Green Chemistry by Design

Expanding Oleochemical Production of Renewable Chemicals

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Verdezyne Technology Platform

Feedstock Strategy

- Vegetable oils
- Soapstocks and distillates
- Other palm co-products (i.e. PKO, PFAD)

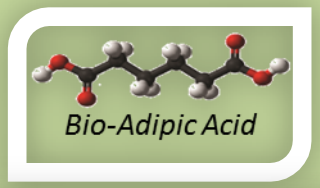
Using fatty acids from <u>any source</u> to produce chemicals

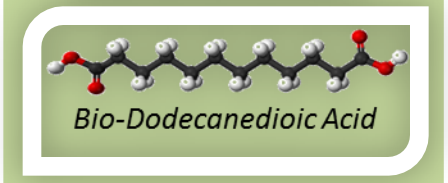
Proprietary Technology

- Organisms engineered for yield and selectivity
- Fermentation-based production

Robust yeast platform using industrial fermentation methods

Chemical Intermediates





- Diacids used in fibers, polymers and coatings
- Other organic acids
- Acrylic intermediates
- Diamines

Total $70B+ Market

End-Products

- Nylon and polyesters
- Fibers
- Polyurethanes
- Engineered Plastics
- Resins
- Lubricants
- Coatings
- Adhesives
- Corrosion Inhibitors
- Transparent Thermoplastics

Total $1.5T+ Market

Engineering Organisms & Processes for Cost-effective Renewable Chemicals

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Expanding the Oleochemical Value Chain

Crude
Vegetable Oils

Standard Conversions

- Edible Oils
- Oleochemicals
  - Fatty acids
  - Fatty alcohols
- Biodiesel

Verdezyne Technology

Crude Oil
&
Natural Gas

Petrochemical Refining

- Petrochemical Intermediates
  - Adipic Acid
  - Sebacic Acid
  - DDDA

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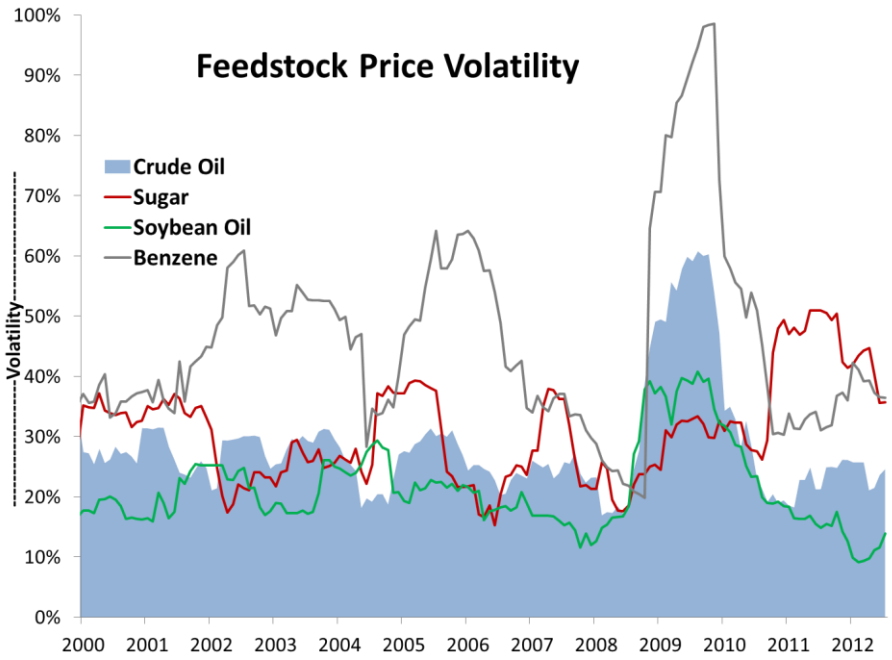
Cost Advantaged Feedstock Strategy

- Feedstock used by organism to reproduce, for energy and to produce target chemical
- Cost can make up 50% to 80% of total cash cost to manufacture
- Fatty acid based production advantaged over incumbent petrochemical production in both cost and *volatility*



2012 Worldwide annual vegetable oil production (billions of pounds)						Est. By-products	
Oil Type	Asia	Europe	Americas	Other	World Total	Distallates	PKO
Palm	104.1	N/A	2.0	9.2	115.2	5.8	13.1
Soybean	28.9	4.5	52.2	9.9	95.5	3.8	
Rapeseed/Canola	19.7	19.8	6.3	6.9	52.7	1.1	
Coconut	7.0	N/A	0.8	N/A	7.8	0.3	
Total	159.6	24.3	61.2	26.1	271.3	10.9	13.1

By-products/co-products

- Verdezyne's preferred feedstocks
- Distillates and fatty acids
- Produced in refining and fractionation process

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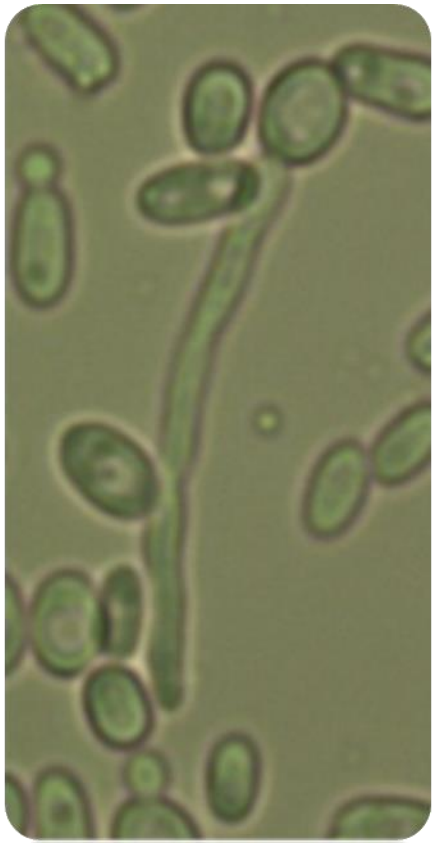
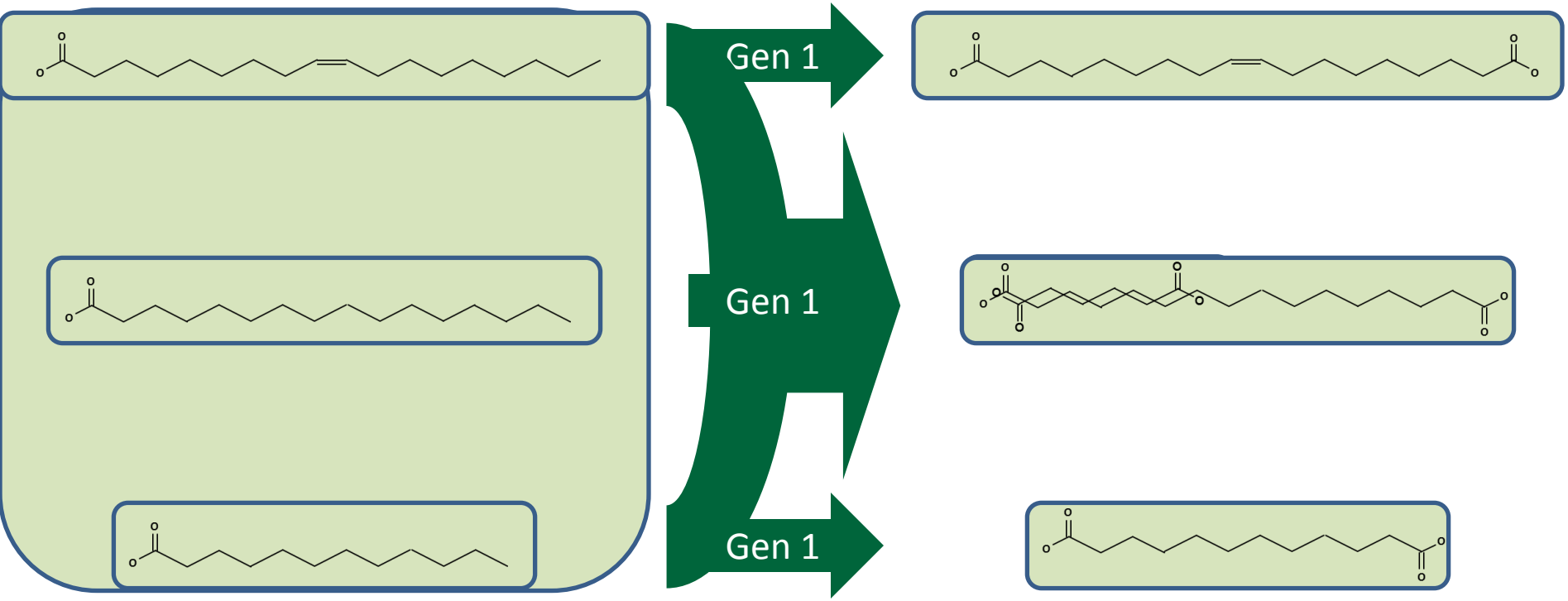
Yeast Production Platform



- Robust under industrial processing conditions
  - Uses inexpensive feedstocks
  - Produces multiple products
  - Fermentation at acidic pH
  - Phage resistant
- Tolerant to saturating product concentrations
- Host genome sequence and advanced genetic toolbox allows rapid development for new products

Multiple Conversion Technologies



Gen 1 Conversion

- Purified fatty acid feedstock
- Product length determined by feedstock

Gen 2 Conversion

- Mixed fatty acid feedstock
- Product length determined by pathway engineering

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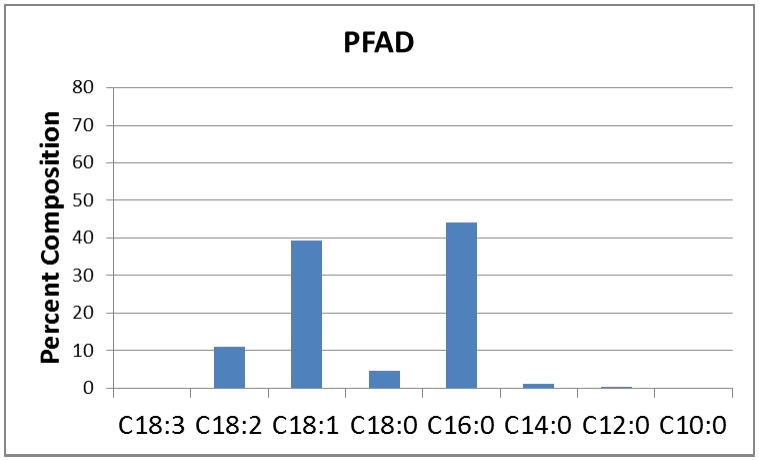
Adipic Acid

Feedstock composition



FAME

Canola SS

PFAD

- Market size = $6 B
- Fermentation performed at 400L scale with canola soapstock, FAME, and PFAD
- Validated applications: Nylon 6,6 fiber, PBAT, rigid polyester foam


Bio-based Adipic acid


BIOLON™ Nylon 6,6

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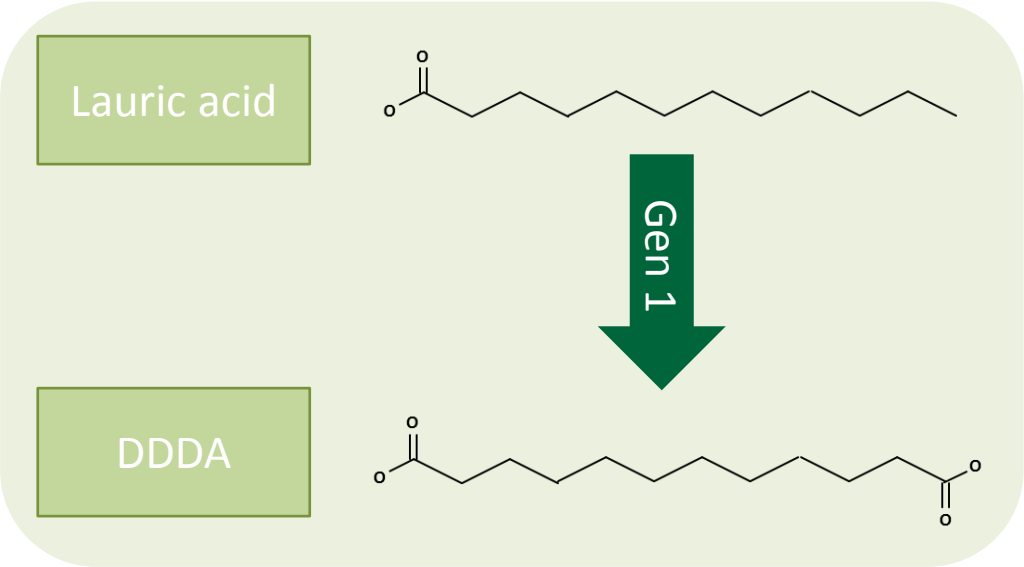
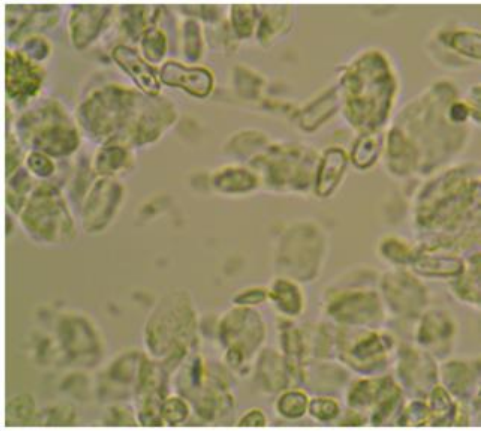
Dodecanedioic Acid



- Market size = $300 M
- Fermentation process performed at 400 L scale
- Renewable feedstock
- Cost-advantaged process
- Final product exceeds all industry specifications



Cells and
Insoluble DDDA product

Nylon 6,12 resin

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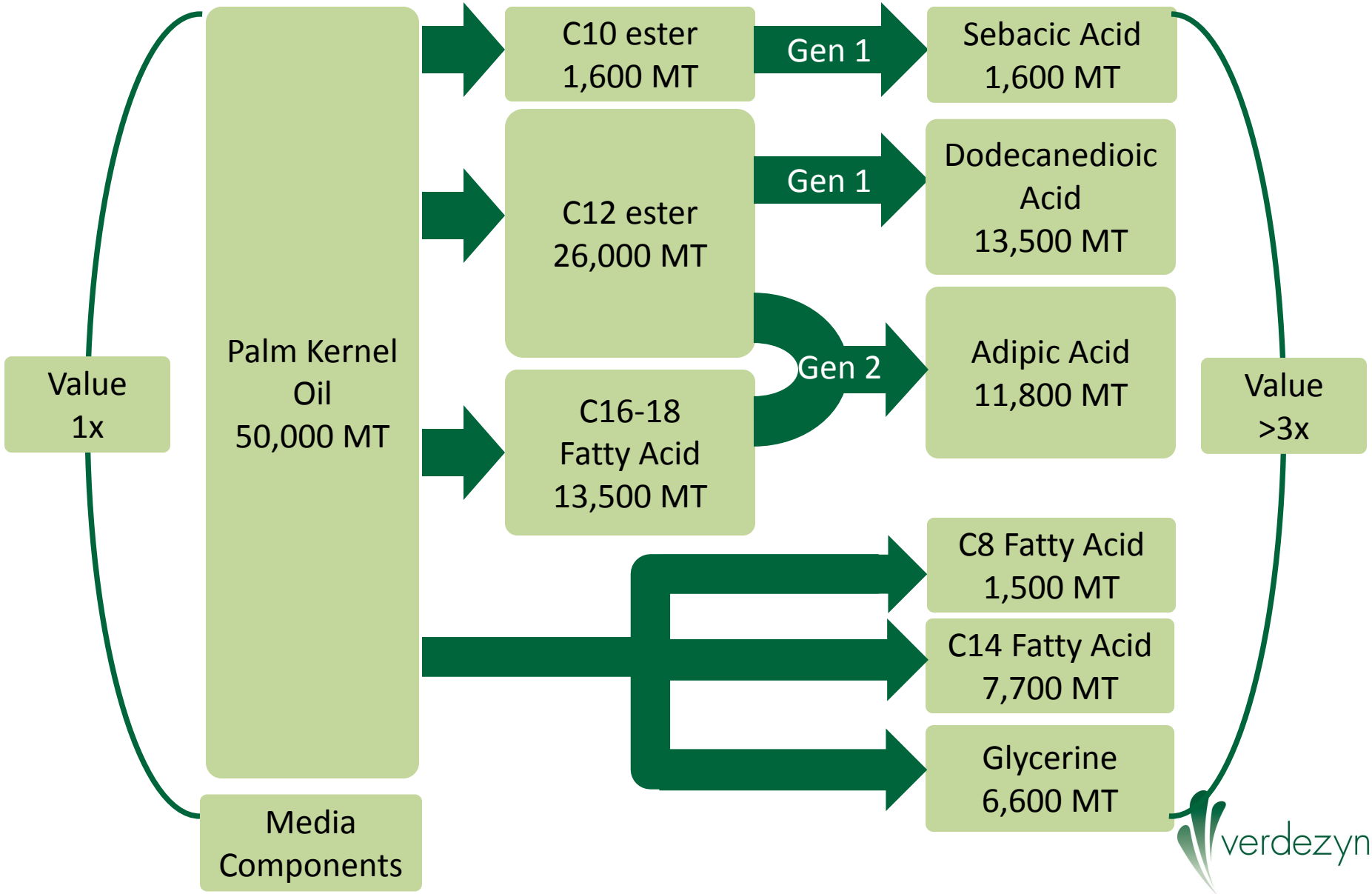
Example of a Diacid/Fatty Acid Bio-refinery



Potential Synergies with Oleochemical Industry Players

	Oleo Company	verdezyne
Feedstock Supply	Available feedstocks and processing co-products	
Feedstock Processing	Fractionation and esterification capabilities	
Fermentation		Engineered organisms, fermentation technology and design package for plant
Separation Purification		Validated processes to produce industry grade purity
Market Development	Existing portfolio of oleochemical products and customer relationships	Pipeline of parties interested in renewable nylon and other products
Sales & Logistics	Existing supply chain infrastructure	
New Products	Novel raw materials	Flexible technology platform and world class development team

Verdezyne Partnership →

Optimal usage of assets and operations
Unique portfolio of renewable and competitive products
Multiplier effect on value of raw materials to higher value chemicals
<u>The World Leader in Renewable Chemicals</u>

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Thank You!

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