Lignin - A Renewable Chemical Feedstock for the Future:

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Biorefining. Redefined.

TSXV : LEC
www.lignol.ca

Lignol Energy Corporation (TSXV:LEC)

- World class biorefining technology:
  - Renewable fuels and chemicals
  - High-value cellulose products
  - Unique High Purity Lignin

- Partnerships with leading companies in target industrial sectors

- Powerful IP portfolio: 90 patents in prosecution (12 granted)*

- Technology proven in integrated pilot-scale biorefinery
  - $50 million invested to date
  - Govt. funding awarded to date: $30 MM / $4MM pending
  - Ready for commercial deployment upon securing off-takes for key products

100%

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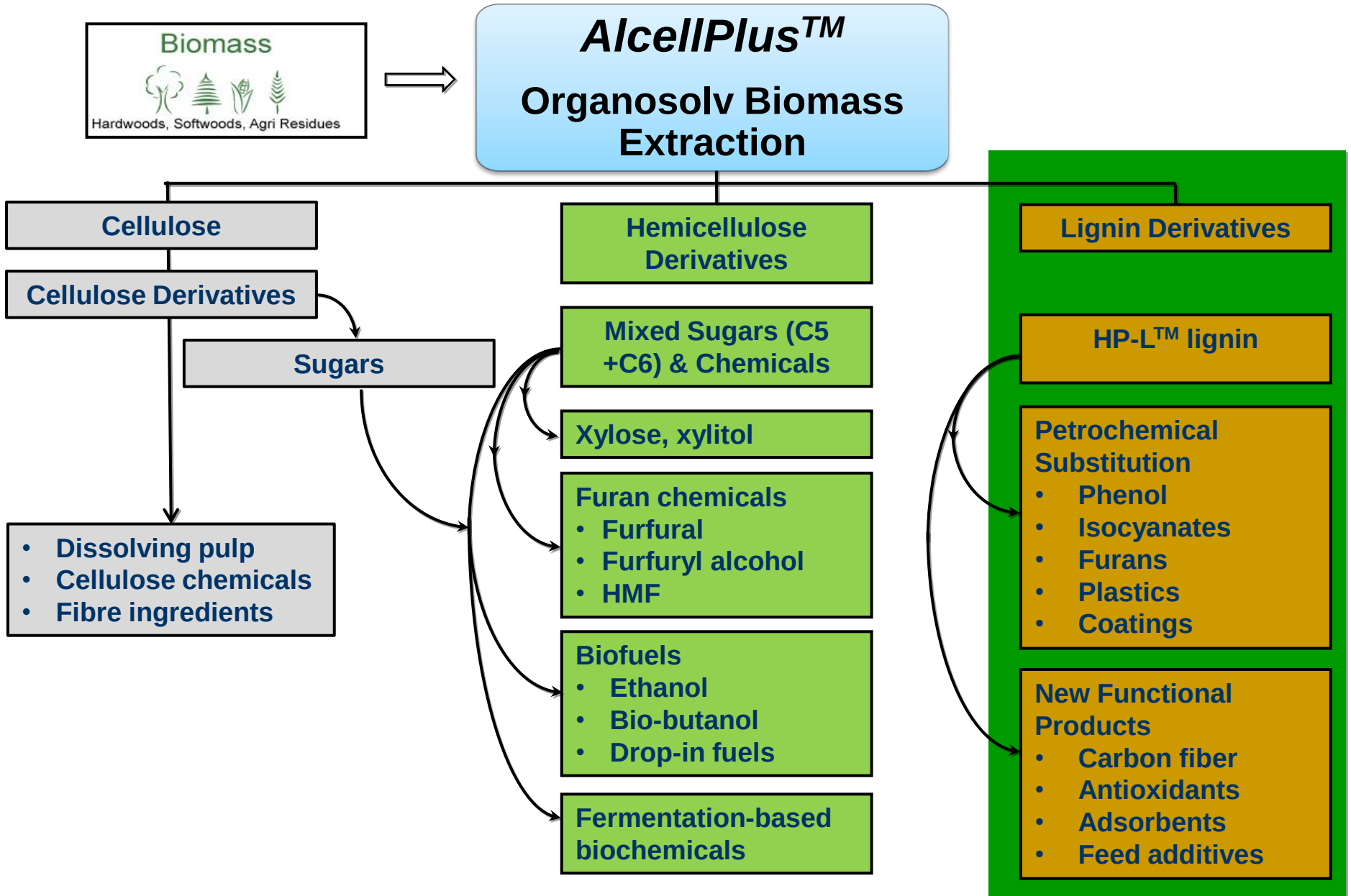
Lignol Innovations Ltd.

Value Streams from Lignol's Biorefinery

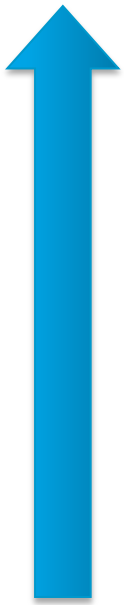


Established Lignin Industry

- Exclusively byproducts of fiber processing
  - Sulfite, Kraft and Soda Pulping
  - Wood and agricultural residues
- Well established applications based on the distinct chemical and physical properties of these technical lignins:
  - Chemically condensed
  - Chemically modified by pulping conditions
  - Non-lignin components:
    - Sulfur
    - Inorganics
    - Carbohydrates
- Estimates vary but this is a $2-3 billion business today

Lignin-based products in today's market – sulfite pulping

- Lignosulfonates
  - Sulfite pulping
  - Water-soluble
  - 1 million tonnes per year
  - $1.0 – 3.0/kg ds
  - Market dominated by Borregaard and Tembec
  - $2-3 billion business worldwide



Price

Applications

- Concrete Additives
- Animal feed pellets and molasses
- Pesticide dispersant
- Oil well drilling mud
- Dust control

Lignin-based products in today's market – kraft pulping

- Kraft Lignins
  - Kraft (alkaline sulfide) pulping
  - Water insoluble (unless sulfonated)
  - 80-100,000 tonnes per year
  - $2.0 – 6.0/kg ds
  - MeadWestvaco is the major player

Price

Applications

- Ag. Chemicals
- Dyestuffs
- Concrete
- Lead-acid batteries
- Resins
- Bitumen

Lignin History – Unrealized Potential

- In 1838 Anselme Payen identified a substance released by the nitric acid treatment of wood.
- He referred to this substance as “encrusting material”
- This encrusting material is the largest non-petroleum source of the aromatic nucleus and the world’s second most abundant naturally occurring polymer.
- Today (after 174 years) approx. 50 Million metric tons of lignin are separated from wood annually by the world’s pulp mills
  - Mostly burnt for energy (which is essential for chemical recovery)
  - Most pulp mills have excess energy
- Only 1.1 million metric tons per year of lignin (~2%) are sold mainly as sulfonated lignin
- In spite of its massive potential, lignin is barely commercialized
- Why?

Some reasons….

- Perception
  - Lignin is seen as a waste product and has a high heating value!
- Purity
  - Most available lignin is contaminated, not sufficiently pure for many applications; highly heterogeneous
- Petro-chemicals do it better
  - Putting lignin into chemical systems and products that were designed for other types of chemicals like petro-chemicals is challenging (technically and commercially)
- Difficult chemistry
  - Lignin is a strongly self-associating, reactive, broad mixture of molecular species; highly reactive
- Lack of knowledge
  - Still large gaps in our knowledge of lignin and its chemistry

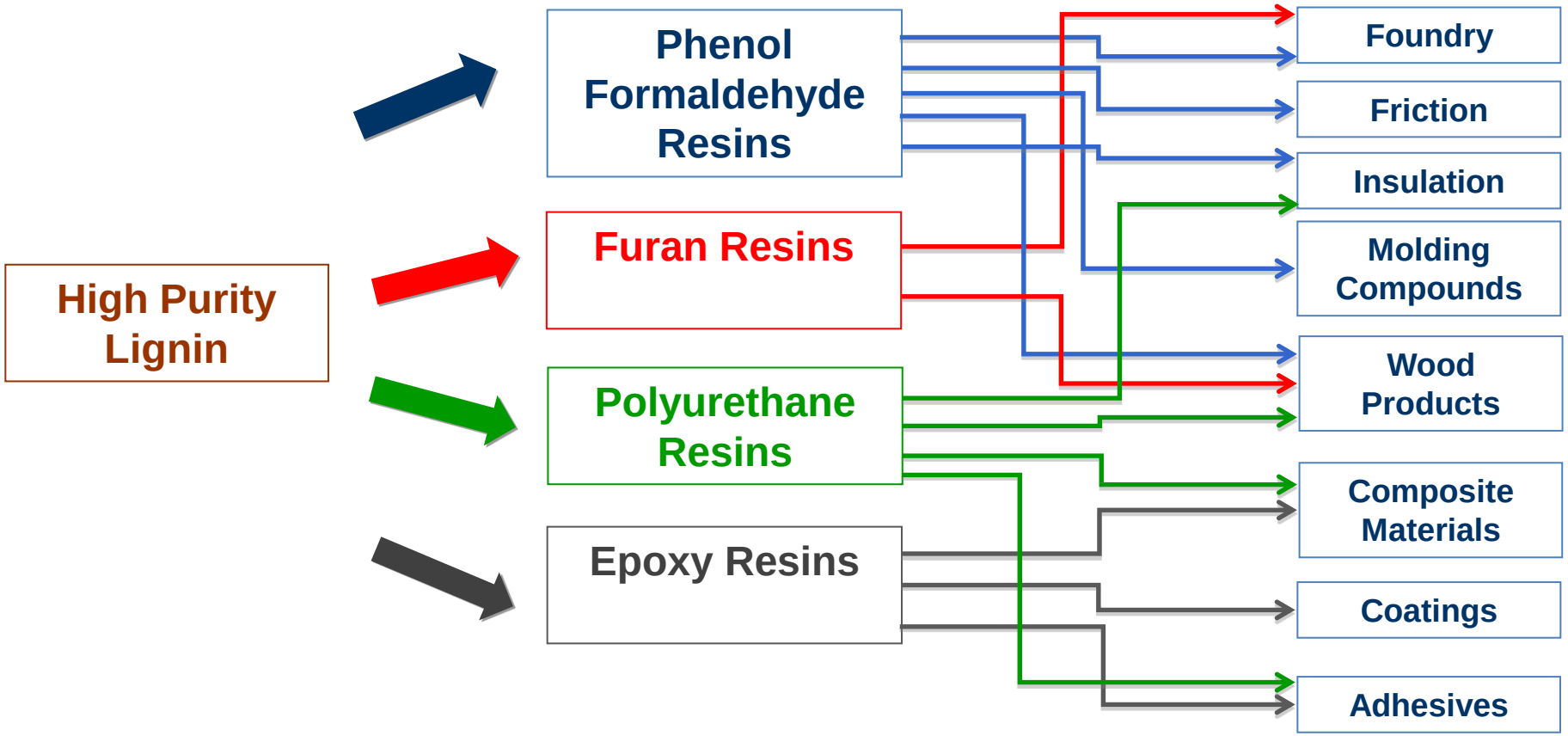
Unique market opportunities for HP-L lignin

- Lignol process extracts lignin fragments to produce valuable functional molecules which make up HP-L lignin
- Highly differentiated from commodity pulp mill lignin
  - High purity; low ash content, essentially sulfur-free
  - Lower molecular weight and polydispersity
  - Chemically reactive in many established chemical industry systems and products
  - Attractive to developers of new materials such as carbon fibre, films and polymers
- Market opportunities to deploy HP-L lignin in several major industrial sectors:
  - Automotive
  - Industrial equipment
  - Wood products
  - Chemicals and polymers
  - Construction

HP-L Lignin Applications Development

- Focus of Lignol's development today is on incorporating HP-L lignin into product formulations as a substitute for incumbent petrochemicals
- Many companies are evaluating HP-L lignin in high-volume product sectors:
  - Resins
  - Coatings
  - Thermoplastics
  - Carbon fibre
  - Building materials
  - Foams
  - Wood composites
  - Adhesives
  - Filtration
- Lignol is working closely with corporate partners, Universities and Institutes to maximize breadth of application development

Key Resin Systems – Applications for HP-L



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Displacement of Conventional Chemicals by HP-L

- Achieved displacement levels controlled by chemistry and stage of development - some examples:

Application	Host Chemical	Achieved Displacement	Scale	Target Displacement
OSB (& MDF)	PF resin pMDI	25% 40%	Commercial Large pilot	50% 50%
Rigid foam insulation	PF resin PIR	10% 5%	Industrial Lab	30% 30%
Coatings	Epoxy	10%	Lab>Pilot	30%
Foundry resins	Furan	15%	Commercial	30+%
Friction binder	PF resin	40%	Commercial	50%
Thermoplastics	Various	30%	Pilot	50%
Carbon fibre	None	100%	Pilot	90-100%

Future directions for HP-L lignin development

- The future for HP-L Lignin – next generation uses and applications:
  - Bridging knowledge gaps in lignin physics and chemistry
    - Solubility, reactivity, rheology, mode of action in target systems
  - Development of products based on HP-L Lignin rather than using it as an additive or substitute ingredient
  - Development of feed, food and nutraceutical applications
  - Fractionation into narrower ranges of chemical composition
  - Chemical modification to create specific functionality
  - Breakdown into aromatic building blocks
- Priority and direction will be determined by economics and by partner priorities

Thanks

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