# Sustainability and Emergence of New Energy Curable Resins “Bioligomers”


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Made with Alphonso Mangos
SFI
This Box Uses Only
SOY Based Inks

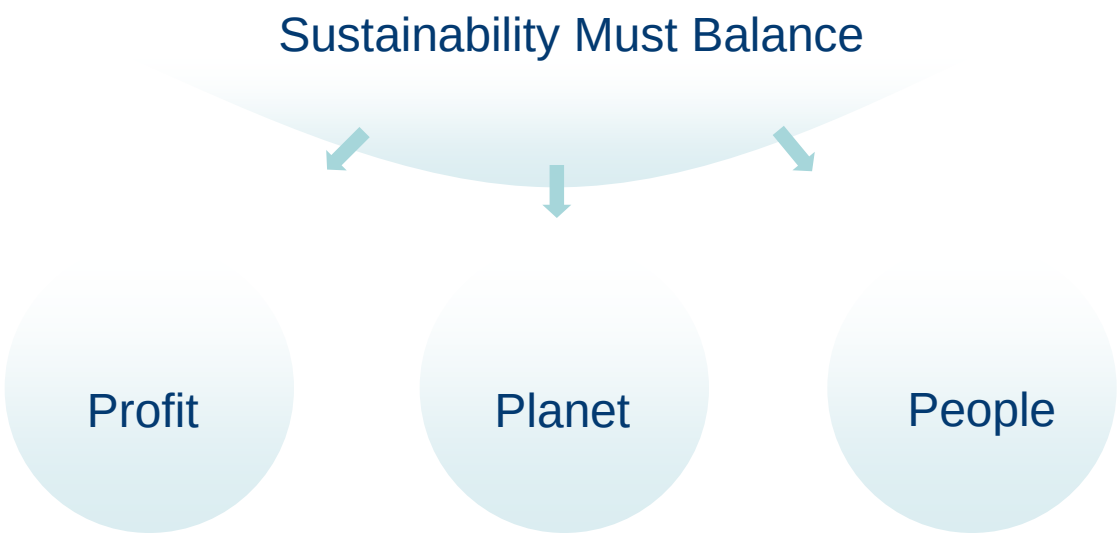
# Sustainability and related concepts


Zero-VOC
Benign Disposal
Carbon Credits
Greenwashing
Biodegradable
Cradle-to-Cradle
Benefit to Society
Photodegradable
Customer Cost
Acidification
Low-VOC
Carbon Footprint
Renewable Raw Material
HAPs
Global warming
Wastewater
Toxic
Life Cycle Analysis
Life Cycle Assessment
Energy Efficient
Emission
Pollution Prevention
Environmental Impact
Eco-chic
Ecosystem
Compost
Green Chemistry
Durability
Greenhouse Gas
Eco-Efficiency
Eco-friendly
Social Responsibility
Employee Health
Waste Reduction
Human Health
Safety
Recycled Content
Employment
Design for the Environment

| | |
|---|---|
| What is it? | Definition |
| Where do we see it? | Trends |
| How CYTEC is approaching it? | The 12 Principles |
| Examples of Renewable EC Products | Bioligomers |

# Sustainability

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs




Sustainability is about making every decision with the future in mind

# Sustainability = Living Our Values In a Changing World

Innovative and sustainable products that compete in a global economy

Achieving the highest standards of safety, health and environmental stewardship

Responsibility to our customers, our employees, our shareholders and other stakeholders

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# The Growing List of Environmental and Regulatory Trends

## Chemical Management

**REACH** [Registration, Evaluation, Authorization and Restriction of Chemicals], single system for the control of chemical produced or imported in the European Community including their usage (Europe)

**BPD** [Biocidal Products Directives], directive applied throughout Europe permits the use of biocidal products containing an active substance that has been approved and authorized for a particular use following and extensive series of toxicity tests (Europe)

**TSCA** [Toxic Substances Control Act], requires testing of new chemical substances (USA)

**HPV** [High Production Volume Program], similar to REACH, put the onus on chemical companies to perform the tests (USA)

## VOC Emissions

EU and North America have taken the lead in term to control volatile emissions in the coating industry during manufacturing ,drying and curing process

**SED** [Solvent Emissions Directive] Europe

**PPD** [Paint Product Directive] Europe

**CAA** [Clean Air Act] USA

## Classification & Labeling

**GHS** [Globally Harmonized System of Classification and Labeling of Chemicals] common system to classify chemicals according to their health, environmental and physical hazards, sets hazard communication requirements for labeling and safety data sheets (international programme)

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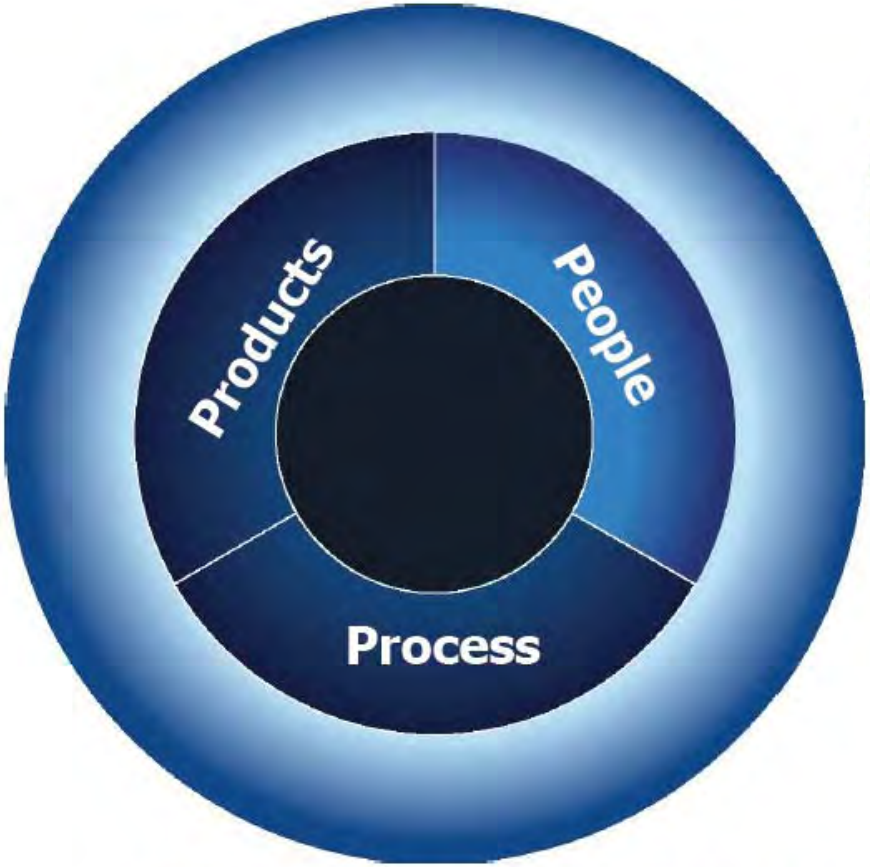
# Commitment to Sustainability

**Sustainability is about making every decision with the future in mind**

- Energy efficiency and renewable material solutions
- Incorporating Green Chemistry Principles into our innovation process




- Driving to zero injuries
- Increasing employee engagement

- Setting aggressive goals and reducing our environmental footprint

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# Trends

In recent years Sustainability has become a key Corporate consideration driven by increased environmental regulations and heightened consumer advocacy.

| MARKET | EXAMPLES |
|---|---|
| GRAPHICS | • De-inkability in paper recycling<br>• Biodegradability in packaging<br>• Renewable raw material |
| INDUSTRIAL COATING<br>- WOOD<br><br>- AUTOMOTIVE | • Wood conservation (hard wood vs soft wood)<br><br>• Adoption of WB technologies |
| ELECTRONICS | • WEEE Directive (Waste from Electrical and Electronic Equipment)<br>• Industry ban on halogenated materials |



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# Principles of Green Chemistry

**Chemical philosophy encouraging the design of products and processes that reduce or eliminate the use and generation of hazardous substances.**

**The principles cover concepts including:**

- design of processes to maximize amount of raw material that ends up in the product
- use of safe, environmentally benign substances, whenever possible
- use of renewable raw materials
- design of energy efficient processes
- best form of waste disposal: do not create it in the first place

Cytec is working with Dr. John Warner, co-author of Green Chemistry: Theory and Practice, to incorporate green Chemistry principles in our innovation process.

**Green Chemistry in not a solution to all environmental problems…but is the most fundamental approach to preventing pollution**



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# Radcure approach to Sustainability

| | Energy, Emissions and Waste | Environmental Impact |
|---|---|---|
| **Benefits of UV/EB Technology** | • RADCURE VOC free technology<br>• RADCURE UV/EB environmentally friendly solvent free platforms<br>• UV/EB as energy efficient curing mechanism | • Some Renewable Feedstock available for syntheses<br>• WB-UV technology further enhance RADCURE reach and replace SB paint |
| **Cytec areas of focus** | • CYTEC works to reduce energy consumption and emissions associated with its RADCURE operations | • CYTEC participates in Radtech working groups looking at specific Sustainability related topics (de-inkability, packaging, etc.) |

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# Ink From Renewable Components

- Inks and coating products formulated with renewable components tend to:
  - reduce the environmental footprint of the final products as compared to those formulated with non-renewable components.

- Cytec believes in the collective effort of the industry to develop more renewable resources and products that will eventually reduce dependence on extractive resources.

# Renewable Energy Curable Resin

- Renewable raw materials used in **EBECRYL** acrylate resins and **EBECRYL 5000 series BIOLIGOMERS** include several derivatives of natural oils and fatty acids

**Renewable Resources Definition.**

- Resources that have a natural rate of availability and yield a continual flow of services which may be consumed in any time period without endangering future consumption possibilities as long as current use does not exceed net renewal during the period under consideration. (Source: WHIT)

# Calculating % Renewable Content in Energy Curable Resin c

- **Calculations:** Renewable % and naturally derived carbon % are calculated accordingly to the formula hereunder and are based on the data gathered from our raw material suppliers for which Cytec does not assume any liability.

$$\%\ \text{Biobased content} = \frac{\text{Amount of Biobased Carbon}}{\text{Amount of Biobased Carbon} + \text{Amount of Petroleum Based Carbon}} \times 100$$

$$\text{Weight \% RRM} = \frac{\text{Weight RRM}}{\text{Weight end product}} \times 100$$

# Polyester & Epoxy Acrylates Energy Curable Resin % Renewable

***EBECRYL* polyester acrylates** with medium to low viscosity have fair to high renewable raw material content. Their excellent pigment wetting and good adhesion to various substrates makes this range very suitable for ink formulations. Some of these products are highly recommended for litho application thanks to their ink-water balance performances.

***EBECRYL* epoxy acrylates** range includes products that are hard, solvent and water resistant, fast curing. In the fatty acid-modification improves the pigment wetting and the ink water balance in litho inks.

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# Polyester & Epoxy Acrylates Energy Curable Resin % Renewable

| Product | Product type | functionality | viscosity | Reenwable Raw Material (w%) | Naturally derived Carbon (%) | Application |
|---|---|---|---|---|---|---|
| EBECRYL 450 | Polyester acrylate | 6 | | 30 | 35 | Main use is in flexo inks. The product gives excellent pigment wetting and high reactivity. |
| EBECRYL 452 | Polyester acrylate | 4 | | 24 | 29 | Recommended for flexo inks. Excellent pigment wetting enables the production of high concentrated pastes, increasing productivity and process flexibility. |
| EBECRYL (1)657 | Polyester acrylate | 4 | | 42 | 52 | Mainly recommended for offset inks. Good pigment wetting, ink water balance and misting properties. |
| EBECRYL 846 | Polyester acrylate | 6 | | 15 | 17 | Recommended for high speed offset inks. The product feature high reactivity and low misting. |
| EBECRYL (1)870 | Polyester acrylate | 6 | | 25 | 30 | Excellent pigment wetting and high reactivity. The product is recommended mainly for offset inks. |
| EBECRYL 10801 (=IRR 691) | Polyester acrylate | 6 | | 24 | 30 | This resin is a very good base to develop inks for indirect food packaging. |
| EBECRYL 2870 | Polyester acrylate | 6 | | 25 | 30 | Resin recommended for offset inks. Excellent pigment wetting and high reactivity. |
| RAYLOK 1124 | Polyester acrylate | 4 | | 37 | 40 | The product is recommended as very good base resin to formulate sealers for parquet flooring. |
| RAYLOK 1621 | Polyester acrylate | 2+1 | | 27 | 31 | Low viscosity natural oil modified acrylate oligomer. It combines air drying and UV curing properties. Used in a clear coat for wood it gives transparent oil-like natural aspect. |
| RAYLOK 1622 | Polyester acrylate | 3 | | 21 | 23 | low viscosity natural oil modified oligomer acrylate. Used in a clear coat on wood it gives a transparent oil-like natural and warm aspect. |
| EBECRYL 860 | Epoxidized soja | 3 | | 60 | 71 | Perfect for developing overprint varnish where hot foil stamping is required. |
| EBECRYL 3608 | Fatty acid modified epoxy acrylate | 2 | | 7 | 16 | Product recommended for ink formulations where improved pigment wetting is demanded. |
| EBECRYL 3702 | Fatty acid modified epoxy acrylate | 2 | | 16 | 16 | Product recommended for ink formulations, good litho behavior and very good pigment wetting. |
| IRR 437 | Diluting acrylate | 2 | | 79 | 85 | Product recommended for ink formulations, good litho behavior. |

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# EBECRYL 5000 series BIOLIGOMERS

- A complete acrylation of epoxidized vegetable oils - such as soya bean oil results in radiation curable epoxy acrylates with renewable raw material content over 60%.

- Polyester acrylates are produced by condensation reaction of polycarboxylic acids, polyols and acrylic acid.

-Examples of polyols from renewable source are: 1. **glycerol** (a by-product in the production of biodiesel or produced by fermentation of glucose) and 2. **sorbitol** and others.

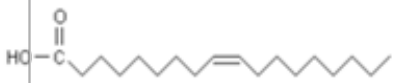
- Also polycarboxylic acids dimerized or polymerized **fatty acids** can be used. Both epoxy acrylates as polyester acrylates may be modified with fatty acids.

**POLYESTER ACRYLATES**

are obtained by **condensation reaction** of

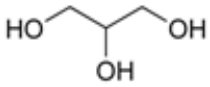
**polycarboxylic acids** + **polyols** + **acrylic acid**

- Dimerized **Fatty Acids**
- Polymerized **Fatty Acids**



Example: Oleic acid

- **Glycerol**
- **Sorbitol**
- others



Example: Glycerol

**AA derived from Propylene (i.e. refining from crude oil)**

**Natural Alternatives Available**

# EBECRYL 5000 series BIOLIGOMERS

**Products** based on renewable resources developed for the US market (they are not EINECS listed).

These products allow for the formulation of partially renewable inks and coatings without the loss of printability, pigment wetting or performance properties

| Product | Product type | functionality | viscosity cP @ 25°C | Renewable Raw Material (w%) | Naturally derived Carbon (%) | Application |
|---|---|---|---|---|---|---|
| BIOLIGOMER 5601 | Epoxidixed Soya Oil Acrylate | 4 | 26500 | 62 | 62 | Bioligomer recommended for overprint varnishes, screen inks and flexographic inks. |
| BIOLIGOMER 5610 | Modified Bisphenol A Epoxy Diacrylate | 2 | 2200 | 12 | 12 | Recommended in overprint varnishes, clear coatings for paper and plastics, screen inks, and wood fillers. Films of EBECRYL 5610 cured by UV or EB exhibit high gloss, good surface hardness, and excellent chemical resistance. |
| BIOLIGOMER 5801 | Polyester Acrylate | 3 | 6000 | 52 | 58 | Excellent product recommended to formulate flexographic pigment dispersions and inks for porous and nonporous substrates. |
| BIOLIGOMER 5820 | Polyester Tetraacrylate | 4 | 66100 | 51 | 56 | Recommended for wet or dry offset inks, formulated for porous substrates. This moderate viscosity polyester acrylate exhibits good pigment wetting, color development and printability. |
| BIOLIGOMER 5821 | Polyester Pentaacrylate | 5 | 27500 | 31 | 37 | Recommended for wet or dry offset inks, formulated for porous substrates. |
| BIOLIGOMER 5822 | Polyester Pentaacrylate | 5 | 29200 | 34 | 37 | Specifically developed for black and pigmented UV/EB lithographic inks. Recommended for wet or dry offset inks, formulated for porous substrates. |

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# Performance of the EBECRYL Bioligomers

# Screen Ink

## Starting Point Formula - Screen Ink

| | |
|---|---|
| **Pigment Dispersion** | |
| EBECRYL 5601 | 91-95% |
| Pigment | 4-6% |
| Additives | 0.5-1.0% |

| | |
|---|---|
| **Ink** | |
| EBECRYL 5601 Pigment dispersion | 78-80% |
| Acrylated monomer | 5-10% |
| Rheological additives | 1-5% |
| ADDITOL® DX (liquid photoinitiator blend) | 4-6% |

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# Screen Ink Performance Results

| | Magenta Ink | | | |
|---|---|---|---|---|
| | 60# semi gloss paper | | BOPP | |
| | Polyester acrylate, standard | EBECRYL 5801 | Polyester acrylate, standard | EBECRYL 5801 |
| **Adhesion, %** | 100 | 100 | 100 | 100 |
| **Gloss, 60°** | 35 | 40 | 55 | 58 |
| **Color Density** | 1.38 | 1.41 | 1.40 | 1.42 |

# Flexo Ink

## Starting Point Formulation

### Pigment Dispersion

| | |
|---|---|
| EBECRYL 5801 | 40-50% |
| OTA 480 | 25-35% |
| Pigment | 30-35% |

### Ink

| | |
|---|---|
| EBECRYL 5801 pigment dispersion | 60-65% |
| EBECRYL 5801 | 10-15% |
| TMPEOTA | 25-25% |
| ADDITOL® DX | 8-10% |

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# Flexo Ink Performance Results

| | Cyan | | Magenta | |
|---|---|---|---|---|
| | Polyester Acrylate, std | EBECRYL 5820 | Polyester Acrylate, std | EBECRYL 5820 |
| **Target: Color Density** | 1.4 | | 1.5 | |
| **Achieved: Color Density** | 1.5 | 1.4 | 1.5 | 1.5 |
| **Target: Print Contrast** | ≥ 36% | | ≥ 36% | |
| **Achieved: Print Contrast** | 40% | 37% | 39% | 41% |

**Press side Comments:**

√ Quick and easy make-ready
√ Consistent printing – stable color density and print contrast
√ Easy press clean-up

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# Over Print Varnish

**Formulation**

| | |
|---|---|
| EBECRYL 5610 | 55% |
| Acrylated monomer | 30% |
| Liquid Photoinitiator blend | 15% |

| | Epoxy Acrylate OPV, Standard | Bioligomer OPV |
|---|---|---|
| **Viscosity, cP @ 25°C** | 230 | 360 |
| **Gloss, 60°** | 94-96 | 94-96 |
| **Reactivity, mJ/cm²** | ~ 100 | ~100 |
| **Solvent resistance** | 60+ | 50-55 |

# Summary

The main industry drivers towards a greater reliance on Renewable Raw Materials are:

- **Responsible Care:**
  - ✓ The coating industry increasingly wishes to demonstrate good product stewardship concerning health and environmental issues.

- **Sustainability:**
  - ✓ The industry is becoming more aware of the need to work in a sustainable way.
  - ✓The marketed products must not only be economically viable **but also** socially and environmentally respectful.
  - ✓ **Renewable raw material** based products can help in achieving this goal of sustainability.

- **Functionality:**
  - ✓Naturally derived materials offer a range of functionalities that contribute to enhance the intrinsic value of these products.

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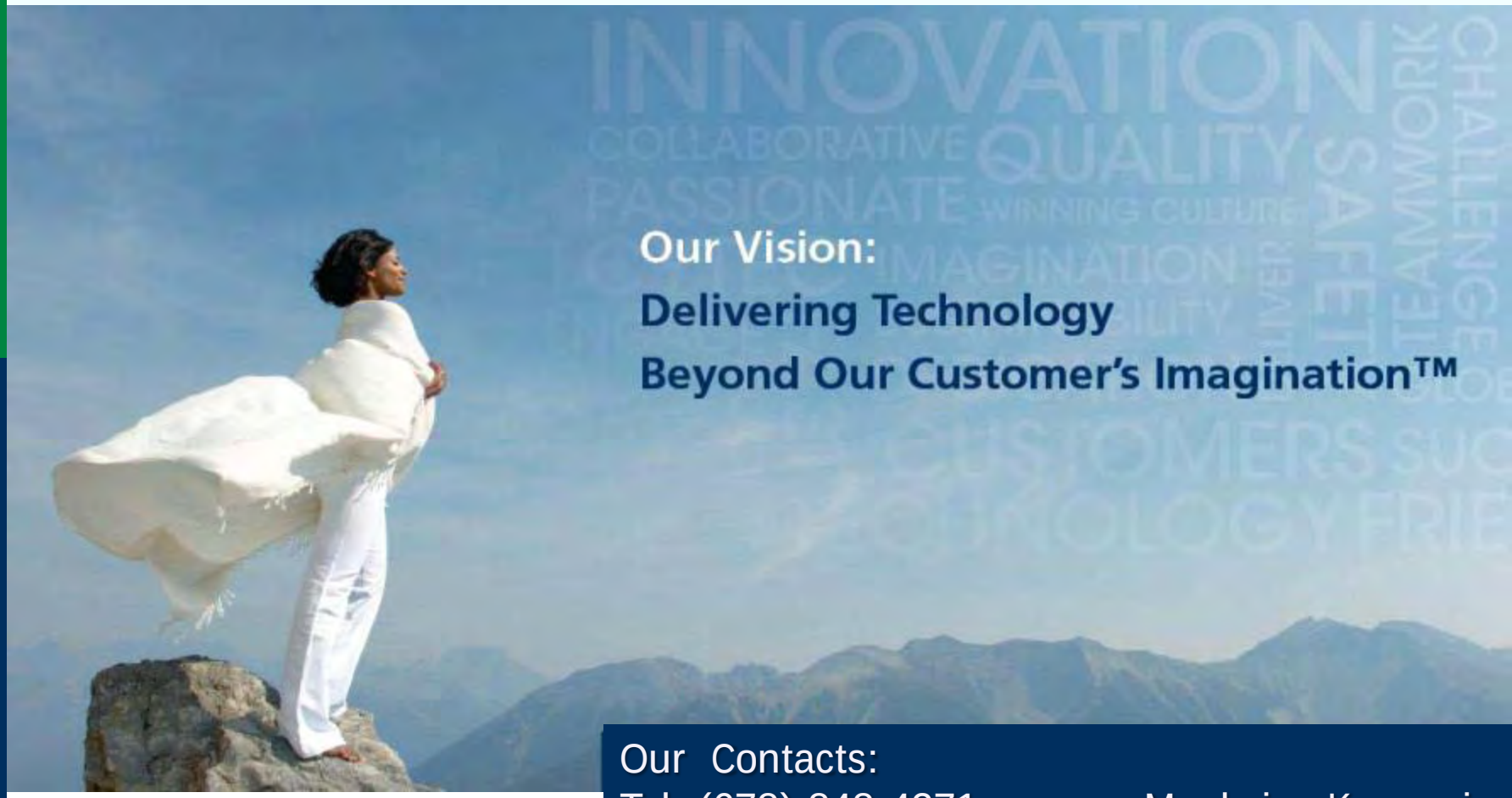
# Thank you

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