ADVANCING SUSTAINABILITY IN SKI MANUFACTURING

Nathan Grothe, Category Manager, REI
Megan Zeeb, MBA Student, Western Colorado University

CONSUMER DEMAND

+71%

RISE IN SEARCHES FOR SUSTAINABLE GOODS IN THE PAST 5 YEARS[1]

60%

OF CONSUMERS RATE SUSTAINABILITY AS AN IMPORTANT PURCHASE CRITERION[2]

7.1x

FASTER GROWTH FOR PRODUCTS MARKETED AS SUSTAINABLE[3]

1) An Eco-wakening, Economist Intelligence Unit, May 2021
2) The Global Sustainability Study, July 2021
3) 2021 Sustainable Market Share Index, NYU Stern's Center for Sustainable Business *vs conventional counterparts

PROJECT OBJECTIVES

UNDERSTAND INITIATIVES

Learn what initiatives vendors are implementing to drive sustainability & what barriers are in the way

ASSESS IMPACT

Better understand what parts of ski production are creating the biggest environmental impact

INFLUENCE CHANGE

Share learnings to encourage collaboration and collective effort to drive sustainability in the category

KEY AREAS OF FOCUS

ENERGY USE

It takes approx. 116 kWh worth of energy to create a pair of skis[1]

MATERIALS

Materials needed to build a pair of skis result in approx. 40 kg CO2e[2]

PRODUCTION WASTE

For every pair of skis made approx. 1 ski of waste is created

PACKAGING

Approx. 12’x10" of single-use plastic used to wrap a pair of skis

END OF LIFE

The average pair of skis lasts 5-8 years or up to 125 ski days[3]

1) A Systems Approach to Sustainable Technical Product Design (2013), kWh = kilowatt hours
2) Higg Material Sustainability Index & Product Module,, based on a proxy ski bill of materials
3) Skiing Lab, Dec 2020

ENERGY USE

It takes approx. 116 kWh worth of energy to create a pair of skis*

*A Systems Approach to Sustainable Technical Product Design (2013)

ENERGY USE

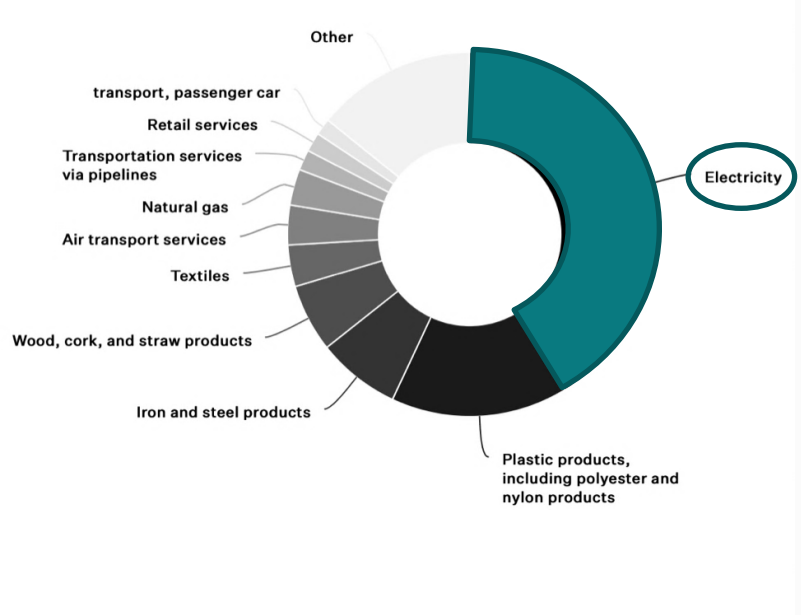
Switching to renewable energy at the production facility can reduce carbon footprint up to 47%*[1]

Barrier: Many producers do not own their own production facility

Opportunity: Collective action for renewable energy at facilities & IREC's

Largest Drivers of Footprint

Example from mid-size US ski producer



Notes:

- Standard energy grid where the production facility is locatedmakes a big difference in total manufacturing emissions
- Push for electrification & have that electricity powered by renewable sources
- Renewable Energy Certificates as an alternative if unable to make changes at the facility (1 I-REC = 1MWh of renewable energy generation)
- Optimize use of ski press (optimal temperature/conditions while pressing & avoid unnecessary power downs/ups)

*Dependent on facility's energy mix

1) Mountain Wilderness Study 'What is inside a ski and who is behind it?'

MATERIALS

Materials in a conventional pair of skis result in approx. 40kg C02e*

*Higg Material Sustainability Index & Product Module, based on a proxy ski bill of materials

Source: Folsom Skis

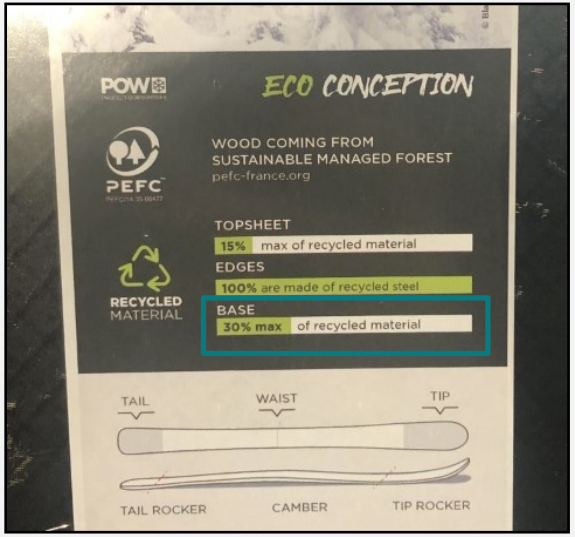
MATERIALS

Recycled or bio-based materials are available for all basic components of a ski

Barriers: Options not widely available, supply chain traceability, LCA info unknown

Opportunity: Understand material impacts and design with impact in mind

BASES



RECYCLED POLYETHELYNE

~38%

CO2e Reduction

vs. virgin PE*

Notes:

- Traditionally made from UHMW-PE
  - Some brands using recycled content in their base material, others noting no viable sourcing options exist for recycled content
  - Importance of supply chain traceability and verification to confirm sustainability/recycled material claims to avoid questions of greenwashing and to help material alternatives gain traction in the category

*Higg Material Sustainability Index

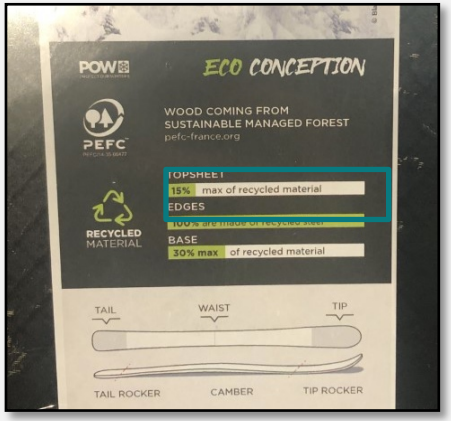
MATERIALS

Recycled or bio-based materials are available for all basic components of a ski

Barriers: Options not widely available, supply chain traceability, LCA info unknown

Opportunity: Understand material impacts and design with impact in mind

TOP SHEETS



RECYCLED NYLON

~75%

CO2e Reduction

vs. virgin*

Notes:

- Traditionally made with a nylon plastic, alternatives being a castor oil-based nylon, or recycled nylon
  - Recycled nylon being experimented with, but high percentages can cause a cloudy appearance
  - Castor oil-based nylon has a negligible reduction in CO2e emissions and can be land/water intensive based on farming practices – responsible sourcing important to mitigate
  - Some brands opting for no top sheet, instead applying a design to the wood core and adding a varnish on top as the protective layer

*Higg Material Sustainability Index

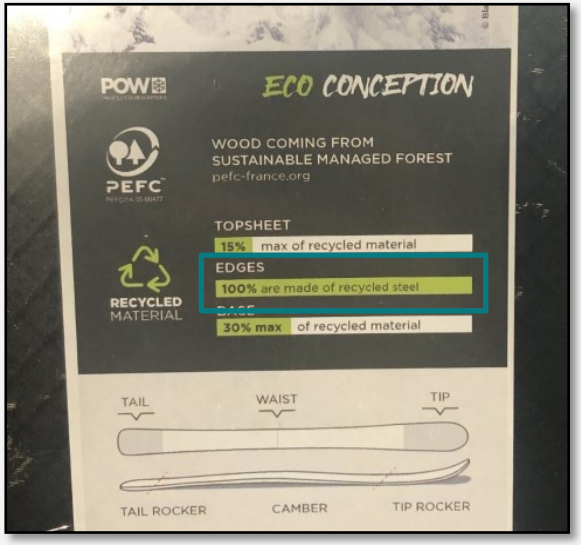
MATERIALS

Recycled or bio-based materials are available for all basic components of a ski

Barriers: Options not widely available, supply chain traceability, LCA info unknown

Opportunity: Understand material impacts and design with impact in mind

EDGES



RECYCLED STEEL

~73%

CO2e Reduction

vs. virgin*

Notes:

- Traditionally made with virgin stainless or standard steel, starting to see the use of recycled steel
  - Some brands noted no sourcing options available for recycled steel edges
  - Importance of supply chain traceability and verification to confirm sustainability/recycled material claims to avoid questions of greenwashing and to help material alternatives gain traction in the category

*Higg Material Sustainability Index

MATERIALS

Recycled or bio-based materials are available for all basic components of a ski

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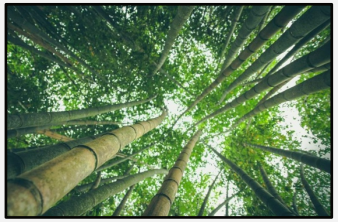
Opportunity: Understand material impacts and design with impact in mind

FSC WOOD

~29%

More CO2 storage than non-FSC*

CORE



Notes:

- Responsible Sourcing:
  - FSC as the most widely known and credentialed, PEFC being another 3rd party certification
    - FSC certification can be hard to hold throughout entire supply chain due to the required chain of custody, can be expensive and brands are reliant on vendors to have certification for transport and production; brands might be sourcing from FSC certified mills, but not able to make the claim on the ski itself.
  - Partnering with local forest service to source wood that is a byproduct of forest management
- Type of Wood Sourced
  - Bamboo as a fast-growing alternative to a common wood core, light and strong
    - Been used heavily by Liberty Skis
    - Unable to source FSC bamboo because it is not a wood, but still should consider responsible sourcing as new demand for bamboo has resulted in clearing of land from existing wildlife to facilitate bamboo groves
  - Fast growing woods like poplar and aspen
  - WNDR's use of Algal Tech (bio-based PU) in their Aspen cores
    - Reduces need for composite materials as the addition of the AlgalTech provides some of the desired performance qualities sometimes obtained with composite materials
  - Isosport Green Core (FSC certified wood + recycled plastic)

*On Average, Tradeoffs in Timber, Carbon, and Cash Flow under Alternative Management Systems for Douglas-Fir in the Pacific Northwest, 2018

MATERIALS

Recycled or bio-based materials are available for all basic components of a ski

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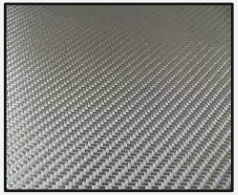
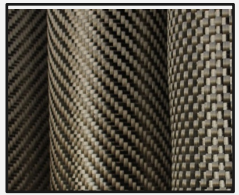
COMPOSITES

Carbon Fiber



Fiber Glass

Flax Fiber



Basalt Fiber

Hemp Fiber

Notes:

- Traditional options are fiber glass & carbon fiber
  - Concern with carbon fiber due to a high LCA CO2e emissions factor
  - Concern with fiber glass due to human health issues when the fibers release causing skin or eye irritation or issues from inhaling the airborne fibers
- Bio based options
  - Flax fiber
    - Flax being scaled by Salomon
    - Study done comparing flax to fiberglass found it to have 40x less human toxicity than fiberglass (Deng and Tian, 2015)
    - Some questions on total impact reduction in the cases of eutrophication and agricultural land occupation due to farming practices but responsible sourcing decisions could mitigate those concerns
  - Basalt
    - Made from crushed volcanic rock
    - Downside being the high heat needed to process the basalt rock into a state to turn it into filament fibers
  - Hemp
    - Fast growing, resilient plant that generally doesn't require a lot of water or pesticides to grow
    - Noted for providing high damping qualities

EPOXY

MATERIALS

Recycled or bio-based materials are available for all basic components of a ski

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Opportunity: Understand material impacts and design with impact in mind

SUPER SAP®

Source: Entropy Resins

BIO-BASED EPOXY

11-16%

Less environmental impact vs. conventional*

Source: Niche Snowboards

Notes:

- Most brands use a petroleum-based epoxy/hardener combo for ski composition
  - Bio-based epoxy resin option gaining more traction and scale as it continues to prove durability
  - Sustainable hardener option is less widespread, but a recyclable epoxy thermoset called Recyclomene exists that allows for disintegration and therefore separation of each material
    - Piloted by Niche Snowboards
    - Not scaled yet but could be a possible solution for end-of-life concerns for skis/snowboards

*Entropy Resins

PRODUCTION WASTE

For every pair of skis made, approx. one ski worth of material is wasted

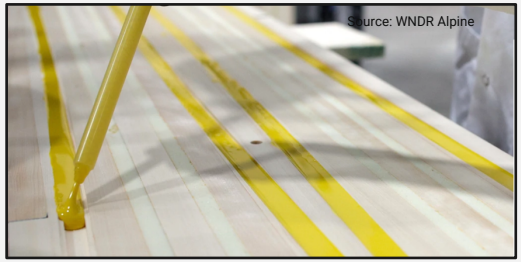
PRODUCTION WASTE

REDUCTION METHODS

- ✓ Additive Manufacturing
- ✓ Alternating Base Color for Die Cuts
- ✓ Work with warped raw materials
- ✓ Prepreg Fibers

Barrier: Many brands do not own the facility where the skis are produced

Opportunity: Collective effort to innovate & implement processes to reduce waste



Notes:

- Additive manufacturing
  - Process of starting with a desired footprint, and iteratively adding only the material needed to gradually move towards a finished product, basically starting with the actual shape of the ski and building it up from there instead of cutting out the shape of a ski once all the materials have set.
  - DPS and WNDR are starting the achieve this by pouring liquid PU into the ski mold to create the sidewalls instead of cutting and shaping ABS plastic as is more traditionally done, resulting in almost no sidewall material waste.
- Alternating base colors to fully utilize all die cut materials
- Find ways to work with warped raw materials
- Pre-preg composites
  - Reduces need for additional layers of epoxy, trade off could be increased energy needed to keep it stored in cold conditions and higher heat in ski press needed to activate

PRODUCTION WASTE

COLLECTION METHODS

- ✓ Granulate wasted materials
- ✓ Wood shavings/pulp for heating
- ✓ Find usage for larger scraps

Barrier: A large amount of production waste is hard to disassemble for separate components

Opportunity: Collective effort to develop innovative ways to use the composite scraps

Notes:

- Granulate Waste
  - Provide to a recycler
  - WNDR creating uniform planks out of the granulate material & currently using as a binding retention plate within their skis
- Woods shavings used for biometric heating
- Using larger cut off scraps for other products/uses
  - One brand finding ways to make iPhone cases out of waste material

PACKAGING

Approx. 12’x10" of single-use plastic used to wrap a single pair of skis

PACKAGING

Innovative packaging solutions are being implemented to avoid single use packaging in skis

Barrier: fear of cosmetic damage and price of alternatives

Opportunity: Remove plastic packaging and opt for post-consumer fiber corrugate solutions

Source: Meier Skis

REI Sustainable Packaging Guidelines

OBJECTIVE:

This document outlines REI's sustainable packaging guidelines. Packaging is necessary to protect products while in transit. Packaging may also enhance the customer experience by communicating key information or displaying products in a compelling manner. REI's goal is to minimize the environmental footprint of packaging while ensuring the packaging is effective in serving its purpose. We have adopted high standards for REI brand products, and we encourage our wholesale brand partners to do the same. These guidelines serve as a resource to those ends. Contact ProductSustainability@rei.com with any questions about this document.

Design to Reduce Material Use

- Assess to what extent packaging is necessary for product protection.
- Minimize material usage, or eliminate packaging completely.
- Measure and manage the package-to-product ratio and the carton efficiency.
- Minimize cutting waste by evaluating the die-line efficiency of the packaging design.
- Partner with print vendors to develop more efficient designs.

Notes:

- Alternatives to single use plastic
  - Corrugate strap to secure skis in place
  - Use of old sublimation paper as packing material in box for protection
  - Corrugate sleeves made from post-consumer fiber
  - Reusable sleeves
  - Bio-Based/Compostable Plastic
    - Avoid relying on too much due to difficulty with proper disposal
- REI's Packaging Guidelines
  - Reduce total packaging
  - Use post consumer paper/corrugate
  - If using bio-based/compostable plastics clearly note how to dispose properly due to lack of consumer awareness on proper disposal for different types of plastics
  - Stick to single materials instead of blends to increase ease and chance of recycling
  - Avoid inks/laminates that would interfere with recycling

END OF LIFE

The average pair of skis lasts 5-8 years or up to 125 ski days*

*Ski Lab

END OF LIFE

Encouraging peer to peer resale and take back programs once reverse logistics infrastructure is scaled

Barrier: Energy intensive and logistically challenging to facilitate widespread collection and disassembly

Opportunity: Durable products that enable longer use & scaling "clean" take back solution

RECYCLE YOUR BOOTS
TECNICA

Source: Tecnica

ECO-FRIENDLY
*NICHE
SNOWBOARDS

Source: Niche Snowboards

Notes:

- Durability/Extending Product Use
  - Providing repair services or designing with repairability in mind
  - Timeless designs that don't encourage constant trade up
    - Season eqpt & 1000 ski examples of this approach
  - Encouraging peer to peer resale or localized used gear sales
    - Likely the most eco-friendly way to keep products in use as it avoids long distance transport
  - Enable re-commerce opportunities with a take back program
- End of Life Solutions
  - Industrial Recycling – inherently challenging for skis because they need to be dissembled, ideally separating each material for reuse, resulting in an energy intensive six-step progression to separate and process the material
    - SIA's partnership with Waste Not Recycle in 2013 – collecting and processing skis, didn't fully come to fruition due to cost and global recycling volatility
    - Recycle Your Boots program by Tecnica - partnering with retailers in Europe to collect old boots to then properly process them and find ways to use the materials as reusable secondary raw materials
    - Disassembly piloted by Niche Snowboards - using the Recyclomene hardener in combination with a biobased epoxy to be able to disassemble snowboards upon retrieval
  - Granulation – granulate end of life skis, but then needing a solution for how can those granulates can be repurposed and ideally upcycled
    - Like the composite planks being created by WNDR out of production waste, what could be some innovative and useful applications for the granulated material

WHERE TO START

- Measure footprint
- Understand impacts of various materials
- Design with sustainability and end of life in mind
- Collaborate

BRAND RESOURCES

- Climate United
- OIA Climate Action Corps
- REI Guidelines
  - Packaging Guidelines
  - Sustainability Attributes/Specs
- Higg
  - MSI & PM
- Carbon Neutral
  - BEE Tool

Does anyone have any questions?

Megan.Zeeb@western.edu

THANK YOU

Dawnielle Tellez
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