



GLOBAL IMPACT OF THE MODERN PINE CHEMICAL INDUSTRY

About Pine Chemicals Association

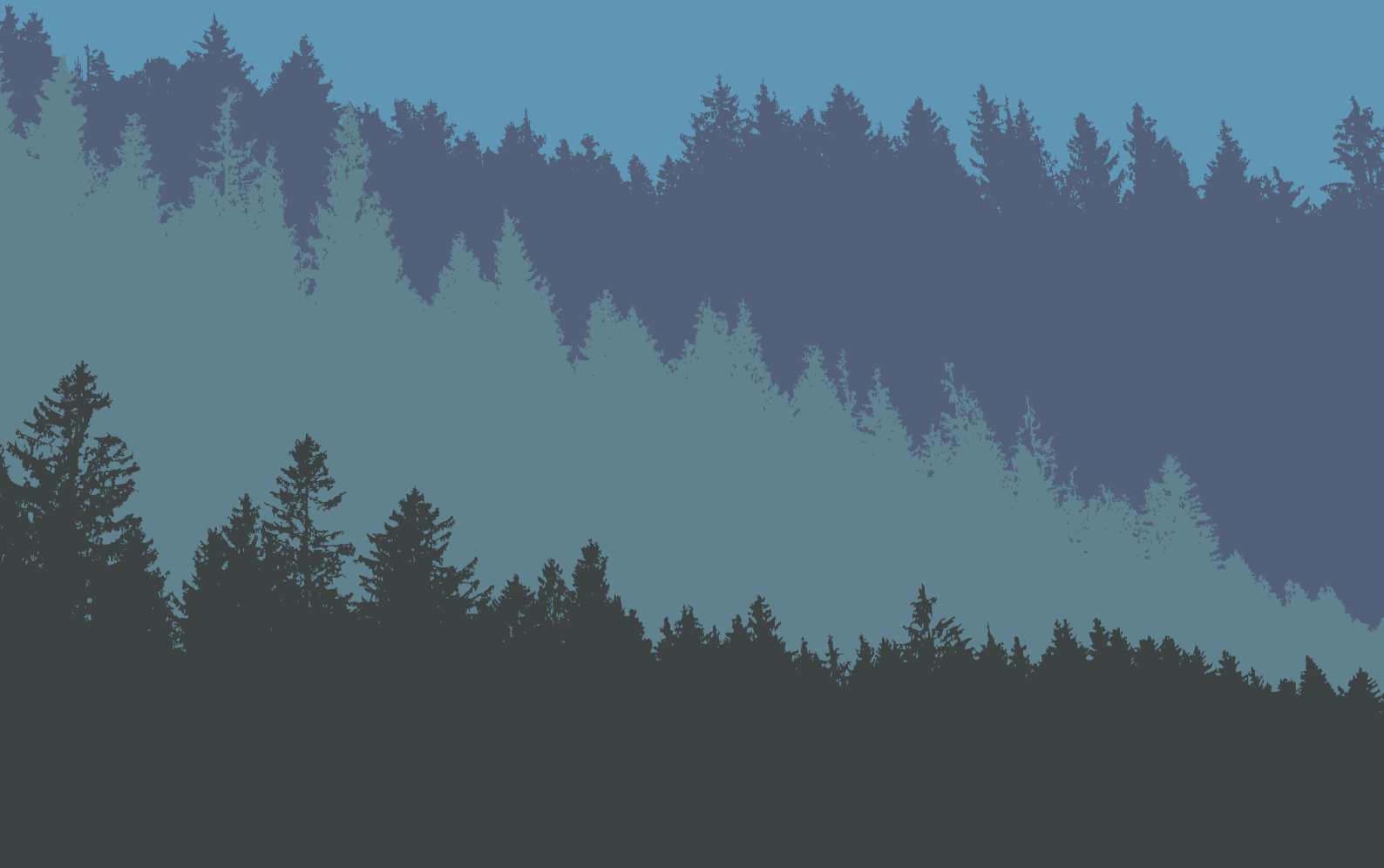
The Pine Chemicals Association International (PCA) is the global trade association representing companies and organizations engaged in the pine chemicals industry. The PCA represents members from over 20 countries around the world engaged in producing, marketing or supporting pine chemical products produced from Crude Tall Oil (CTO), Crude Sulphate Turpentine (CST), oleoresin tapped from pine trees or from wood stumps. It is the only association dedicated exclusively to promoting the growth, success and sustainability of the global Pine Chemical Industry.

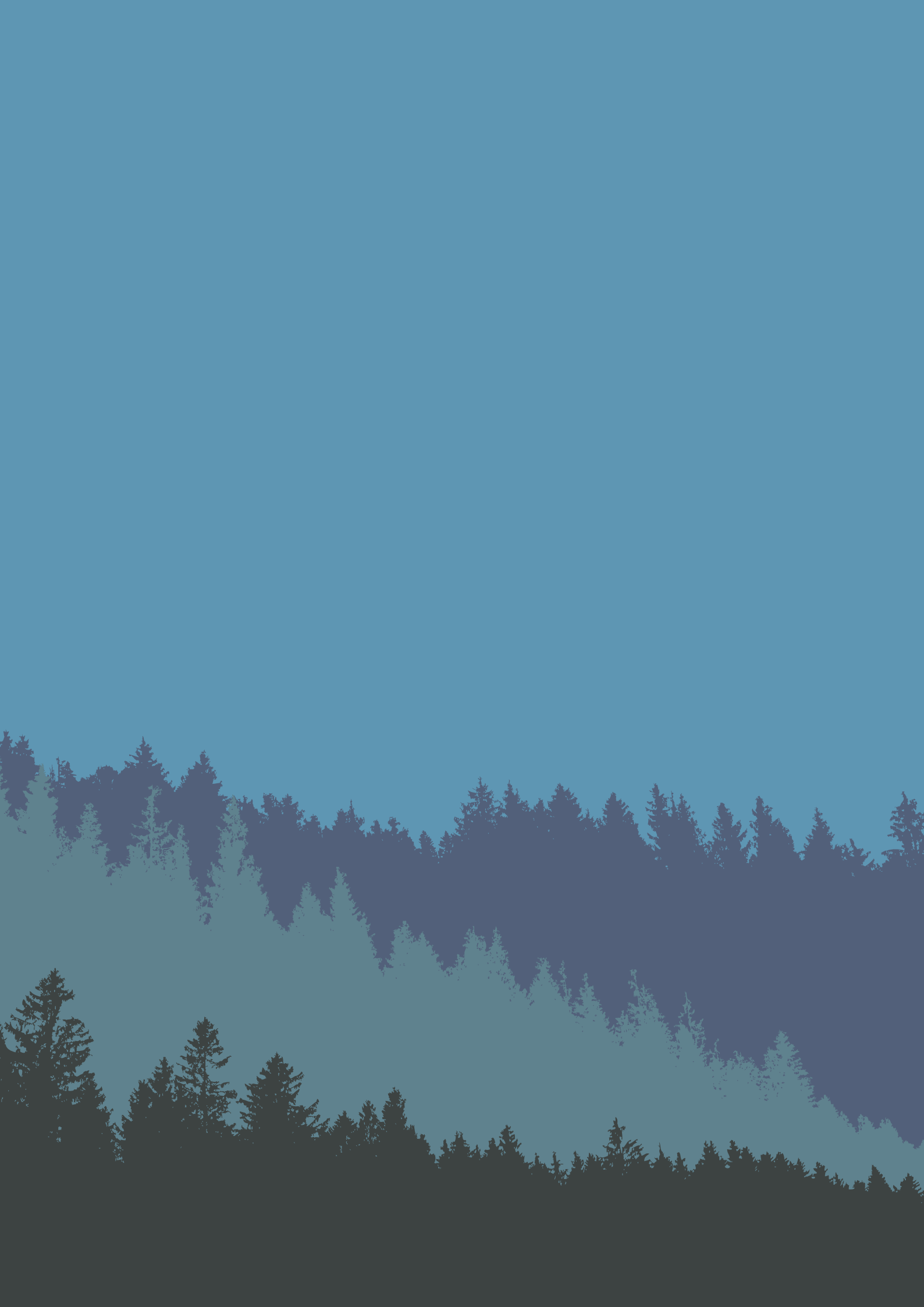
The PCA provides its members with statistical data; research on the industry; safety best practices; technical information; education and training and advocacy.

The association also monitors, and as needed, addresses key regulatory issues around the globe. Excellent networking opportunities and industry updates are provided at the PCA's Annual Meeting, the annual International Conference and periodic training conferences.

The Pine Chemicals Association International is proud of more than 50 years of service and remains committed to serving as a leading advocate and resource for the global Pine Chemical Industry in the future.

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Executive Summary

The Pine Chemical Industry (PCI) embraces science and technology, employs a highly-skilled global workforce and exemplifies sustainable development. A multitude of products based on chemicals from the pine tree touch almost all spheres of our lives, from perfumes and cosmetics to food additives, adhesives to automobiles and printing inks to oil wells. The industry has continuously adapted itself over centuries and is today at the forefront of renewable bio-based industries.

The Pine Chemicals Association (PCA) commissioned an independent global economic survey to assess the global magnitude and significance of the impact of the industry.

An initial survey reached out to nearly 200 companies across the world. Survey data was segmented into the following regions:

1. North America
2. Europe
3. China
4. South America
5. Rest of the World (ROW)

ROW includes Central America, India, Indonesia, Japan, Pakistan, Russia, South Africa, Vietnam and a number of other small producer/consumer countries. Due to confidentiality issues, survey responses were aggregated into ROW. Economic analysis of ROW is therefore limited to direct effects only.

The survey results were combined with input-output tables and social accounting matrices to determine the economic multiplier effects of the industry. Specifically, the direct, indirect, and induced effects were calculated for industrial revenue, employment, and compensations.

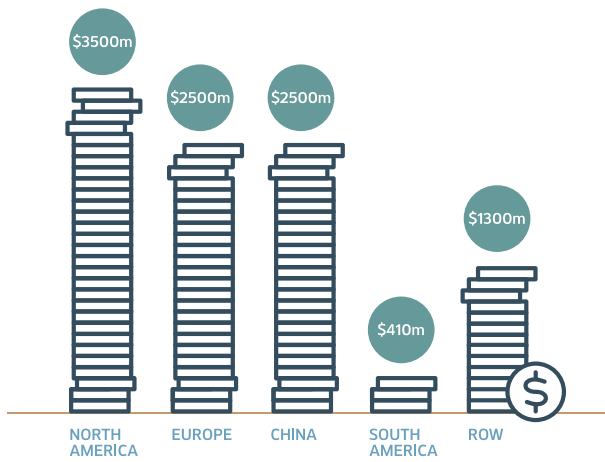
Pine Chemicals directly account for over \$10b in annual revenues and employ a skilled workforce of 14,100 people globally. The global impact of the industry is even larger at \$55b. The industry provides employment to nearly 186,000 people with a compensation of \$7,804m. North America emerged as the leader accounting for almost 35% of the direct global revenue and 28.3% of direct global employment.

In addition to manufacturing employees, the PCI also engages tappers for oleoresin extraction from pine trees. China has the most tappers at 200,000, followed by South America with 6,500 tappers. North America and Europe have relatively low number of tappers, 570 and 432 respectively. There are over 10,000 tappers in ROW.

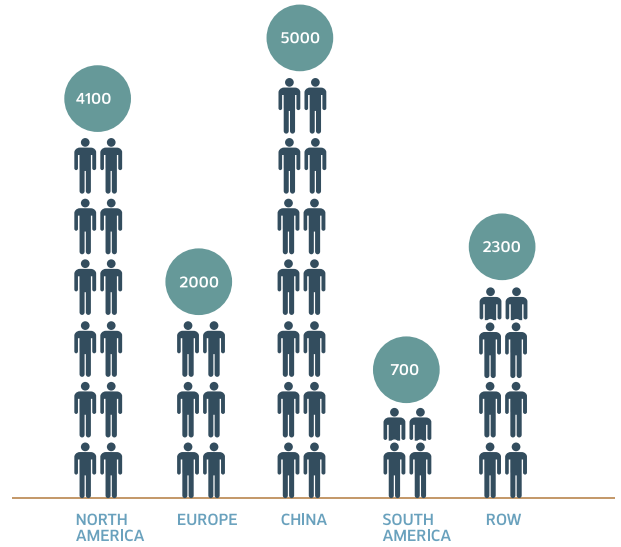
Dr. Smita Bhatia
Director, L&S

PINE CHEMICALS: DIRECT GLOBAL IMPACT

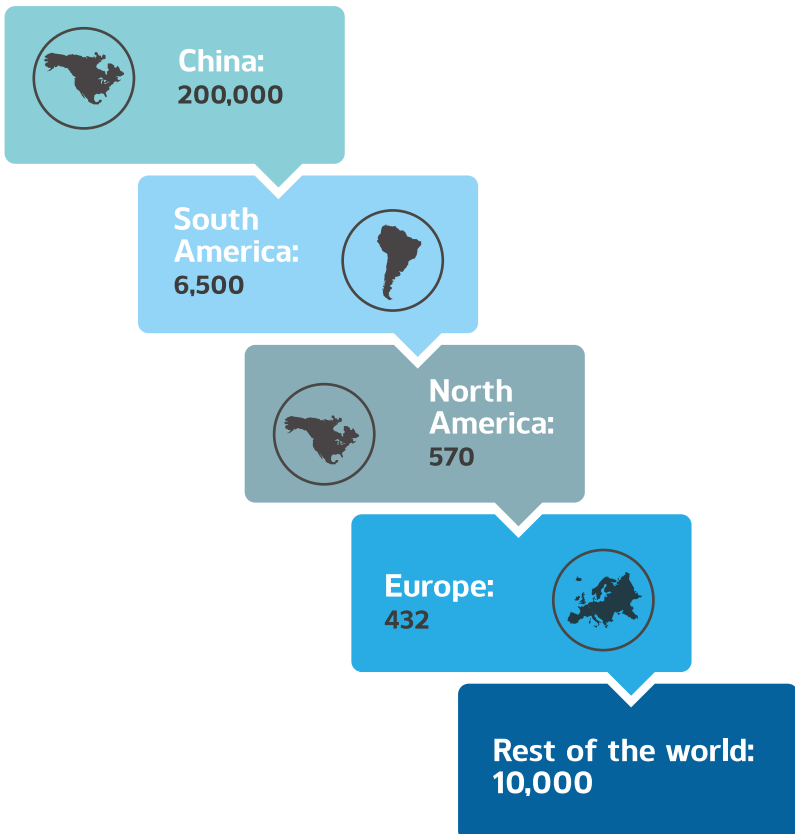
\$10 BILLION
GLOBAL DIRECT REVENUE



14,100
GLOBAL DIRECT EMPLOYMENT

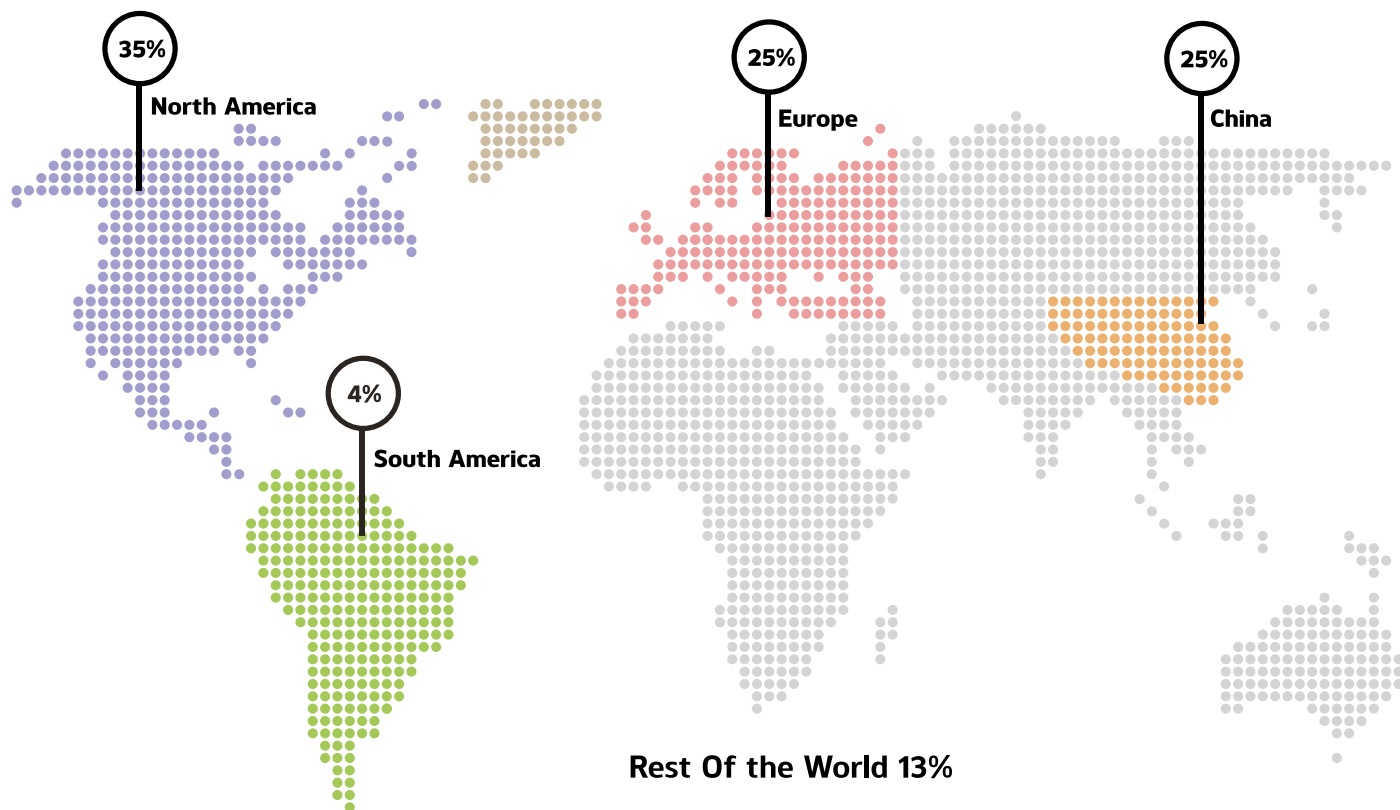


TAPPERS IN PINE CHEMICAL INDUSTRY

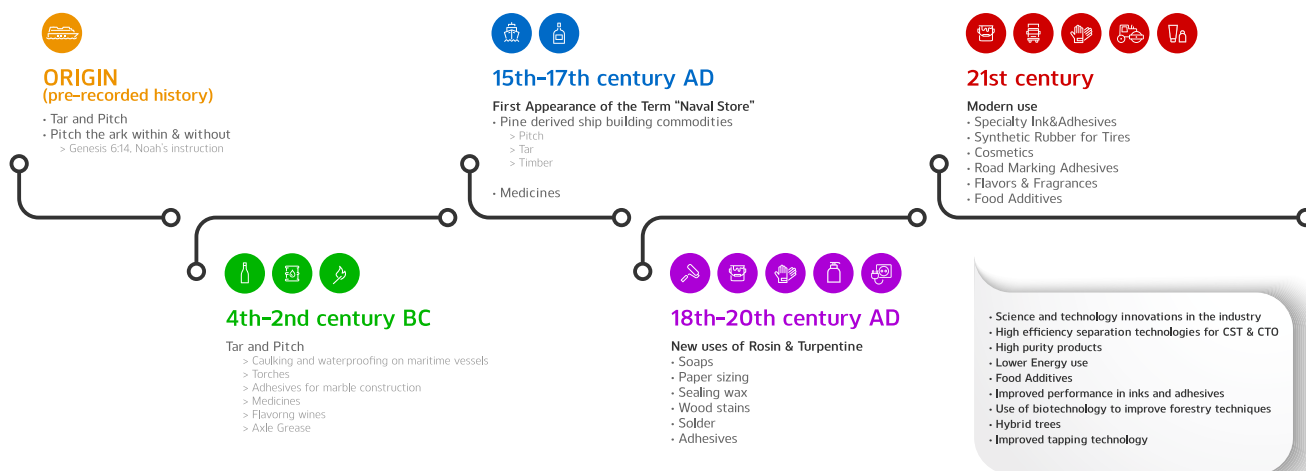


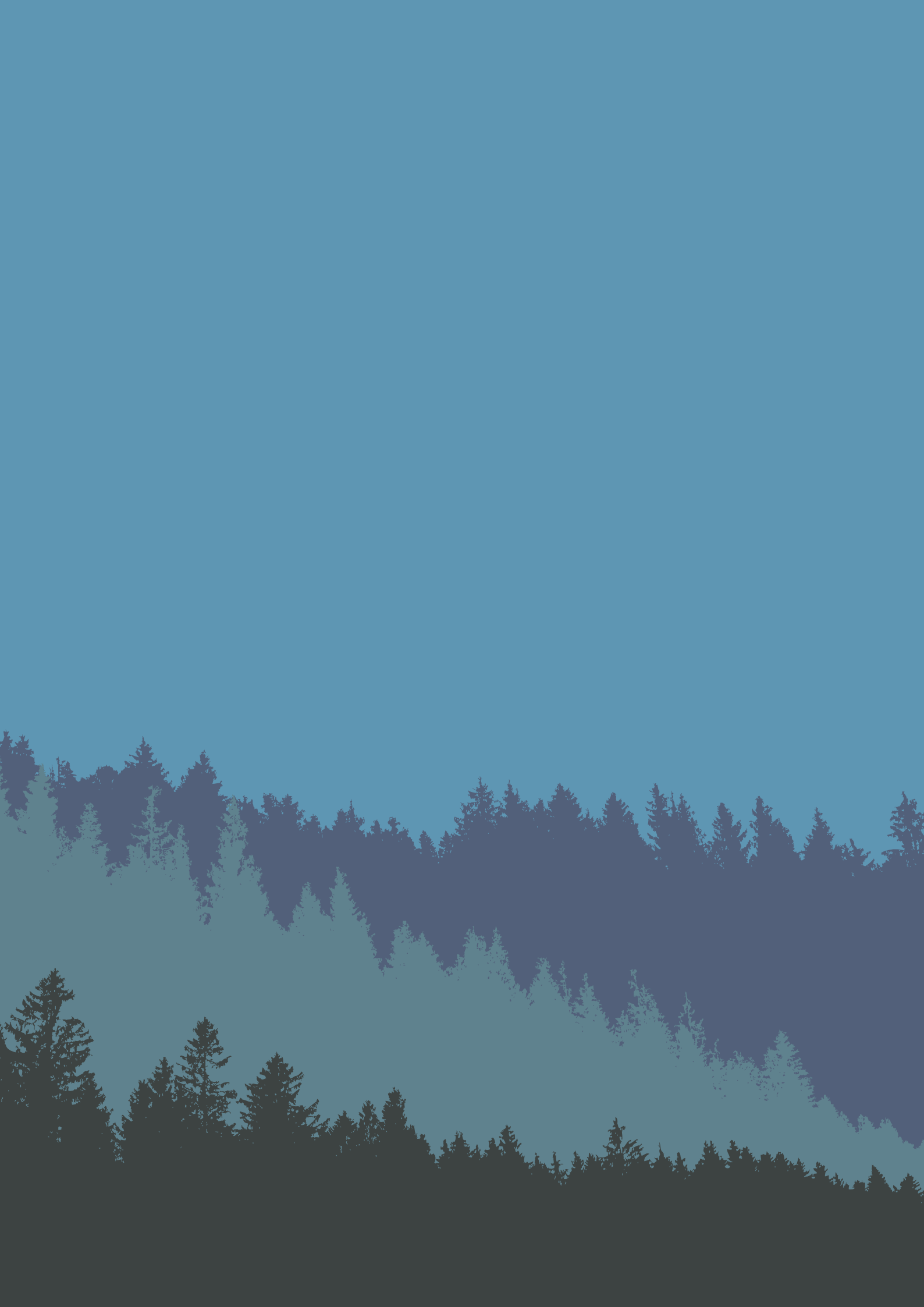
PINE CHEMICALS

A \$10 BILLION GLOBAL INDUSTRY



EVOLUTION OF PINE CHEMICALS





1

THE MODERN PINE CHEMICAL INDUSTRY



INTRODUCTION

The Pine Chemical industry (PCI) is a pioneer in utilizing biomass resources to produce sustainable value add products from a renewable resource. Pine chemical products, extracted from pine trees, are used in a wide array of consumer goods including paints, inks, adhesives, perfumes, flavors in soft drinks and food, fragrances in soaps and household cleaners, food additives, vitamins, automobile tires, and many more applications. Consumers touch, smell, and consume pine chemical products every day.

Tall Oil	Rosin	Turpentine
<input type="checkbox"/> CTO-Crude Tall Oil	<input type="checkbox"/> GR-Gum Rosin	<input type="checkbox"/> CST-Crude Sulphate Turpentine
<input type="checkbox"/> TOFA-Tall Oil Fatty Acid	<input type="checkbox"/> TOR-Tall Oil Rosin	<input type="checkbox"/> GT-Gum/Wood Turpentine
<input type="checkbox"/> DTO-Distilled Tall Oil	<input type="checkbox"/> Wood Rosin	<input type="checkbox"/> Flavors & Fragrances
<input type="checkbox"/> Pitch	<input type="checkbox"/> Rubber Emulsifiers	<input type="checkbox"/> Vitamin Intermediates
<input type="checkbox"/> Dimer/Trimer Acids	<input type="checkbox"/> Paper Size	<input type="checkbox"/> Solvents
<input type="checkbox"/> Sterols	<input type="checkbox"/> Ink/adhesive Resins	<input type="checkbox"/> Disinfectants
<input type="checkbox"/> Others	<input type="checkbox"/> Others	<input type="checkbox"/> Others

The prolific pine tree, a plant of the genus *Pinus* grows on every continent except Antarctica, and is the source of these products. The modern pine chemical industry is highly focused on forestry management and sustainability to maximize the long term value of the unique pine tree resource.

Global revenues from the pine chemical industry are currently valued in excess of USD 10 billion,¹ and the industry directly employs over 14,000 people including scientists, engineers, plant operations personnel, and other technically trained personnel as well as over 200,000 tree tappers and farmers². The industry contributes significantly to global trade for both industrialized and developing countries with over \$3 billion export revenue in 2014.³

The global impact of the pine chemical industry extends to a wide spectrum of society. Pine based products are made from renewable raw materials and are a long term source of intermediate chemicals needed to produce consumer products used every day by people across the world.

¹Data from survey and industry experts.

²Ibid.

³Pine Chemicals Association, *Statistics on Worldwide Import & Exports of Pine Chemicals*

TAPPERS IN PINE CHEMICAL INDUSTRY: AN AGROBUSINESS MODEL

Tappers are workers who collect oleoresin from forest pine trees. Oleoresin is extracted from pine trees by removing a section of the bark to form a “face” and then cutting into the first several layers of the skin of the tree, generally to the Xylem layer. There are several different methods of working the face but all are labor intensive. The tree can be “worked” daily, every two to three weeks, or even less often based on the type of process used to keep the oleoresin flowing and collected.

Tappers are skilled in cutting and treating the tree face to maximize the yield over time. In China, the largest oleoresin producer, tapping is a seasonal employment, lasting about 6 to 9 months per year. Tappers are generally local farmers who work on a natural land of pine trees that they have either leased or paid a small fee to access. The farmers or tappers are independent, standalone operators. They set their own tapping process techniques and forestry management methods and they alone determine whether the market value is such that the work has value to them.

In the last several decades, tapping has evolved from a subsistence-based model to an agribusiness model. Countries like Brazil and Argentina have developed business models wherein business owners purchase or lease the land and grow plantation forests with trees efficiently spaced. Tappers are either hired directly or are contracted through “tapping companies” who supply the skilled labor to conduct the oleoresin extraction. In this agribusiness model, the tapping techniques and forestry management are defined and structured. The tappers are gainfully employed in companies operating pine tree plantations, with competitive salaries and work with modern technology.

PCI’s utilization of scientific advances in molecular pine tree genetics, as well as the use of chemical stimulants have increased the oleoresin output from pine trees. As a result of the modern PCI’s R&D efforts, a single worker can now productively tap 7,000-10,000 trees each year, compared to 1,500-2,000 trees tapped with traditional methods. The process is more efficient with a single tapper working 4 to 6 times more trees each year than a tapper in a natural forest. In addition, tapping trees in a plantation forest generally yields about 3 times more oleoresin per tree.

The understanding of molecular genetics, development of hybrid pine trees, modern tapping techniques and forestry management are maximizing oleoresin production as well as its economic value. As a result, the PCI business model is rapidly evolving. The industry is collaborating with several universities, industry groups, and company R&D departments to improve the productivity and economic value of pine forests. All of this is also changing the role and needed skills for the pine tapper.

This report has collected data on the number of tappers engaged by pine chemical firms from around the world and this data is summarized below. China has the most tappers at 200,000, followed by South America with 6,500 tappers. North America and Europe have a relatively low number of tappers, 570 and 432 respectively. There are over 10,000 tappers in ROW.

Economic multipliers have not been calculated for tappers because tapping models vary from country to country. Furthermore, statistical data on tappers are typically included in agricultural and forestry sectors. However, in order to highlight the importance of the PCI in supporting and sustaining employment for nearly a quarter million tappers, this segment of employment in the pine chemicals industry was counted separately and is shown in the data as a separate group.

TAPPERS IN PINE CHEMICAL INDUSTRY



SUSTAINABLE BUSINESS STRATEGY

The viability of the pine chemical industry over many eras is due to the strong roots embedded in the principles of sustainability. The industry has been at the forefront of sustainable development much before the term became a popular global *mantra*.

Pine chemicals extraction from pine trees can be traced back to Biblical times. However, today the modern industry is highly focused on forestry management, raw material extraction efficiencies, and sustainable operations to maximize the long term value of the unique pine tree resource.

Pine chemicals are recovered through three different methods. During the papermaking process the chemicals natural to the pine tree are recovered as coproducts of the pulping process in the form of Crude Tall Oil (CTO) and Crude Sulphate Turpentine (CST). Additionally, pine trees can be tapped in the forest to recover "oleoresin" which is separated into Gum Rosin (GR) and Gum Turpentine (GT). In a much smaller segment of the industry, aged pine tree stumps are pulverized and solvent extracted to produce wood rosin and certain terpenes.

CTO and CST are sent to complex high technology bio refineries and distilled into their pure components. CTO is separated into tall oil rosin (TOR), tall oil fatty acids (TOFA), distilled tall oil (DTO), Pitch (TOP) and Heads. CST is processed to produce primarily alpha and beta pinene. Each of these products are basic chemical building blocks that are further upgraded to many value add products. When no further upgrading can be done, the residues are burned to produce steam used in the bio-refinery processes.

In the tapping process, pine trees are tapped for their useful life and then cut to recover lumber or chips for pulping. The unused portion of the tree is used for fuel. The forest is then replanted for future harvesting.

This latter segment of the industry today is in evolution. In the last several decades, selective pollination and genetic engineering have allowed the development of hybrid pine trees which when, planted in plantations, grow faster and yield 2 to 4 times more oleoresin per tree than in a natural forest. New tapping methods improve yields and plantation planting increases productivity 4 to 5 fold. Additionally, improved forestry protects the trees. Along with these changes have come improvements in worker salaries, safety training, and equipment.



Cascading Use of Biomass

The industry's success in its sustainable business strategy is attributable to the concept of 'cascading use of biomass resources'. In the cascading use of a biomass resource, the first round of upgrading produces the highest value products. The co-products from the first round are further refined in subsequent rounds to increase their value and finally, the residual products are used for fuels. The cascading use of biomass reduces stress on land use as well as preserves biodiversity and ecosystems.

The business strategy of the PCI exemplifies the concept of cascading use. For instance, one of the primary raw materials, Crude tall Oil (CTO) is distilled into its pure components and each of these is then converted into a variety of chemicals used in products like inks, adhesives, paper sizing, paints, coatings, food additives etc. The residual portion is used as biofuel.⁴

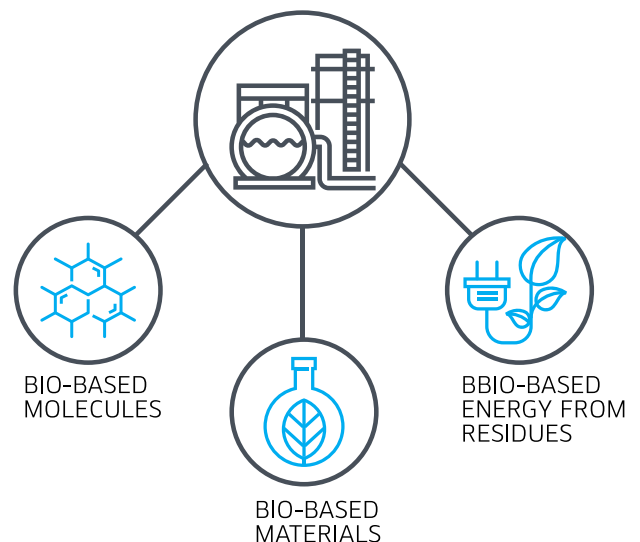
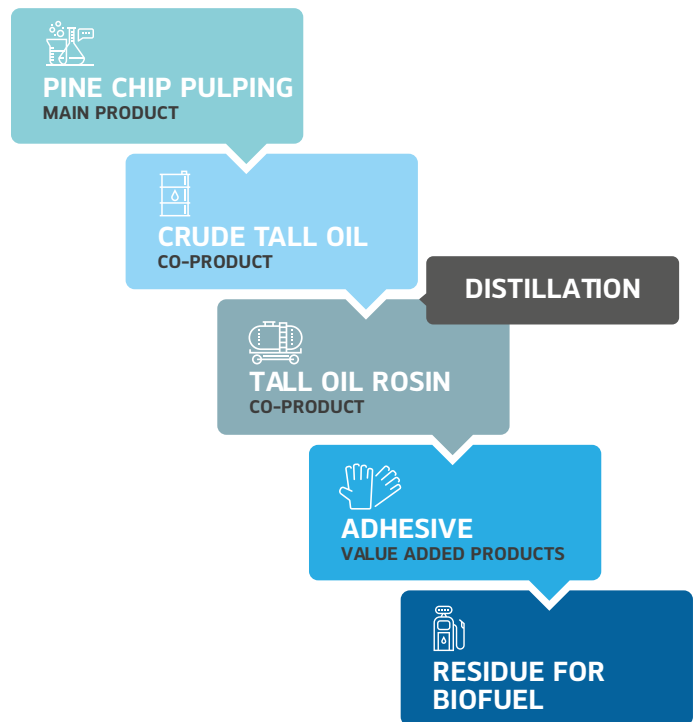
Biorefineries⁵

Pine chemical bio refineries are operated across the globe, including New Zealand, China, Japan, France, Austria, Sweden, Finland, Russia, Brazil, Chile, India and the United States. These bio refineries are large technically complex operations and employ highly skilled workers not only in operations but also in R&D laboratories developing new products and applications. Most refineries further process the base products to marketable intermediate chemicals which are then sold for further processing into consumer products.

Biorefinery is the sustainable processing of biomass into a spectrum of marketable products and energy

IEA Bioenergy Task 42
(Jong & Jungmeier, 2015)

CASCADING USE OF PINE CHEMICALS Crude tall oil Processing



⁴ 'Cascading use': a win-win scenario for biomass. Science Omega Review: Issue 3

⁵ Jong & Jungmeier, 2015

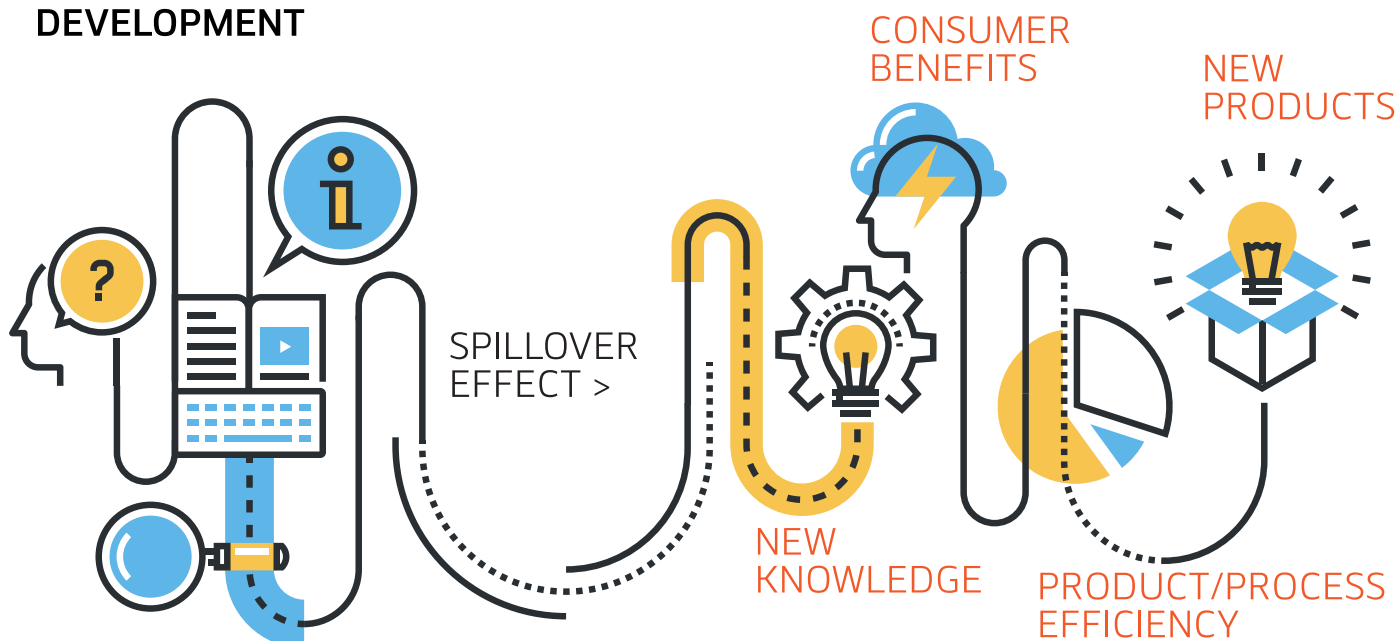
Research & Development: Spillover Effect

For over 75 years, the PCI has processed CST and CTO to provide bio based raw materials used in society. Innovation, science and technology in the PCI have kept the industry viable.

While the socioeconomic contributions of the PCI are many, including jobs and economic prosperity; one aspect of the industry's contribution, often understated, is the *spillover effect*. Because of the complex chemistry involved, the industry is focused on science and technology. This requires chemists, biologists, botanists, engineers, geneticists, and many more researchers from different branches of science for developing efficient processes and innovative products.

Historically, pine tree tapping has been highly labor intensive and production has migrated to areas of the world where low cost labor was readily available. This business model has been changing with the advent of new efforts in R&D and with an innovative technology focus. The modern PCI is transforming the traditional subsistence-like agricultural model for pine tree tapping to an 'agribusiness' model. Today the focus is on forestry management and sustainability and new tapping methods to allow the forest worker to become more efficient and productive.

RESEARCH & DEVELOPMENT



As a result, the PCI disseminates new knowledge, technology and commercial products to the society at large. The industry, working with its suppliers has developed new technologies that improve yields, radically reduce energy use, minimize environmental footprints, and improve product quality. Many of these concepts and developments are useful in other industrial areas. Additionally, high efficiency analytical techniques, like gas chromatography and mass spectrometry, that in some cases had to be modified specifically for the PCI, have helped to increase the quality and purity of the pine chemical products.

The business of pine tree tapping is also experiencing a technological evolution. Through the use of biotechnology, the industry has improved forestry management techniques, developed new tapping technology and has planted plantations of sophisticated hybrid trees. As a result of genetic engineering, the hybrid pine trees grow two to three times faster and produce twice as much oleoresin compared to native trees.

2

PRODUCTS AND APPLICATIONS OF THE MODERN PINE CHEMICAL INDUSTRY



Pine Chemicals

The basic chemicals extracted from pine trees are fatty acids, rosin, pitch and heads (Low chain fatty acids and other low boiling chemicals), and turpentine. These chemicals are obtained from pine trees in three ways⁶:

1. Living trees
2. Aged pine stumps
3. Co-products of Kraft pulping

The journey from pine trees to products involves complex technology and processes. The products are heat and pressure sensitive and require optimal fractionation processes. Today's biorefineries are highly efficient operations, minimizing energy use and producing very high purity products. Many CTO bio refineries also engage in further processing of rosin and fatty acid into upgraded value added products such as ink and adhesive resins and dimerized fatty acid. These products are then sold as intermediate chemicals to specialty companies who manufacture products such as synthetic rubber used in automobile tires, lubricants, adhesives, inks, paints and coatings.

CST bio refineries normally first separate the turpentine into alpha pinene and beta pinene. The pinenes are upgraded to cleaners, disinfectants, flavors and fragrances, vitamin intermediates, and other products that are sold to companies that utilize them in consumer products.

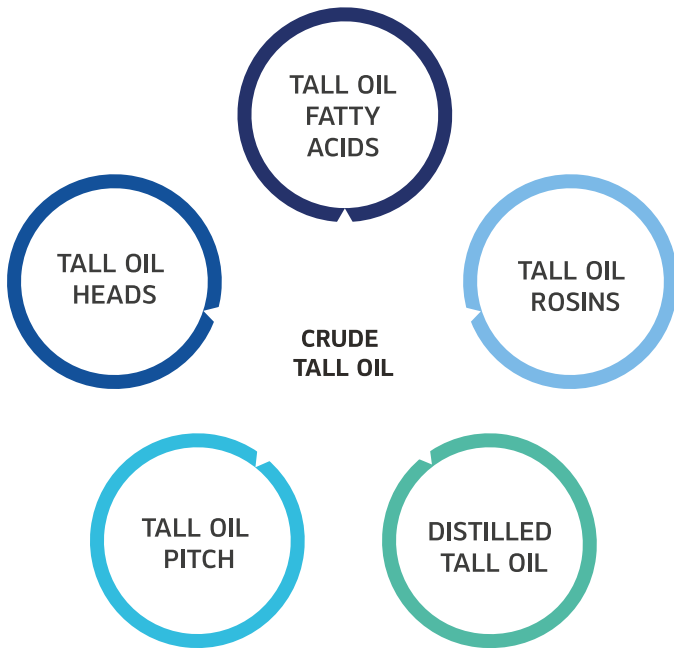


⁶ The Economic Benefits of the Pine Chemicals Industry: American Chemistry Council

Crude Tall Oil

Crude tall oil (CTO) is a major renewable source for a number of basic pine chemical raw materials. The most important being rosin and fatty acids.

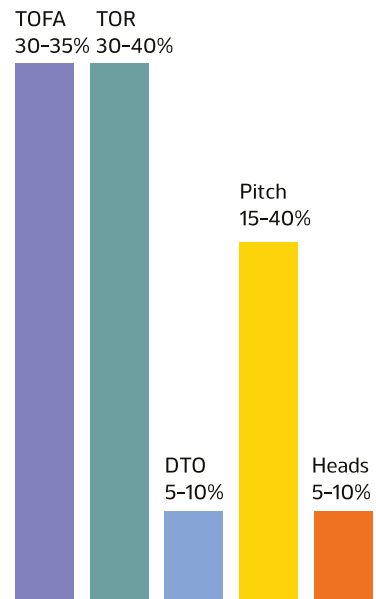
CTO, obtained as a co-product of the Kraft pulping process, is a mixture of fatty acids, rosin and neutral materials. This mixture is distilled into five primary product streams:



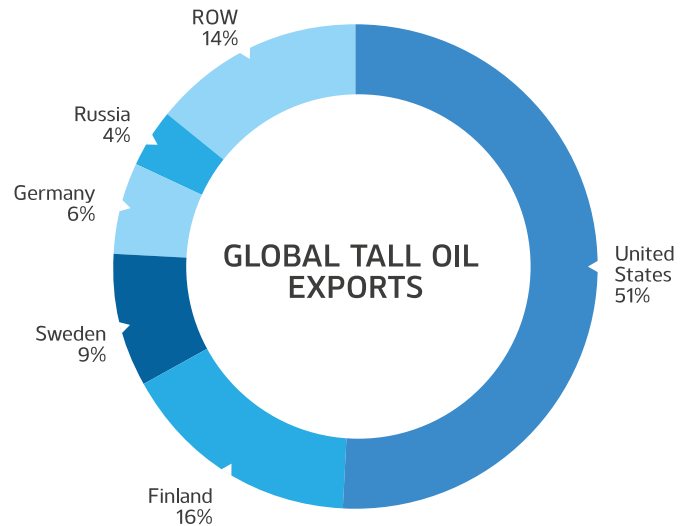
Ninety percent of the global CTO produced is distilled to produce these products. Yields of each product stream vary considerably based on the pine species used in the paper mills and this varies by global location. TOFA yields are about 30 to 35%, TOR yields vary from 30 to 40%. Pitch yields vary from about 15% to 40%.

The total world exports of Tall Oil were valued at \$243 million USD in 2014. This is nine percent of all pine chemicals traded in that year. The USA was the largest exporter followed by Finland and Sweden (see figure). USA captured over fifty percent of the global market share.⁷

CTO DISTILLATION PRODUCTS



GLOBAL TALL OIL EXPORTS



⁷ Pine Chemicals Association, Statistics on Worldwide Import & Exports of Pine Chemicals

Tall Oil Fatty Acids

Tall oil fatty acids (TOFA) are long chain monocarboxylic acids. The main fatty acid isomers recovered in the fractionation of tall oil are oleic, linoleic, linolenic (all 18 carbon fatty acids) and palmitic acids. The palmitic acid is shorter chain (16 carbon) and is recovered in the Heads stream. The TOFA stream generally accounts for about 30 to 35% of the total yield from tall oil fractionation.

Depending on the rosin content, the TOFA is categorized as⁸:

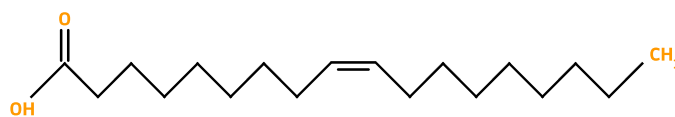
1. TOFA containing under 2% rosin acids
2. TOFA containing 2% or more rosin but at least 90% fatty acids

Most TOFA is consumed in the region where it is produced, but there is an export market as well. The total world exports of TOFA were valued at \$309 million USD in 2014 which was eleven percent of all pine chemicals traded in the export markets that year. Finland was the largest exporter followed by the USA (see figure). Finland, Sweden and the USA accounted for about 80% of the global market exports.

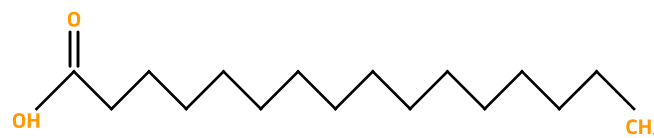
TOFA is similar to the fatty acids that are found in certain vegetable oils such as soybean oil but TOFA is generally used in nonfood applications including paints and coatings, soaps, specialty inks, mining chemicals, lubricants, metalworking fluids and adhesives.

TOFA CHEMISTRY

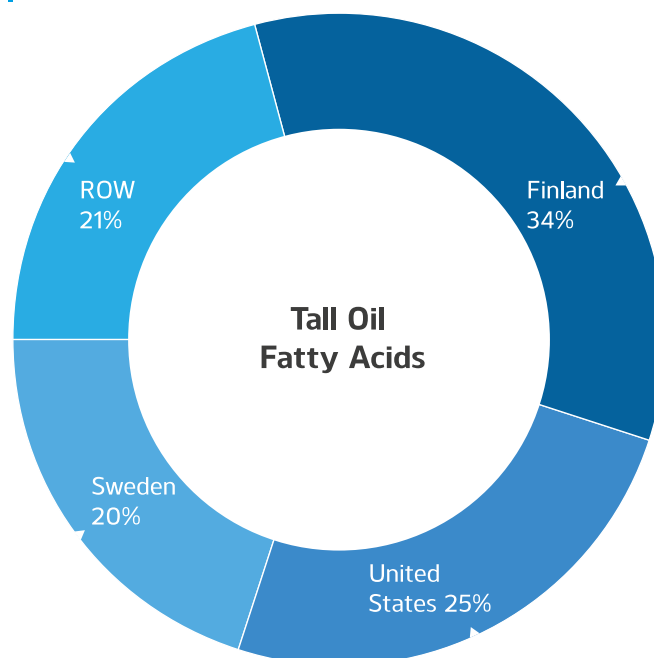
OLEIC ACID



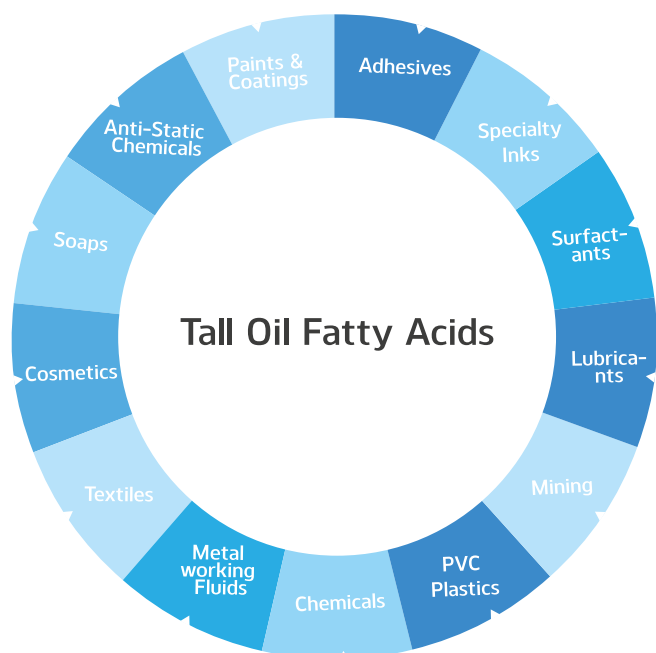
PALMITIC ACID



GLOBAL TOFA EXPORTS



TOFA PRODUCTS



⁸Drew & Propst, 1981

Rosins

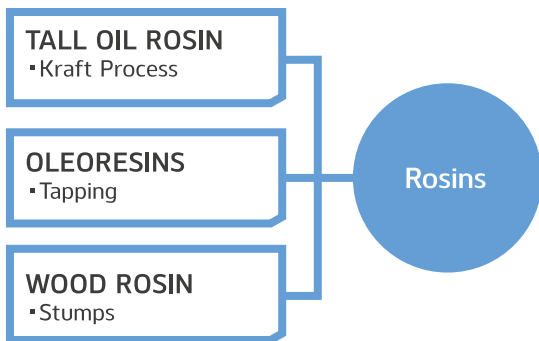
Rosin, one of the primary products from processing CTO is also recovered from tapping pine trees or extracting pine stumps. Rosin is a tricyclic carboxylic acid and exists in a number of isomer forms, each with a different functional value.

Rosins from different sources are similar, but differ in their isomer mixtures. While some rosins are better suited for certain applications, for the most part, rosins are interchangeable with minor formulation changes.

Rosins are modified or reacted to provide functionality for specific applications. Examples of modified resin products include polymerized rosin, salts, dimers and trimers, adducts, and esters. These modified rosins have many specific applications, for example pigment-binders in printing inks and tackifiers in adhesives.

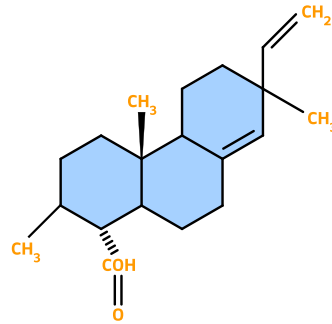
The unique functionality of rosin makes it a preferred source for ink and adhesive rosins, chewing gum, drink stabilizers and many other applications. Tall oil rosin (TOR) accounts for about 30% of the global rosin supply and Gum rosin provides about 70% of the world supply of rosin. Wood rosin production is about 1% of global supply.

The total world exports of rosins was valued at \$2 billion USD or 73% of all pine chemicals traded in 2014. China was the largest exporter of rosins and captured forty eight percent of the market.⁹

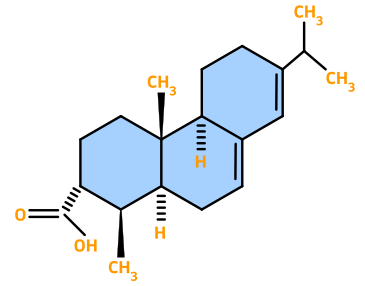


ROSIN CHEMISTRY

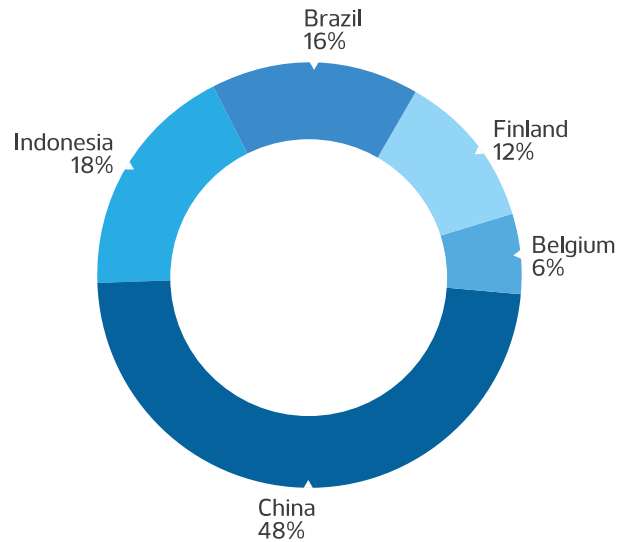
PIMARIC ACID



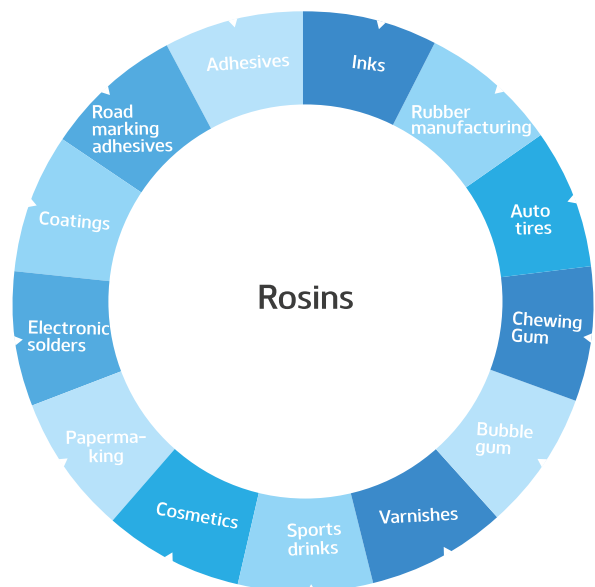
ABIETIC ACID



GLOBAL ROSIN EXPORTS



ROSIN PRODUCTS



⁹ Pine Chemicals Association, Statistics on Worldwide Import & Exports of Pine Chemicals.

Turpentine

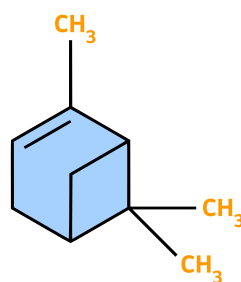
Turpentine, the other basic raw material for pine chemicals, is the volatile oil present in pine trees. Gum turpentine is derived by steam-distillation of oleoresins tapped from living trees. Crude Sulphate Turpentine (CST) is recovered as a by-product of the Kraft pulping process and wood turpentine is obtained from aged pine stumps.

Even though turpentine from different sources is similar, the composition (quality) and quantity of turpentine (and rosins) are determined by the genetic traits intrinsic to each *Pinus* species¹⁰. Turpentine is distilled in high technology bio refineries to separate the key components that are then used for further processing into a number of different applications. The two primary components recovered are alpha and beta pinene, but in some pine species there can be relatively large amounts of other components such as delta-3-carene. Alpha and beta pinenes are the building blocks for many natural fragrances and flavors and by reacting these pinene products, a manufacturer can reconstitute and replicate many natural flavors and fragrances. Additionally, alpha and beta pinenes are reacted into polyterpenes used in specialty inks and adhesives and, disinfectants, electronic solvents, pharmaceuticals, vitamins, and many other products.

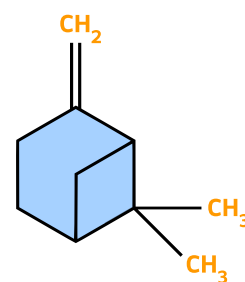
The total world exports of turpentine was valued at \$202 million USD or 7% of all pine chemicals traded in 2014. The US was the largest exporter at 29% of global market share followed by Brazil and China.¹¹

TURPENTINE CHEMISTRY

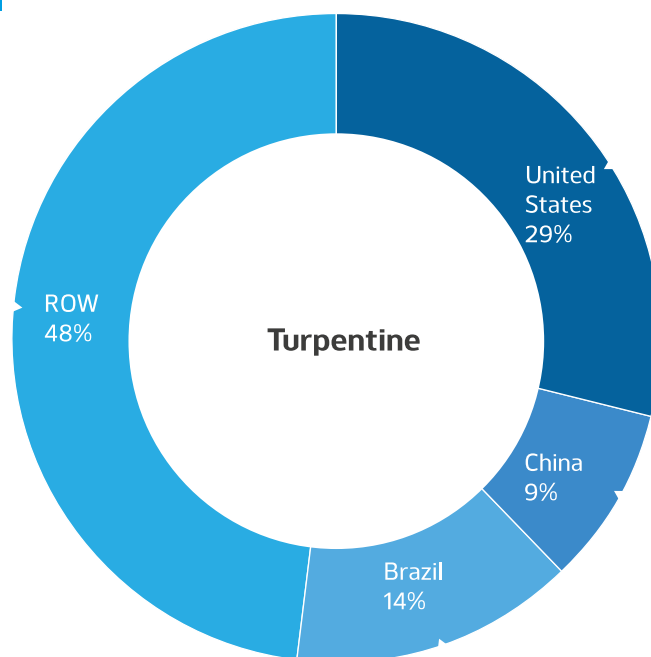
ALPHA-PINENE



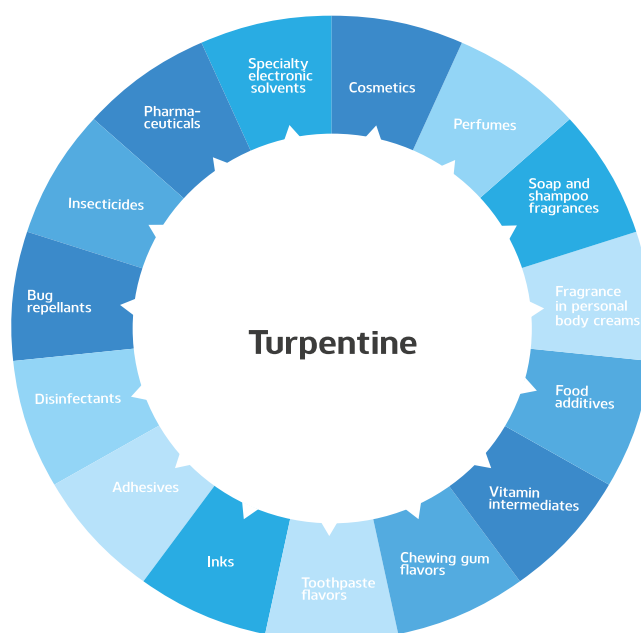
BETA-PINENE



GLOBAL TURPENTINE EXPORTS



TURPENTINE PRODUCTS



¹⁰ Rodrigues-Corrêa, Lima, & Fett-Neto, 2013

¹¹ Pine Chemicals Association, Statistics on Worldwide Import & Exports of Pine Chemicals.

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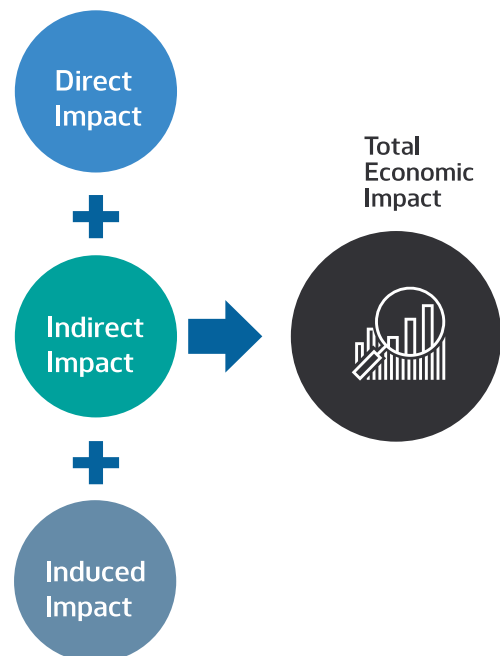
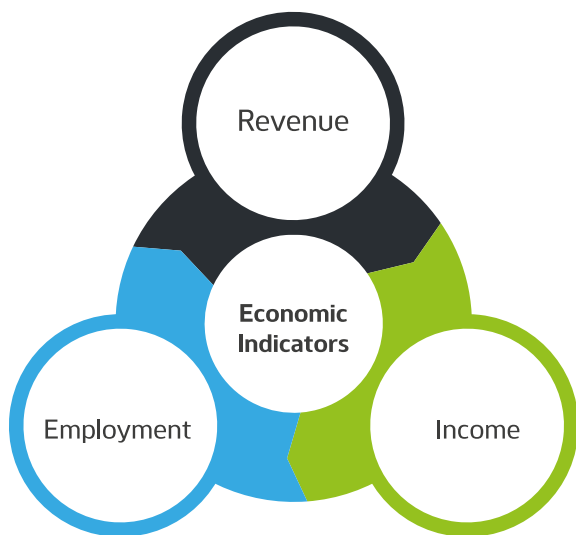
ECONOMIC IMPACT



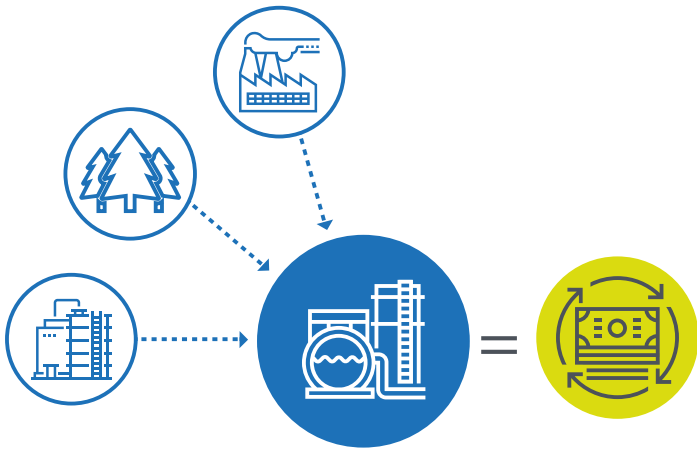
Economic impact of global pine chemicals was calculated for three regional geographies and China. In order to maintain confidentiality, data from countries with less than five firms or with any firm with more than 20% of market share have been aggregated into the three regions and rest of the world. ROW includes Central America, India, Indonesia, Japan, Pakistan, Russia, South Africa, Vietnam, and a number of other small producer/consumer countries. Only direct effects for ROW are reported.

GEOGRAPHY	EMPLOYMENT DATA	REVENUE DATA(\$MILLION)
» North America	» North America: 4,100	» North America: \$3,500
» Europe	» Europe: 2,000	» Europe: \$2,500
» China	» China: 5,000	» China: \$2,700
» South America	» South America: 700	» South America: \$410
» ROW	» ROW: 2,300	» ROW: \$1,300

Economic multipliers were calculated for revenue, employment and income. Total effects were calculated by summing up direct, indirect, and induced effects.

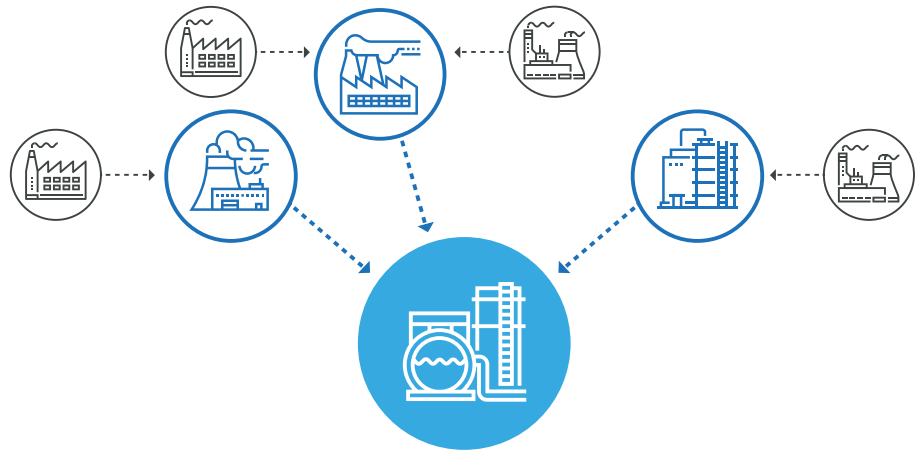


DIRECT EFFECT



Pine chemical firms buy supplies from other industries to produce output

INDIRECT EFFECT



Supplying industries buy inputs from other industries to supply to Pine Chemicals

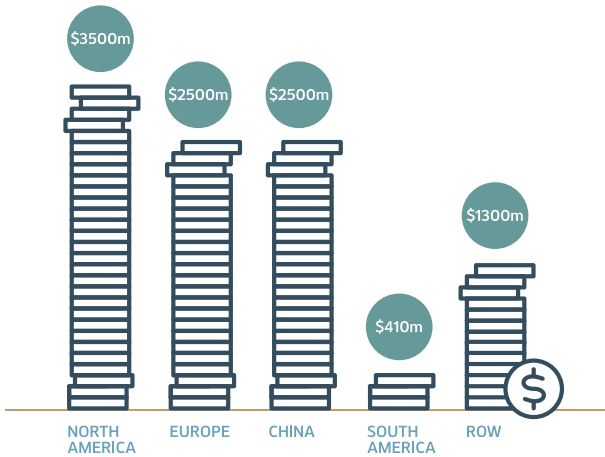
INDUCED EFFECT



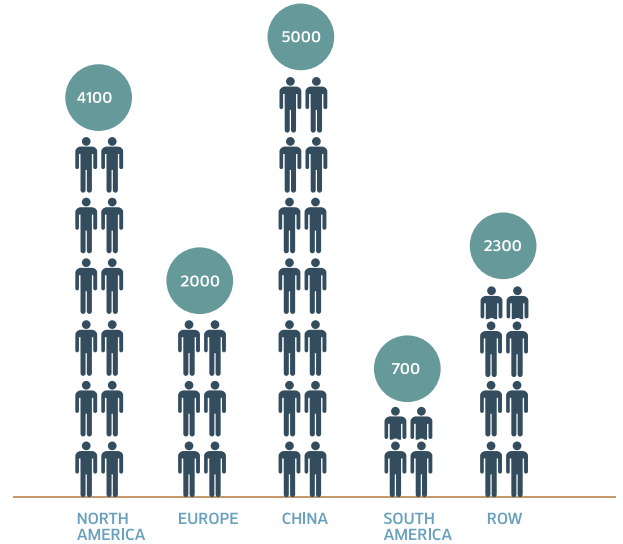
Increase in household income and spending supports the local community

PINE CHEMICALS: DIRECT GLOBAL IMPACT

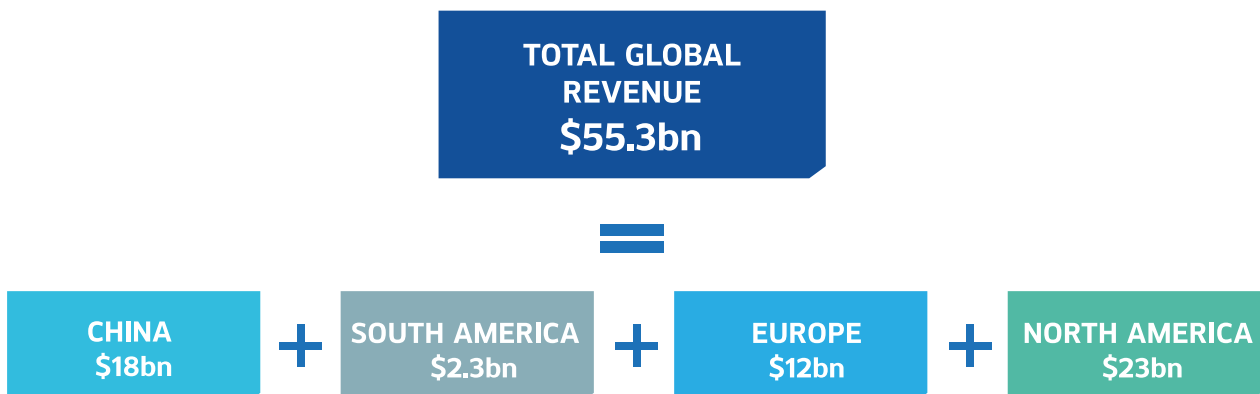
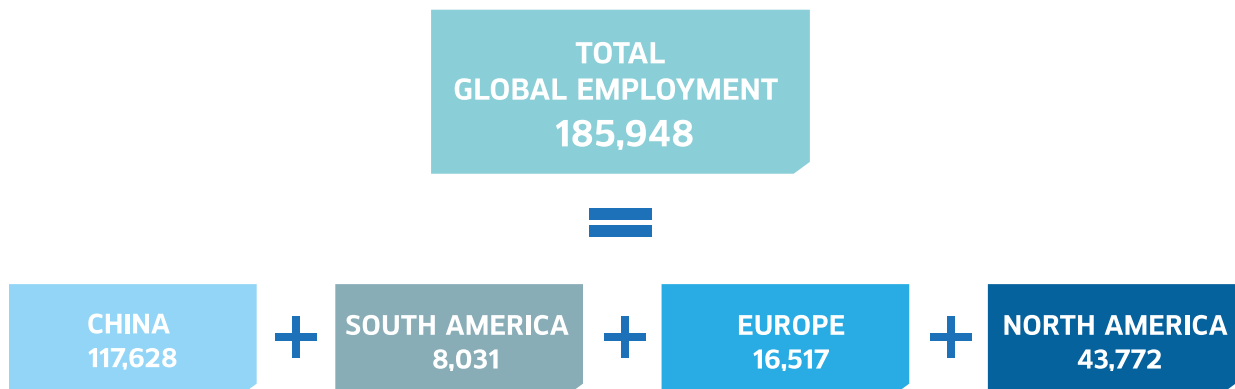
\$10 BILLION
GLOBAL DIRECT REVENUE



14,100
GLOBAL DIRECT EMPLOYMENT



PINE CHEMICALS: TOTAL GLOBAL IMPACT





NORTH AMERICA PINE CHEMICALS

ECONOMIC IMPACT

In North America, \$1 output revenue generates an additional \$5.5 in revenue, 9.6 additional jobs and an additional \$10.2 household income across the economy (see methodology for details). Thus, initial output revenue of \$3,500m generated an additional revenue of \$19,250m across the economy for a total revenue of \$22,750m. The additional revenue, generated 39,622 additional jobs for a total of 43,722 jobs across the economy. As a result of additional revenue and employment, the household incomes increased by \$3,273m for a total income of \$3,595m.



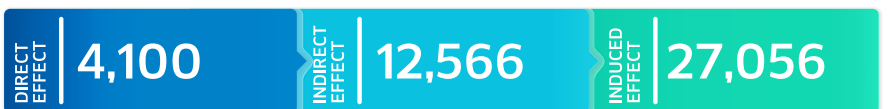
REVENUE
\$22,750
million
REVENUE



INCOME
\$3,595
million
TOTAL INCOME



EMPLOYMENT
43,722
TOTAL EMPLOYMENT





EUROPE PINE CHEMICALS

ECONOMIC IMPACT

In Europe, \$1 output revenue generates an additional \$3.9 in revenue, 7.3 additional jobs and an additional \$5.03 household income across the economy (see methodology for details). Thus, initial output revenue of \$2,500m generated an additional revenue of \$9,688m across the economy for a total revenue of \$12,188m. The additional revenue generated 14,517 additional jobs for a total of 16,517 jobs across the economy. As a result of additional revenue and employment, the household incomes increased by \$1,693m for a total income of \$2,029m.



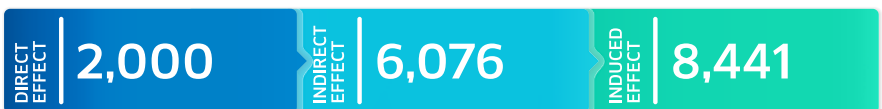
REVENUE
\$12,188
million
TOTAL REVENUE



INCOME
\$2,029
million
TOTAL INCOME



EMPLOYMENT
16,517
TOTAL EMPLOYMENT





CHINA PINE CHEMICALS

ECONOMIC IMPACT

In China, \$1 output revenue generates an additional \$6.24 in revenue, 22.5 additional jobs and an additional \$11 household income across the economy (see methodology for details). Thus, initial output revenue of \$2,500m generated an additional revenue of \$15,589m across the economy for a total revenue of \$18,089m. The additional revenue, generated 112,628 additional jobs for a total of 117,628 jobs across the economy. As a result of additional revenue and employment, the household incomes increased by \$1,648m for a total income of \$1,796m.



REVENUE

\$18,089

million

TOTAL REVENUE

DIRECT
EFFECT

\$2,500m

INDIRECT
EFFECT

\$6,743m

INDUCED
EFFECT

\$8,846m



INCOME

\$1,796

million

TOTAL INCOME

DIRECT
EFFECT

\$148m

INDIRECT
EFFECT

\$638m

INDUCED
EFFECT

\$1,010m



EMPLOYMENT

117,628

TOTAL EMPLOYMENT

DIRECT
EFFECT

5,000

INDIRECT
EFFECT

38,549

INDUCED
EFFECT

74,079





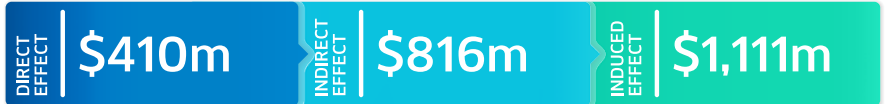
SOUTH AMERICA PINE CHEMICALS

ECONOMIC IMPACT

In South America, \$1 output revenue generates an additional \$4.7 in revenue, 17.8 additional jobs and an additional \$6.25 household income across the economy (see methodology for details). Thus, initial output revenue of \$410m generated an additional revenue of \$1,927m across the economy for a total revenue of \$2,337m. The additional revenue, generated 12,450 additional jobs for a total of 13,150 jobs across the economy. As a result of additional revenue and employment, the household incomes increased by \$331m for a total income of \$384m.



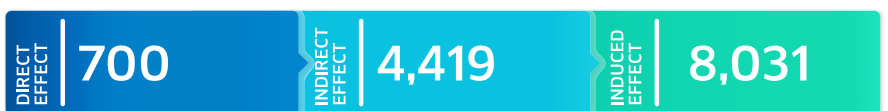
REVENUE
\$2,337
million
TOTAL REVENUE



INCOME
\$384
million
TOTAL INCOME

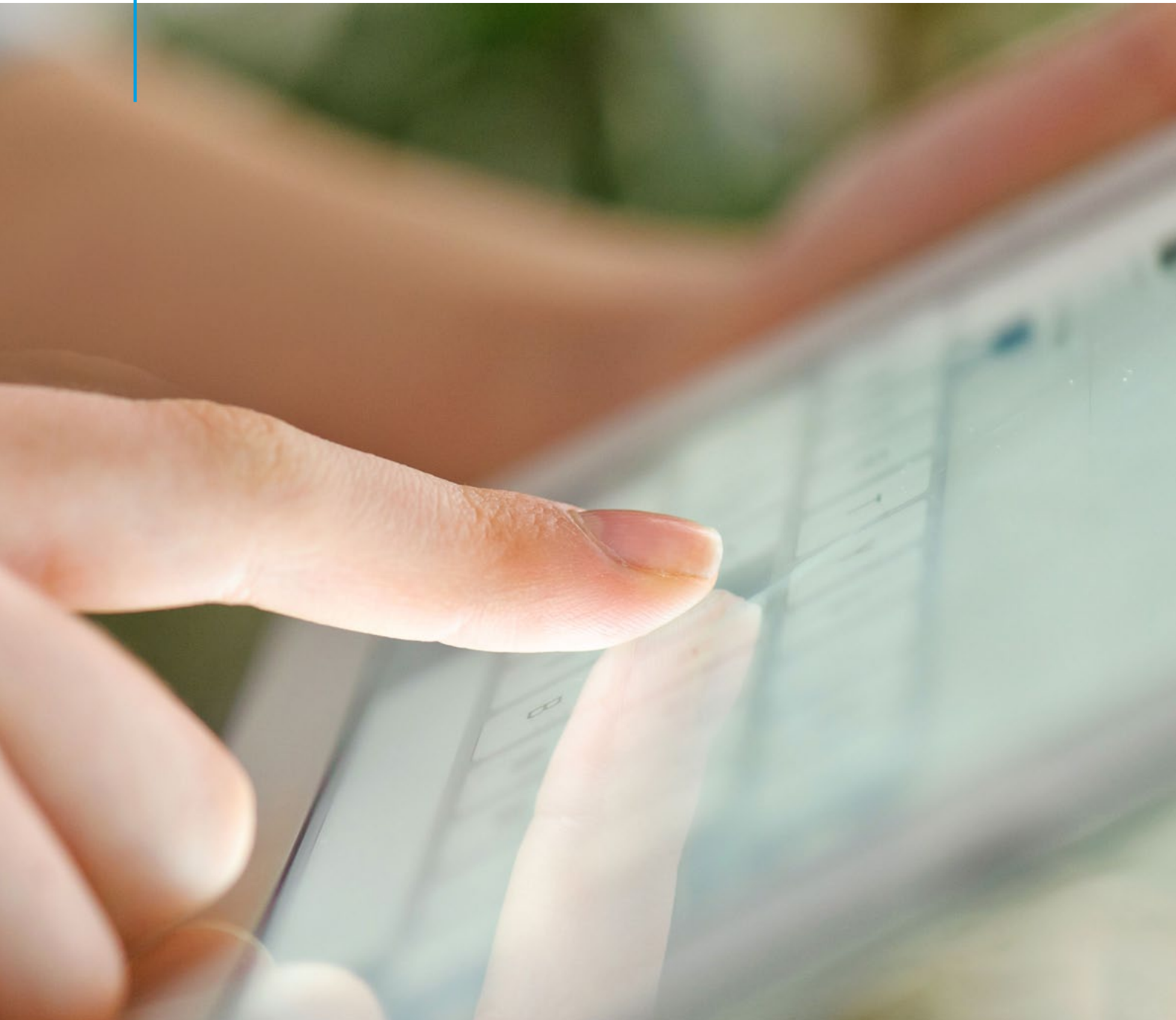


EMPLOYMENT
13,150
TOTAL EMPLOYMENT



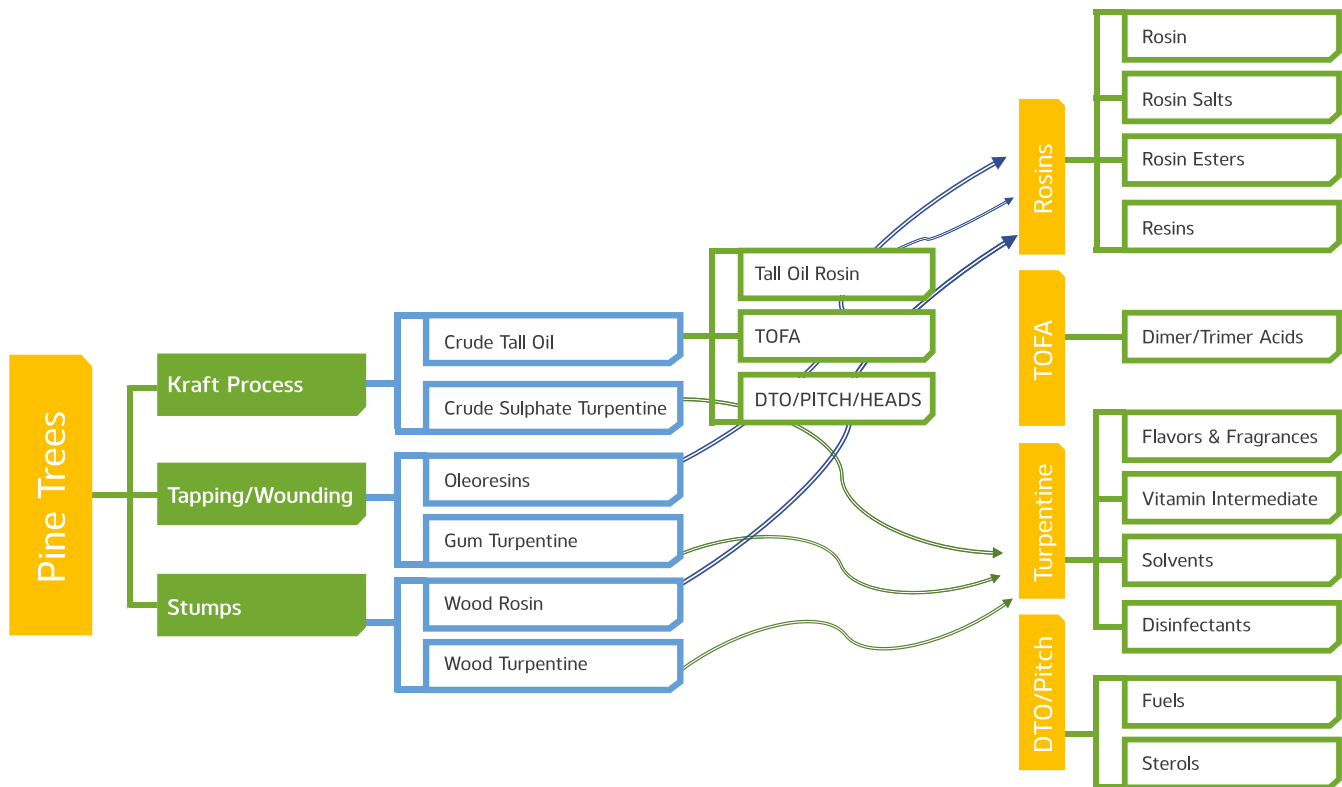
4

METHODOLOGY



Industry Definition

The Global Pine Chemical Industry is defined in this report as companies located across the world that produce, use, or resell to consumers, materials derived from pine trees. The types of products included in the analysis are the most significant revenue generators and are listed below:



Industry Segmentation

For the purposes of this report, the Global Pine Chemical Industry is segmented into the following regions:

1. North America
2. Europe
3. China
4. South America
5. ROW includes Central America, India, Indonesia, Japan, Pakistan, Russia, South Africa, Vietnam, and a number of other small producer/consumer countries.

Collection of Data

A survey questionnaire was sent to nearly 200 companies around the world. A copy of the questionnaire is included in this report. A response rate of about 20% was achieved. Expert inputs, research reports, and government data sources were used to complement the primary survey data.

The survey counted the revenue and employment for the plants processing CTO, CST or Oleoresin through to the 1st generation products made from the tall oil or CST fractions or from gum and wood rosin or from gum turpentine. For example, rosin processed into an ink or adhesive resin would be considered a 1st generation product and could be produced at the rosin producers plant or a downstream plant. Employment and revenue from the production of CTO or CST at a paper mill were not included in the study.

For gum rosin and turpentine the tapping industry which produces the oleoresin including the tappers engaged in the production of oleoresin was counted. (See detailed survey). However, the tappers were not included in the economic impact analysis. This is because tapping models vary from country to country. Furthermore, since tappers are mainly farm-workers, statistical data on tappers are typically included in agricultural and forestry sectors.

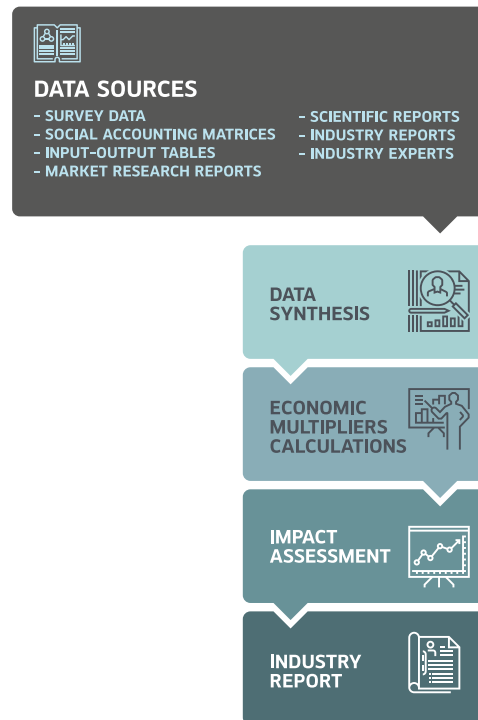
Confidentiality of Survey Data

Lakshmikumaran & Sridharan Attorneys (L&S) have used the confidential information supplied by the Pine Chemicals Association for the intended purposes only, i.e., to evaluate and analyze the economic benefits of the pine chemical industry. L&S will not disclose to any other client any confidential information or knowledge which L&S obtains as a result of acting for Pine Chemicals Association or any companies related to Pine Chemicals Association without prior approval of Pine Chemicals Association or the respective companies.

In order to maintain confidentiality, data from countries with less than five firms or with any firm with more than 20% of market share have been aggregated into the respective regional data.

Economic Impact Analysis

Economic analysis measures the impacts generated by the Pine Chemical Industry on the regional economy. For instance, an impact analysis addresses questions like how much of an industry's supply is used as an input by other industries; or, what is the final demand for an industry's output¹⁴.



Data for economic analysis in this report were obtained from the following sources:

- **Survey Data (Global data)**
- **Bureau of the Census (US data)**
- **Bureau of Economic Analysis (US Data)**
- **World Input Output Tables¹²**
- **Industry Experts inputs**
- **Market Reports¹³**

The analysis captures the ripple effect of one industry's output on all industries including the household sector. The ripple effect is described by direct, indirect, and induced multipliers which are explained below.

Information from survey responses, research articles, and industry experts in addition to published statistics have been utilized to develop a comprehensive data set. However, as a result of some information gaps, the economic impact estimates in this report are at best conservative.

Economic multipliers are generated through the use of input-output(I-O) models and social accounting matrices (SAM). For this economic analysis, the I-O tables and SAMs were used to calculate additional income and jobs created in various regions. I-O tables provide a detailed segmentation of transactions or supply and use of products in the entire economic system.

¹² <http://www.wiod.org>

¹³ MarketsandMarkets, 2015

¹⁴ McLennan No. 52460

I-O tables for USA are based on U.S. Bureau of Economic Analysis.¹⁵ For all other countries and/or regions, the I-O tables were obtained from the World Input Output Database.¹⁶ Multipliers for South America are derived from Brazil's I-O tables.

Economic Multipliers¹⁷

Multipliers are quantitative tools that measure the outcome or effects of economic activities. The multipliers capture the ripple effect of a change in the economy.

Multipliers were calculated by the author and were extracted from the Input-Output tables and SAM based on methodology illustrated in the following publication:

1. Information Paper: Australian National Accounts: Introduction to Input-Output Multipliers¹⁸

The ripple effect impacts the economy in three ways:

Direct Impact¹⁹

This is the *initial output effect* which measures the requirement for an extra dollar's worth of output of an industry A. Within the context of the report, industry A is the Pine Chemical Industry (PCI). Thus, *initial output effect* includes expenditures associated with labor, materials, supplies, and capital.

Direct Impact=Initial Output Effect

Indirect Impact²⁰

This is the total amount of output generated by the requirements of all supply industries to produce the initial one dollar of extra output from the PCI. Utilities, energy, transportation are a few examples of the supply industries.

The indirect impact encompasses the *first round effect* (FRE) which is the amount of output required from all supply industries of the economy to produce the initial one dollar of extra output from the PCI. The FRE from all supplying industries induces extra output from all industries which in turn induce extra economic activity. The induced output from FRE is termed the *industrial support effect* (ISE).

The *production induced effect* (FRE + ISE) is the indirect impact that measures the industrial outputs as well as the subsequently induced outputs to support the output from the PCI.

Indirect Impact =

(Initial output effect + Production induced effect)

(Initial output effect)

Induced Impact²¹

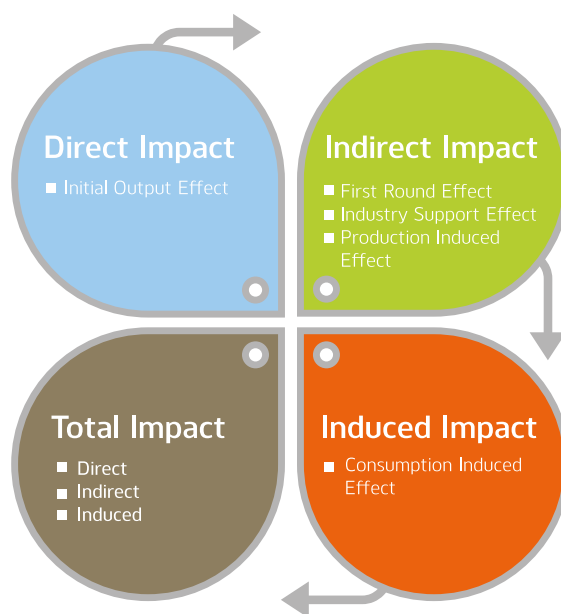
This impact results from the changes in the household expenditure as a result of employees of all industries spending money on goods and services at a household level. For instance, money spent at beauty salons, restaurants, cultural events, etc. This is the *consumption induced effect* (CIE).

In order to produce the initial and the production induced output, employees of all industries will earn extra income which they will spend on commodities produced by all industries in the economy. This spending will induce further production by all industries. The output resulting from this further induced production is the *consumption induced output*.

Induced Impact =

(Initial output effect + Production induced effect + Consumption induced effect)

(Initial output effect)



¹⁵ U.S. Bureau of Economic Analysis

¹⁶ <http://www.wiod.org>

¹⁷ McLennan No. 52460

¹⁸ Ibid.

¹⁹ Ibid.

²⁰ Ibid.

²¹ Ibid.

Interpretation of Multipliers

Output Multiplier

The output multiplier is defined as the total value of production by all industries of the economy required for one extra dollar's worth of final demand for that industry's output.

Employment Multiplier (EM)

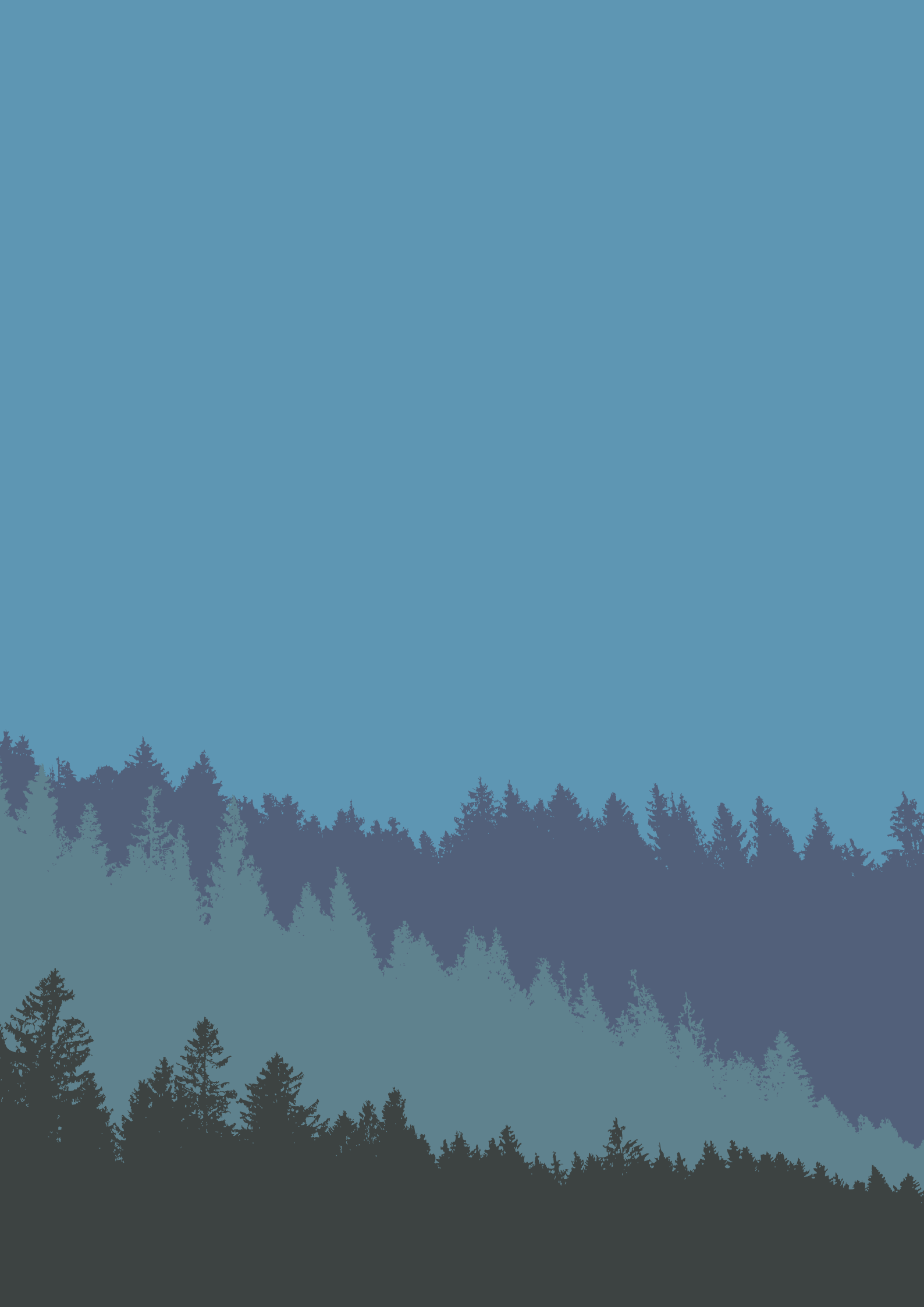
EM is defined in terms of total number of jobs per direct job. In other words, EM measures the number of jobs effected by a change in employment for the particular industry. For example, if an EM for an industry is 3, it implies that for every person employed in that an additional two people are employed in all other industries.

Income Multiplier (IM)

IM for a given industry is defined as the total value of income from wages and salaries required for one dollar worth of final demand for the output of industry. IMs measure the change in income (compensation of employees) which occurs throughout the economy as a result of a change in the final demand.

Limitations of Input-Output Tables and Multipliers

The main caveat in the use of I-O tables is that they do not take into account economies of scale, or technological change. Multipliers are specific to regions and economies. Hence, they cannot be used to estimate impacts for other countries or regions.



5

SAMPLE SURVEY

Survey of Global Pine Chemicals Industry

1. Welcome to the Survey of Global Pine Chemicals Industry

Background: Thank you for participating in our survey. Your feedback is extremely important.

This survey is in response to the letter from Charlie Morris, the President of the Pine Chemicals Association (PCA).

The Pine Chemicals Association is initiating a study to determine the size, in both revenue and employment, of the global pine chemicals industry. The study will include Crude Tall Oil and Crude Sulphate Turpentine fractionation, wood rosin production and Gum Rosin and Gum Turpentine collection and production. The study will include the manufacturing and sales of modified rosins (i.e. adhesive or ink resins or paper size) and fatty acids (i.e. dimer acids).

The final report will be used in advocacy efforts with legislators and regulators around the world and will be shared with all companies that supply data for the study.

PCA has contracted our firm, Lakshmikumaran & Sridharan law firm to collect and assimilate the data for a full report on the industry.

Use of the data: The data you provide using this survey will be seen only by the project team. The data you provide here will NOT be presented to other parties or made public - only cumulative or statistical formats (totals, averages, variances, etc) of the data provided by all of the respondents will be provided, to ensure that no confidential data is revealed.

Guidelines for Questionnaire: (Please read through before answering the questionnaire.)

1. Report all revenue in US dollars USD.
2. If you have plants/offices in different countries, please use separate questionnaires for each
3. location.
4. For multiple EU countries location, you can provide aggregate EU revenue/employee information.
5. Please designate a contact person and provide relevant information.

Point of Contact: Please feel free to contact me at Lakshmikumaran & Sridharan at any time if you have any questions. Smita Bhatia, Director, (smita.bhatia@lakshmisri.com).

Thank you for taking the time to complete this international industry survey.

Click on the "next" button to continue the survey. You can close the survey window and come back to it to complete information at any time by clicking on the link in the email you were sent.

Survey of Global Pine Chemicals Industry

2. Company Information

***1. What is the name of your Company?**

2. Contact /Respondent Information

Country Location

Name of Respondent/Contact Person

Phone Number of Contact Person

Email of Contact Person

Survey of Global Pine Chemicals Industry

3. Business Information

***3. Type of Business Activity**

- Are you a Producer
- Are you a Reseller
- Both

***4. Type of Product manufactured by your company**

- | | |
|--|--|
| <input type="checkbox"/> CTO-Crude Tall Oil | <input type="checkbox"/> Vitamin Intermediates |
| <input type="checkbox"/> CST-Crude Sulphate Turpentine | <input type="checkbox"/> Solvents |
| <input type="checkbox"/> GR-Gum Rosin | <input type="checkbox"/> Disinfectants |
| <input type="checkbox"/> GT-Gum Turpentine | <input type="checkbox"/> Modified Resins |
| <input type="checkbox"/> DTO-Distilled Tall Oil | <input type="checkbox"/> Ink Resins |
| <input type="checkbox"/> TOFA-Tall Oil Fatty Acid | <input type="checkbox"/> Adhesive Resins |
| <input type="checkbox"/> TOR-Tall Oil Rosin | <input type="checkbox"/> Dimer/Trimer Acids |
| <input type="checkbox"/> PITCH | <input type="checkbox"/> Sterols |
| <input type="checkbox"/> Flavor | <input type="checkbox"/> Others |

*** 5. Business Statistics**

\$Total Revenue in US Dollars (from all products that you have selected above in Question 4)

Number of **Tappers** that support your operations (Gum Rosin/ Gum Turpentine)

Total Employees (**excluding Tappers**) from all operations including R&D, Administration, contractual etc

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U.S. Bureau of Economic Analysis.

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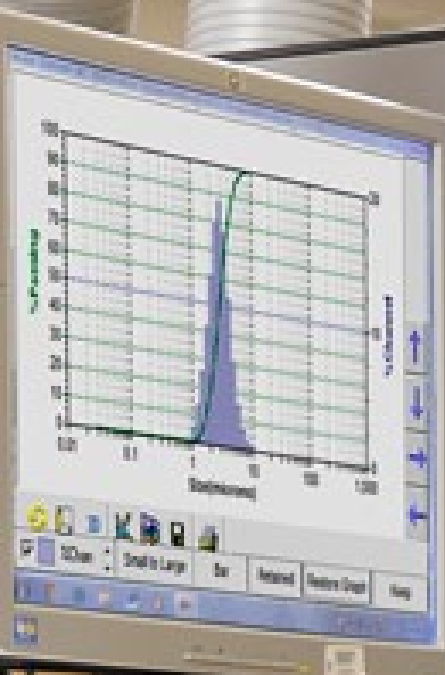
1. Ingevity
2. Woodapple Interactive
3. Dr. Smita Bhatia, Director, L&S

About the Author

Dr. Smita Bhatia is a Director at Lakshmikumaran & Sridharan (L&S). She brings over two decades of research and analytical experience to provide analysis and insights for science based industries. Prior to joining L&S, Smita founded Specstra Consulting Inc. in Ottawa, Canada. Her consultancy practice was grounded in her industry association as well as academic experience. Earlier, Smita was Director, Chemistry and Industry Dynamics, at the American Chemistry Council in Washington DC. She also served as the Senior Manager for Economics and Environment at the Chemistry Industry Association of Canada in Ottawa. She collaborated with industry, government and other stakeholders for regulatory issues and product stewardship. She provided economic and regulatory analysis of various chemical management regimes such as REACH (EU), TSCA (USA) and CMP (Canada).

Smita was responsible for developing strategies in support of social, technological, and economic benefits of the products of Chemistry. She has authored reports highlighting the significance of the chemical manufacturing industry and has managed the production of annual reports pertaining to emission standards. As a consultant, Smita focuses on environmental and industrial economics. Recently, Smita was selected to present her work in the conference of Society for Benefit Cost Analysis in Washington DC.

Smita seamlessly combines her science, public-policy and economics experience to offer unique insights on a wide range of regulatory issues. She has actively promoted the competitiveness and growth of chemical industry in the US and Canada. During her academic years, Smita researched a variety of subjects from biopolymers, pathogen genomics and viruses as well as environmental science, economics and international development.



2.5%

notes...

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