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From Green Olympics to Green China --- and how Purac can help!

甄光明 博士 K. Jim Jem, Ph.D., P.E.

Chief Representative of Greater China, Purac

Presentation outline

- Green Olympics --- Opportunities for BJ
- Green China --- How to make it happen
- Carbohydrates vs. Crude Oil for biochemicals & plastics
- PURAC Business model for sustainable Bio-plastics growth
- Conclusions

Green BJOG 2008: Will it lead to a Green China?

- Green Olympic Game for 2 weeks! Great, but ...
- Will Beijing be Green before the BJOG?
- Will Beijing be Green after the BJOG?
- Will all this activity lead to a Green China?
- If not, a “GREEN” 2008 Beijing Olympic Game (BJOG) is not really Green and becomes meaningless!
- BJOG must serve as a catalyst and a model to build a Green China for future generations to come!!!

Green BJOG 2008: What has yet to be done? (A)

1. A suitable infrastructure is needed to support Garbage classification, Re-usable Waste Recycling, Biowaste composting, etc. --- Currently, garbage is not separated in the household, toxic waste (battery, needles, ...) is mixed with bio-waste, composted waste is not welcomed by farmers, PLA cannot be degraded under managed conditions reliably, ...
2. An official regulatory system to review and approve new BDP for food contact safety is needed --- Currently, new BDP’s such as PLA cannot officially be approved for food use locally due to lack of clear and relevant government (MOH) guidelines and a functioning approval system. Consequently, major brand-name owners are reluctant to use non-approved BDP’s for cups, food trays, etc. without approvals being in place first.

Green BJOG 2008: What has yet to be done? (B)

3. Entities related to the government and BJOC (e.g. contracted hotels and BJOG sponsors such as China Airline, Coca Cola, etc.) must start using BDP's now and slowly increase to using 100% BDP's for disposable goods before the start of the BJOG so as to build up the BDP business credibly --- Currently, BJOC only talks about BDP use, but no one will use them until the BJOG starts. So, at best, BJOG will be GREEN for only two weeks and no more than 2 months in 2008. BDP companies will not establish a base line operation or survive on the basis of such short-term business.
4. Grant 3-5 year tax-free status (import / export duties, VAT, income tax, etc.) for real bio-based BDP's, their immediate monomer ingredients, compounded resins, and final products so as to make BDP's competitive enough in the market to attract more investment --- Without established and profitable BDP companies, there will be no GREEN China!

Green BJOG 2008: What has yet to be done? (C)

5. Set up Regulatory, Waste Disposal Fee and Law Enforcement systems to prohibit fake BDP's, as well as penalize / restrict traditional plastics for use in disposable applications --- Currently, most, if not all, lunch boxes marked as being made from BDP's are actually non-biodegradable. Partially dis-integrated PE or PS can cause more environmental problems for China in the future if this situation is not carefully managed.
6. Establish a 100% sewer treatment system, more mass-transport, a spitting and smoking free environment, ...
7. Set up Beijing as a model city for GREEN CHINA and demonstrate to the world that China is a cultural, healthy, clean, developed, responsible society which modern Chinese can be proud of and foreigners can respect.

Green China after 2008: How to make it happen?

1. *Air Pollution, Green House Gases, and Global Warming* --- Mass transportation (vs. private cars), carbohydrate (vs. oil) sources for biochemicals and fuels, more trees and green lands (to stop desertization), more alternative energy sources, less oil & coal usage, greater energy efficiency, ...
2. *Solid waste* --- BDP industries, Regulations, Disposal fees, Penalties, Recyling / Composting systems, Clear authority and responsibility to EPA offices, ...
3. *Water pollution* --- Sewage treatment, law enforcement, industrial zoning, ...
4. Education, Policy, Habit, Economic incentives, …
5. BJOG 2008 can serve as a model to trigger the above!

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Increasing use of renewable resources

Drivers: **Concern about CO_2 emissions / global warming / limited fossil resources / increasing oil prices**

- **Bio-energy**
  - From bio-waste e.g bagasse
- **Bio-fuels**
  - Bio-ethanol
  - Bio-diesel
- **Bio-monomers**
  - Lactide
  - 1,3-propanediol
  - Succinic acid
  - Epichlorohydrin from glycerine (by-product of bio-diesel)
- **Bio-plastics**
  - PLA
  - Starch-based
  - PHA, PHB, PHBV, etc.

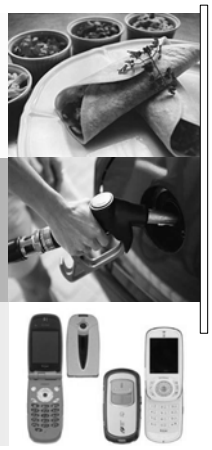
Crops over the world

PURAC's process is substrate flexible

NB. 1.410 mio tons of carbohydratres produced annually

Priorities in case of shortages in Carbohydrates

1. Food
2. Fuels
3. Plastics



Sustainability of bio-plastics threatened by bio-fuel developments

Bio-ethanol: The New Market Dynamic

- **2006:** 40 mio tons of bioethanol (<1 % of global fuel consumption)
- **Brasil** worlds biggest carbohydrate producer
  - Over 50% of Brazilian cane harvest is now used for ethanol
- **USA** has set goal of 130 mio tonnes of bio-ethanol in 10 years
  - Requires 100% of corn harvest in the US (2008 level)

Prices of Oil and Sugar coupled via ethanol

Oil	Ethanol	Sugar
Prices of oil and ethanol partially coupled through fuel use		Prices of sugar and ethanol partially coupled through food versus fuel use

Renewable is not necessarily sustainable

Next generation Carbon & Energy sources for ethanol production

Carbon-source / Energy-source	Feed-stock: Edible (Carbohydrates)	Feed-stock: Non-edible (Cellulose)
 Fossil energy	Today	
 Renewable energy	3-5 years →	5-10 years

Technology to convert (ligno-)cellulose to fermentable sugars is critical to make *bio-plastics and bio-fuels* developments sustainable

Global availability of biomass for bio-fuels

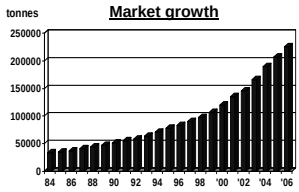
Renewable resources (cellulose)	Bio-fuels
Global natural **cellulose** **> 200.000 mio tonnes**	Global gasoline production **3000 mio tonnes**
< 1 % of Global cellulose **2000 mio tonnes**[2)]	**10%** of Global gasoline production 300 mio tonnes ethanol = **490 mio tonnes** energy equivalent

Bio-fuel developments based on cellulose *<u>can be sustainable</u>*

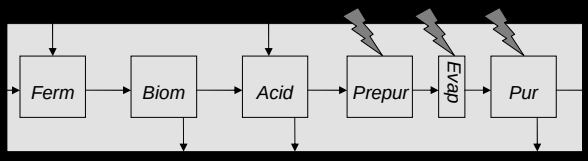
1) **Average carbohydrate to bio-fuel conversion rate: 50%**
2) **Average cellulose to bio-fuel conversion: 25%**

Markets for Natural lactic acid

- Food
- Industrial
- Cosmetics
- Pharmaceutical
- Polymers
- Feed



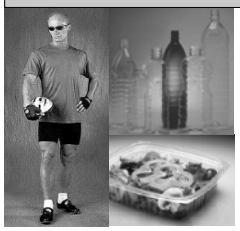
PURAC's present technology position



Poly Lactic Acid Production Step

Sugars → Fermentation → Lactic acid → Monomer production → Lactide Monomer → Polymer production → PLA → Polymer conversion

Efficient conversion of carbohydrates is critical factor for Economically Sustainable PLA production

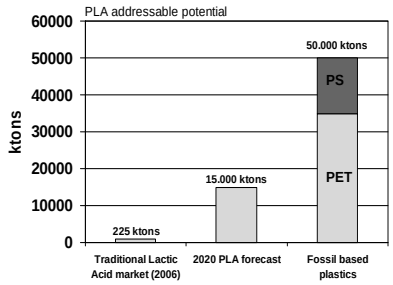


Present PLA growth stage

- New applications being developed continuously
- Market demand for PLA and other bio-based polymers is growing fast
- Various companies plan investments in PLA, mainly
  - Polymer producers
  - Polymer converters

PLA capacity/supply is currently limiting in market growth

Potential PLA market dwarfs traditional Lactic Acid market



Lower end PLA forecasts ranging from 15 to 30 mio Tonnes

- Key drivers of PLA demand:
  - Increased drive for sustainability and reducing dependence on oil-based plastics
  - No commercially equivalent or better bio-plastic alternative
- Demand for PLA is burgeoning:
  - NTR sold out; constrained by current production yield
  - Prices for PLA have increased in in excess of fossil based polymers
- Long term demand driven by large commercial interests:
  - Favourable government policies (Green dot Germany; Japanese directives)
  - Many companies look to set up captive PLA plants

PLA capacity/supply is currently limiting the market growth

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PURAC Overview

- Part of CSM
  - Public company
  - Turnover 2.5 bio €
- Global representation
- Production from renewable resources
- More than 70 years of experience in lactic acid production
- Continuous investments in capacity and quality

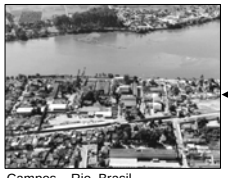
- Strong balance sheet
- Money available to invest
- Focus on sustainable growth
- PURAC strategically important
- Innovation as key-enabler for growth
- Focus on customer needs and solutions

PURAC production sites

Blair-Nebraska, USA

Gorinchem - Netherlands

PURAC Thailand under construction



Campos – Rio, Brasil

Montmelo, Spain

PURAC Headquarters (The Netherlands)

PURAC Lactic acid plants

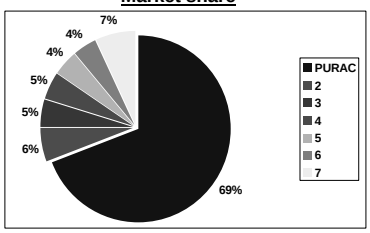
PURAC sales offices

PURAC new lactic acid plant in Thailand

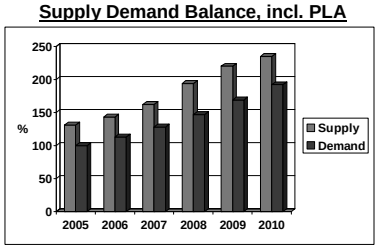
World-Market for Lactic Acid

- The world-market for lactic acid in 2006 amounted to approximately 225.000 tonnes (excluding PLA)
- PURAC Market share approximately 70%
- Sustainable supply guaranteed by 300.000 tons capacity as of 2008 (including Thailand)

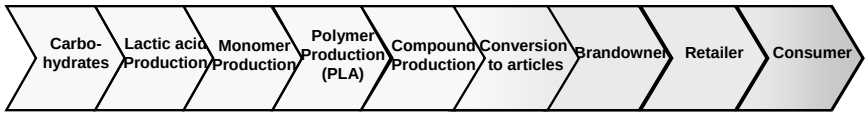
Market share



Supply Demand Balance, incl. PLA



PLA Value Chain

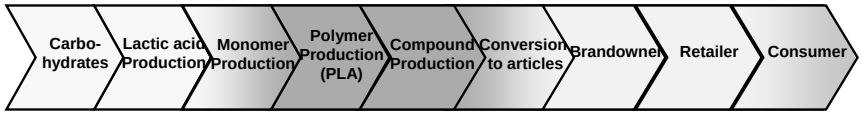


Drivers for bio-plastics in the Retail Chain

- Consumer concern about environment
- Green image of retailers and brand-owners
  - Adding value through "Sustainability Branding" and creating consumer awareness
- Regulatory framework conditions:
  - National policies for reduction of green-house gases, bio-bags
  - Green dot (Germany) and Packaging Directives
- Key issues:
  - Cost versus fossil based polymers
  - Non-GMO carbohydrates required (esp. in Europe)

Retail chain

PLA Value Chain



Drivers for Plastics Industry

- Demand for 'green' materials from retailers and brand-owners
- Adding value through material innovations and technology
- Framework conditions

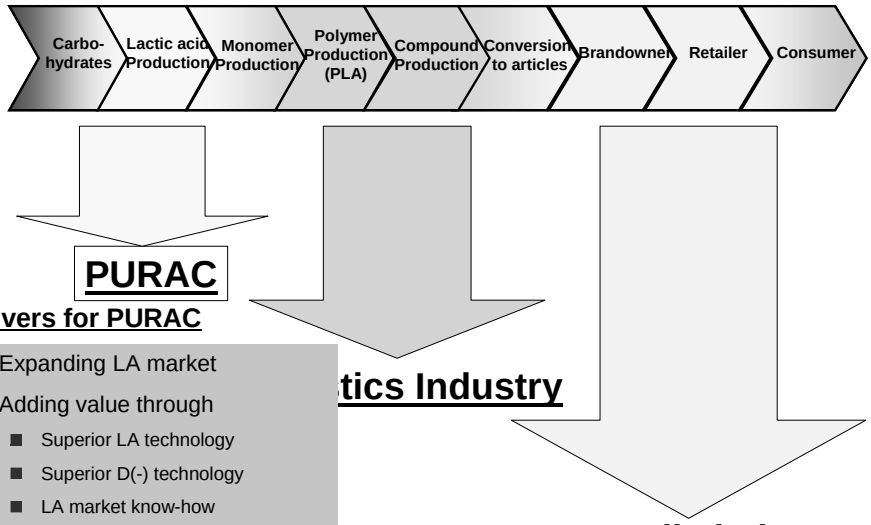
Key issues

- HDT, impact strength and barrier properties of PLA
- PLA technology, esp. lactide step
- Eco-Efficiency

Plastics Industry

Retail chain

PLA Value Chain

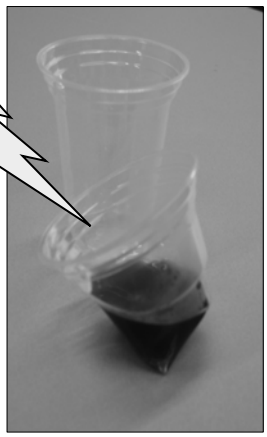


Drivers for PURAC

- Expanding LA market
- Adding value through
  - Superior LA technology
  - Superior D(-) technology
  - LA market know-how

Weaknesses of PLA

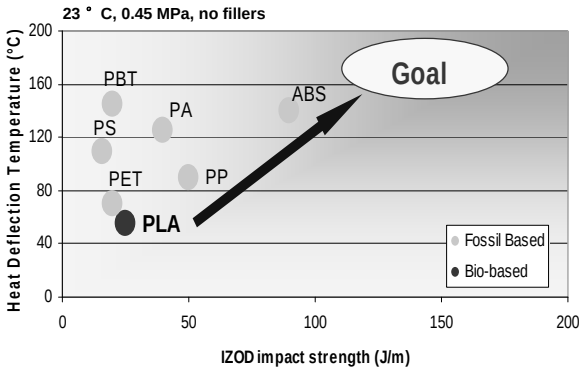
- Heat Deflection Temperature 50-60ºC
  - Poor resistance to heat
  - Lumping of pellets during transport, storage, and processing
  - Deformation during transport and use of trays, preforms, cups, etc.
- Poor Impact Resistance
  - Engineering applications
- Gas Barrier Properties
  - Carbonated drinks



Hot coffee in PLA cup for cold drinks

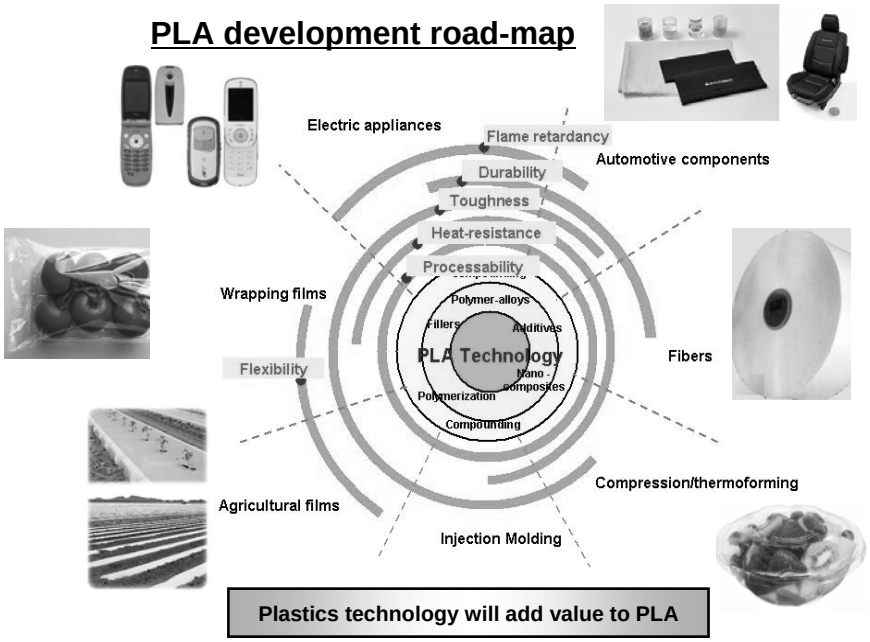
Weaknesses of PLA are limiting range of applications

PLA properties improvement



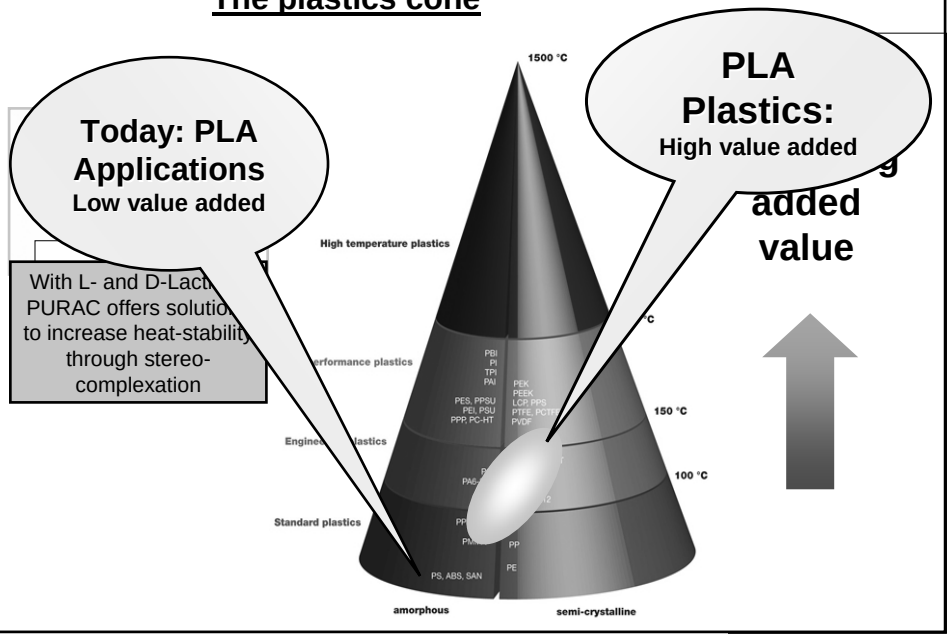
Plastics technology needed to improve PLA

PLA development road-map

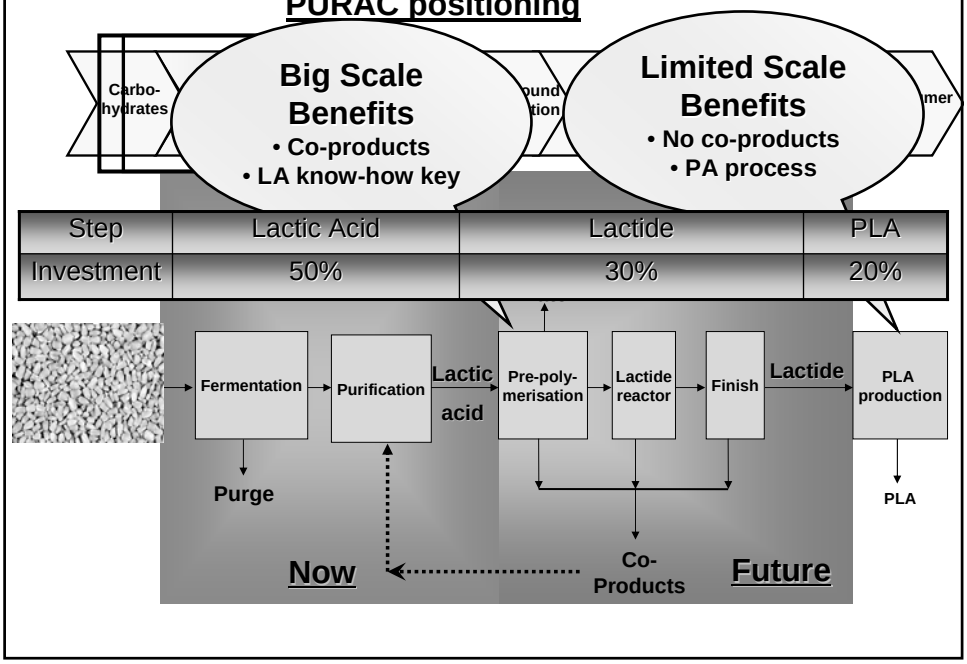


Plastics technology will add value to PLA

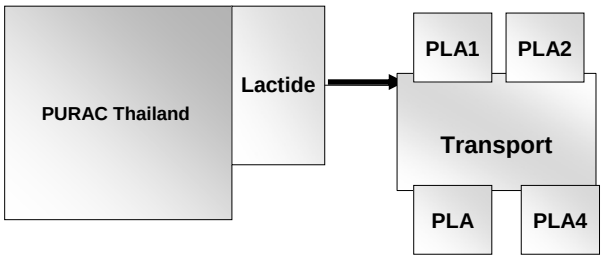
The plastics cone



PURAC positioning



Lactide value-proposition



- L-Lactide is **flexible PLA monomer** for PLA polymers and co-polymers.
- D-Lactide enables for flexible **polymer architecture**, including **stereocomplex** technology for high heat.
- Due to different scale economy , Lactides allows polymer producers to step into PLA at smaller scale, allowing for **captive use** production of PLA.
- PURAC's technology and **economy of scale** for lactic acid and lactides allows for **sustainable** PLA development.

Conclusion: PURAC as a LA supplier and a partner for PLA producers

- Lactides to **reduce technology, scale and investment hurdles** for PLA producers
- **Economy of scale** for lactic acid
- **Flexible sourcing** of carbohydrates
- **Best proven practice** lactic acid technology
- Investing for adequate lactic acid **capacity**
- **D(-) lactic acid** technology for improved sc-PLLA-PDLA
- **IP** for key lactide and lactic acid fermentation and purification technologies
- Solutions for **PLA co-products**

→ PURAC Most sustainable partner for PLA

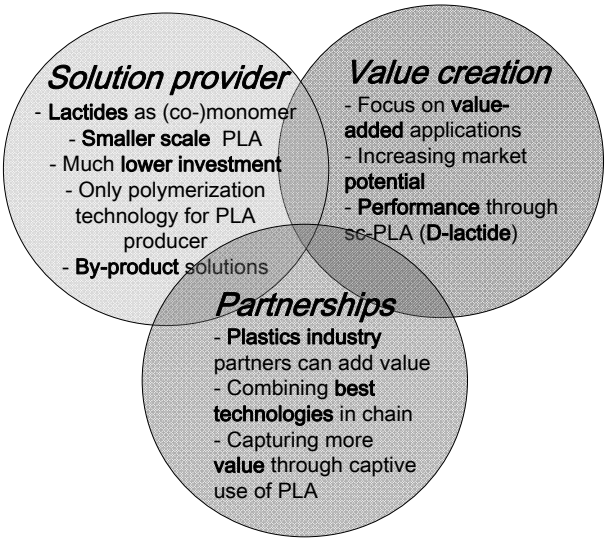
Lactide reduces entry barrier for PLA production

- Lowers **economy** of scale
- Lowers **investment** hurdle
- Lowers **technology** hurdle
  - Lactic acid and Lactide technology **core PURAC competence**
  - Polymerization **core polymer industry competence**
- No **by-products** for PLA producer
- Good fit with **existing** polymerization equipment
- Full **control** over PLA quality and properties

Lactides allow for overcoming existing hurdles for PLA growth

VISION:
PURAC as the enabler for the PLA industry

- ***Value-proposition:***
  - PURAC investment in L- and D-Lactides removes technical and investment barriers for PLA industry
  - Plastics industry can add value to PLA through polymerization and compounding know-how



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From Green Olympics to Green China

and Purac can help!

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