery/saving 50% of energy from drying 100,000 m³ timber saves $330k pa. (partial recovery of energy currently lost through venting)

Strategic Objective

Improve occupational safety, health and ergonomics

Rationale:
Better working environment and improved return on investment

Supporting Research projects

Noise and dust reduction and control
Performance measurement & benchmarking

Opportunities / Benefit / Examples

SWI Head rig operator ergonomic study
DOL 5mg/m³ of air – 2 mg/m³ air
Robotics in exposed parts of plant
Paints – VOC reduction
Understand cause and effect and remediation
5.2 Fibre Products and Bio-energy Research

Market size:

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Export</th>
<th>NZ Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibre &amp; Particle Board</td>
<td>583,000 m3 $267 million</td>
<td>233,000 m3</td>
</tr>
<tr>
<td>Paper &amp; Paper Board</td>
<td>620,000 tonnes</td>
<td>495,000 tonnes</td>
</tr>
<tr>
<td>Newsprint</td>
<td>298,000 tonnes</td>
<td>138,000 tonnes</td>
</tr>
<tr>
<td>Chemical pulp</td>
<td>814,000 tonnes</td>
<td>239,000 tonnes -for paper &amp; board</td>
</tr>
<tr>
<td>Mechanical pulp</td>
<td>732,000 tonnes</td>
<td>513,000 tonnes –for paper &amp; board</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>NZ consumption est.</th>
<th>NZ consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export</td>
<td>$227 million</td>
<td>$227 million</td>
</tr>
<tr>
<td>NZ consumption</td>
<td>138,000 tonnes</td>
<td></td>
</tr>
<tr>
<td>NZ consumption</td>
<td>239,000 tonnes -for paper &amp; board</td>
<td></td>
</tr>
<tr>
<td>NZ consumption</td>
<td>513,000 tonnes –for paper &amp; board</td>
<td></td>
</tr>
</tbody>
</table>

Strategic Objective

Enhanced processing systems

Rationale:

Productivity improvement is essential to ensure continued cost competitiveness for our large capital intensive mills. Fibre, energy and chemicals are major cost inputs and continuing effort is required to ensure optimum and world-class conversion efficiencies. Without such a focus, the NZ mills will drift up the cost curve into an uncompetitive and ultimately, terminal position.

Modern chemical pulp mills are net producers of heat and power, while middle-aged mills, such as those in New Zealand are less efficient and require inputs of fossil fuels and electricity (this is in spite of NZ’s kraft mills producing some 800 MW of biomass-derived energy). Mechanical pulping has a high demand for electrical power and the industry, world-wide is constantly
improving the efficiency of mechanical refining. Hence, both the chemical and mechanical mills in NZ must strive to close the “energy gap” by improving the overall energy efficiency of their manufacturing processes. Past evidence suggests that significant potential exists to achieve these improvements. Such efforts, as well as improving cost competitiveness, will increase the availability of biomass-derived energy for external uses.

Large energy savings can be realized both by improving current processes and by developing less energy consuming, breakthrough technologies to replace or improve the energy intensive processes used in chemical and mechanical pulping, paper making, and product drying. Energy management tools need to be developed for optimised integration of energy generation, consumption, conversion and recovery in order to achieve the best combination of economic and environmental benefit.

Improvements in conversion yields will also have major benefits to the pulp and paper industry, particularly the chemical pulp industry, where yields are currently about 45 – 50%. This can be achieved, for example, by improving the properties of the fibre, when produced at higher yield, and also by finding higher value end-uses for the wood components which are solubilised during processing.

More efficient chemical use during processing will also deliver valuable gains in productivity, which will be increasingly important as chemical costs increase due to future supply/demand imbalances.

**Supporting Research projects**

| Reduced energy use in P&P and panels production |
| Improved product yields |
| Reduced chemical consumption |
| Reduced environmental impacts and c- footprint |
| Advanced labelling and tracking systems |
| Automated material handling and robotics |

**Opportunities / Benefit / Examples**

- Conversion yield efficiency gains through improved pulping and panels processes. For example, a 1% yield gain in kraft pulping, would reduce mill gate costs by about $12 million/year. This could be achieve, for example, by modified pulping processes, which enhance the properties of the fibre, when produced at higher yield.
- Improving energy use and integration within existing technologies and processes. This could be achieved by changing process conditions, increased energy integration and reuse, use of advanced process control technologies, and by application of improved process technologies.
- Reducing electrical power use in mechanical pulp refining. NZ’s mills produce 1 million tonnes/year of mechanical pulp, with a power use of about 2 million MWh. Past NZ research efforts have made significant gains in reducing power consumption in refining. Research needs to make further gains while retaining or enhancing the end-use performance of the radiata pine fibre.
• Improving the efficiency of chemical use in pulp, paper and panels production. This could be achieved by improving the effectiveness of current processes or by developing new chemical treatments and process stages.

**Strategic Objective**

**New and enhanced products**

**Rationale:**

Wood and fibre-based packaging materials provide protection for a wide range of products and efficient communication of information. Wide use of these renewable materials improves the sustainability of distribution systems through improved durability and protective capabilities. In particular, the materials must provide enhanced consumer safety and prolonged shelf life of packaged, perishable goods. New functionalities and services must be enabled to provide more information and experience about the packaged product and its use. Production costs must be reduced. Flexible production technologies and new distribution models are needed to enable on-demand production and tailoring of wood and fibre-based packaging solutions for customer needs.

Development of new or improved paper grades, for communications, packaging, and new end-use applications will improve the viability of NZ’s existing paper machines, providing growth opportunities in current and new markets.

The physical and chemical characteristics of wood and its constituents make it an excellent resource for a large number of differentiated materials, in addition to today’s wood and paper products. An increased and advanced use of wood constituents for composites and other materials would expand existing value chains and also form an essential basis for new types of forest-based value chains.

**Supporting Research projects**

<table>
<thead>
<tr>
<th>Improved product performance in existing fibre-based products</th>
<th>New and high performance products integrated into existing production lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Next generation composites</td>
<td>Use of more cost-effective technologies</td>
</tr>
<tr>
<td>Future markets</td>
<td></td>
</tr>
</tbody>
</table>

**Opportunities / Benefit / Examples**

• New, higher value pulp grades, such as dissolving pulps for the burgeoning Asian textile and chemical cellulose derivatives market.

• Currently, much of NZ’s produce is exported in fibre-based packaging. The high humidity performance of this packaging is critical to protecting the produce during storage and transport to distant markets. Improving the properties of this packaging, by making enhanced paper grades, will result in significant costs savings by enabling lower weight papers to be used.
• New wood-derived chemical products from modified pulping processes. For example, pre-hydrolysis of hardwoods, prior to conventional pulping, can yield a xylose hydrolysate for food industry end-use, while still producing a pulp for papermaking. Such process integration can improve conversion efficiencies and utilise waste energy in the process.

• Modified wood and pulp fibres, with improved reinforcement performance in existing composite products such as fibre-cement board and in new composite materials, such as fibre-plastics and fibre-based bio-composites.

• Development of new types of composites based on wood, pulp fibres, and other wood constituents.

• Advanced, functional cellulose-based materials with specific properties are used for technical and life sciences applications.

• Specific materials prepared from lignin and hemicelluloses are used in industrial applications.

**Strategic Objective**

**Next generation and sustainable energy production**

Rationale:

New types of forest-based value chains can be based on the bio-refinery concept. A key element here is the close integration of chemical pulp manufacture with the production of bio-fuels and different base or platform chemicals. An essential further element is then (besides using the pulp in papermaking) the conversion of the isolated chemicals and fibrous elements to value-added specialty chemicals and other products.

If biofuels are to be major players in our energy future, they should be drop-in fuels, so called because they do not need to be blended with petroleum fuels. Only wood can be grown in sufficient quantities to make biofuels a main stream option for New Zealand. Strategically, it makes sense to focus on biofuels which can substitute for diesel, rather than petrol.

Accordingly, processes which can convert wood to biodiesel should be the priority for research funding. A leading technology in this regard is Wood Gasification - Water Gas Shift reaction - Fischer-Tropsch synthesis for biodiesel production. The Parliamentary Commissioner for the Environment recently commissioned CRL to review the production costs for this route to biodiesel. Implementation of this technology at a significant scale in NZ will likely require process integration at an existing large wood processing site, so that energy efficiencies can be maximized. Substantial and focused R&D effort will be required to reduce the process risk to the point that capital can be committed to a significantly scaled plant.

“In light of these conclusions, if biofuels are to play a significant role in our energy future, we should move toward developing drop-in biodiesel made from wood.”

**Dr Jan Wright**
Parliamentary Commissioner for the Environment
Supporting Research projects

| Advanced conversion technologies |
| Production of new, base or platform chemicals |
| Process integration to transform existing plants (biorefineries) |

**Opportunities / Benefit / Examples**

- An industry-CRI partnership to explore the best production route for biodiesel production from wood, based around integration with an existing chemical pulp mill. Process designs for the Gasification-Water Shift- Fischer-Tropsch synthesis process are currently being developed at a scale of 1 m tonnes wood/year (compare with Kinleith Pulp and Paper mill at 2.25 m tonnes/year) producing 133 ML liquid fuels/year.

- Development of alternative end-uses for lignins from chemical pulping, which are currently burnt for energy production. New Zealand’s chemical pulp mills are operating close to their recovery boiler capacity constraints; meaning that significant increases in production will require expensive recovery boiler replacements. If the lignin from the cooking process can be separated for sale as a chemical raw material, this will unload the recovery boilers and enable increased mill throughput. A 10% increase in chemical pulp production amounts to 80,000 tonnes/year, which would all be exported at a value of about $80 million/year.

- New concepts in process integration are required to realise the bio-refinery concept, in which the wood components are recovered as new pulp mill product streams. New or customised process solutions will be required, in which the carbohydrate and lignin-derived chemicals are obtained efficiently and in the right form for conversion to higher-value, marketable products. An example would be xylose production by pre-hydrolysis of hardwoods, where the xylose can be purified and converted to xylitol for sale into the food industry. Another example would be reactive lignin production for use as a phenol substitute in phenol-based resins.

**6: Research Capability and Capacity:**

In many areas the breadth of and scope of research is beyond the capability of a single research provider and as such the industry will work to encourage collaboration between CRIs, Universities and other research providers.

Innovation relies on collaboration and interactive learning. Recent examples can be found in successful industry led collaborative programmes such as SWI (Solid Wood Innovation), STIC (Structural Timber Innovation Company) and Bodyguard Wood Products Limited. Innovation also requires commercialisation, and a mix of business skills including analysis and assessment of markets, engineering capabilities and design skills that exist in industry.

The Wood Processing sector encourages a collaborative and integrated approach involving Universities, CRI’s and End users. In collaboration with the Wood Council of NZ, the WPA and PMA is committed to work with, advise and direct research providers and to contribute an end-user perspective to assist with research governance and management, and encourage and participate in regular reviews of the science underpinning the wood and fibre processing sector.
7. References and Sources:

a/ “Public Policy Framework for the New Zealand Innovation System”
Keith Smith MED 06/06

b/ “Forest and Wood Products Industry Strategic Plan” Woodco Strategy 2006

c/ “MAF Statistical Release” September 2010 Qtr

d/ “Statement on Research Needs for the Forest Industry” Woodco release July 2010

e/ “Forest and Wood Products Industry Strategic Plan” Woodco 2008

f/ “Forest-Based Sector Technology Platform - 2006
   The European Confederation of woodworking industries (CEI-Bois)
   The Confederation of European Forest Owners (CEPF)
   The Confederation of European Paper Industries (CEPI)


h/ Industry consultation documents relating to the formation of SWI

i/ Report to Ministry of Research Science & Technology “Economic Impact of Wood Drying”
   June 2004 Business and Economic
   Research Limited

j/ “Wood Product: Processes and Use June 2006” Statistics New Zealand

k/ “Energy trends and technologies for the coming decades” Address to the Harvard University
   Center for the Environment, March 8, 2006

l/ “Some biofuels are better than others”: Thinking strategically about biofuels 29 July 2010
   Dr Jan Wright Parliamentary Commissioner for the Environment