# Research expectations and utilization in Stora Enso


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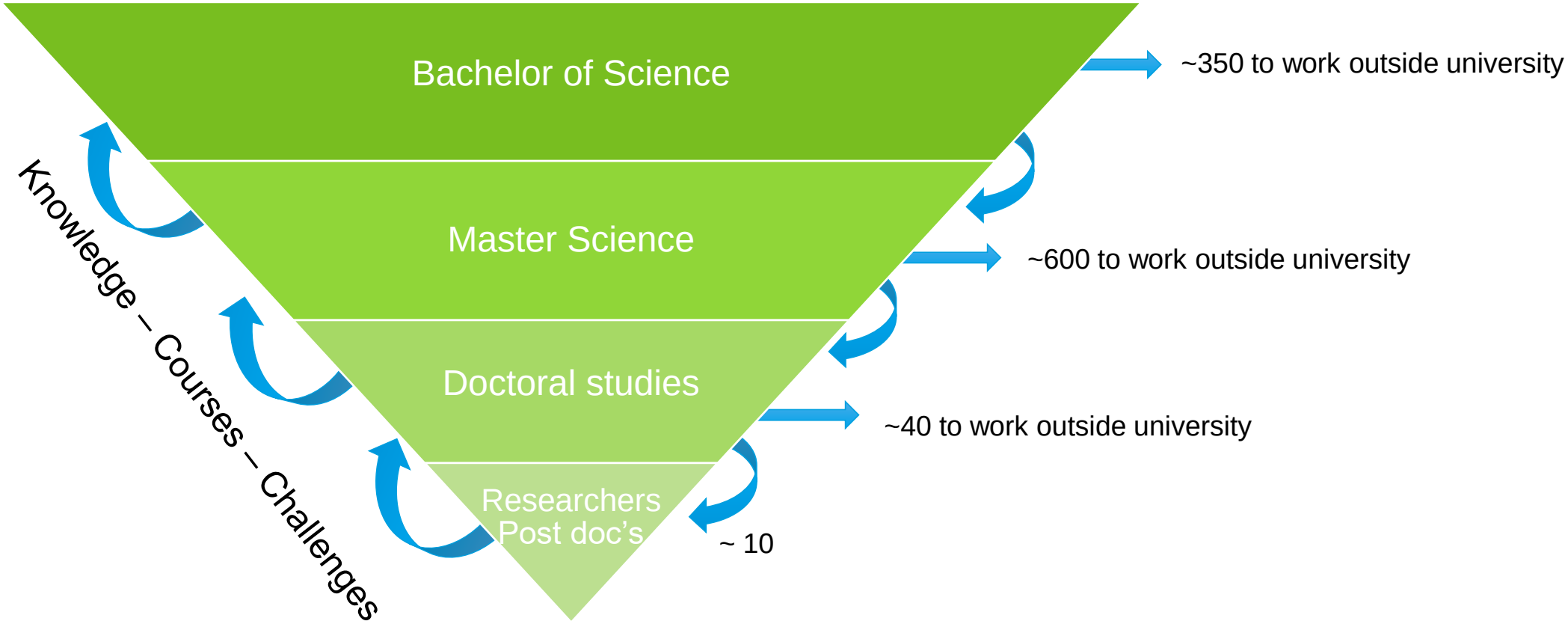
# Education and research connection

## For every 1000 new student



# Bio-economy research expectations…

| Short term | Medium term | Long term |
|---|---|---|
| Characterization methods and models for understanding current and new opportunities close to existing products | Process technologies with disruptive cost competitiveness for existing and new products | Radical resource and energy efficiency improvements for processing of biomass to competitive products |
| Knowledge opening new opportunities for the future bio-based products | Bio-based materials and chemicals with properties & competitiveness in pair with fossil materials | Materials circularity enhanced |
| Solid base and research competences in biomass physics and chemistry | THE most attractive area in chemical and material research | CO2 becoming an increasingly important resource |

# …and we are continuously developing

| | PRODUCT / TECHNOLOGY | CUSTOMER USE EXAMPLES | R&D | PILOTING | SCALING | FULLY ADOPTED BY MARKETS |
|---|---|---|---|---|---|---|
| **1. BIO-CHEMICALS – INDUSTRIAL INTERMEDIATES** | **Lignin** | ▪ Replace phenol | | | ● | |
| | **Xylose** | ▪ Sweetener, personal care | | ● | | |
| | **Biomass polymers** | ▪ Replace oil-based plastic | ● | | | |
| | **Dissolving pulp** | ▪ Textiles, packaging | | ● | | |
| | **Modified fibres** | ▪ Performance chemicals | ● | | | |
| | | ▪ Personal care ingredients | ● | | | |
| **2. REPLACING FOSSIL MATERIALS IN PRODUCTS** | **Micro-fibrillated cellulose** | ▪ Bio-barrier in food cartons | | ● | | |
| | | ▪ Lightweight board | | | | ● |
| | | ▪ Strengthening liner | | | | ● |
| | **Biocomposites** | ▪ Building & construction | | ● | | |
| | **Lignin bio-carbon fibre** | ▪ Lightweight structures, energy storage, transportation | | | ● | |
| | **Building systems** | ▪ High rise buildings | | | ● | |
| | **Modified wood** | ▪ Cladding, decking | | ● | | |
| **3. ENABLING INNOVATIONS OF NEW CONSUMER EXPERIENCES** | **Nano cellulose** | ▪ Transparent / Electronic Programmable / Foam / Spheres | ● | | | |
| | **Digitalisation** | ▪ Material with in-built monitoring and tracking capabilities for intelligent packaging | | ● | ● | |