

Redefining Solvent Innovation for Tomorrow's Chemistry

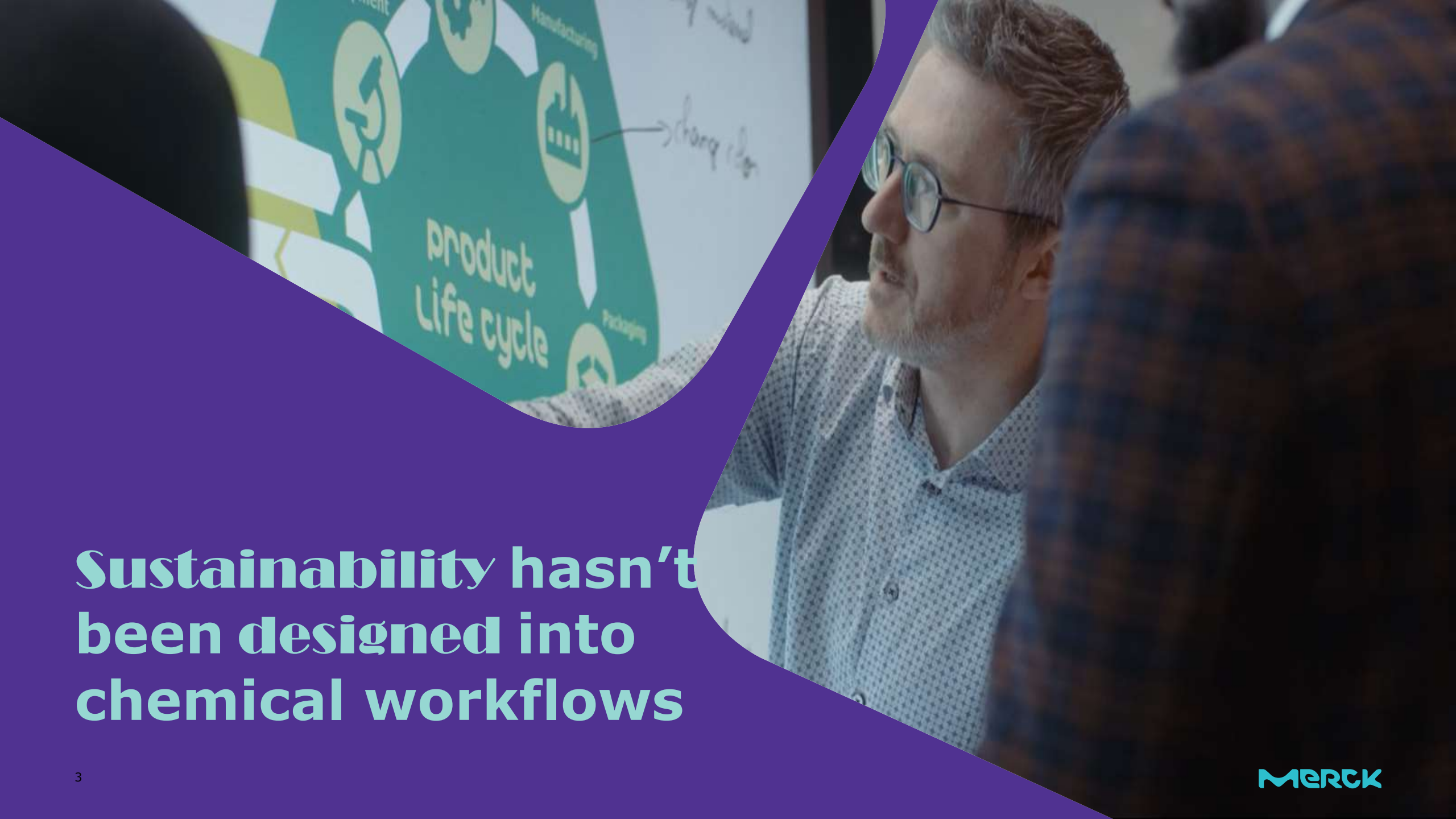
Driving Circularity Through Bio-Based Solutions

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Social Business Innovation

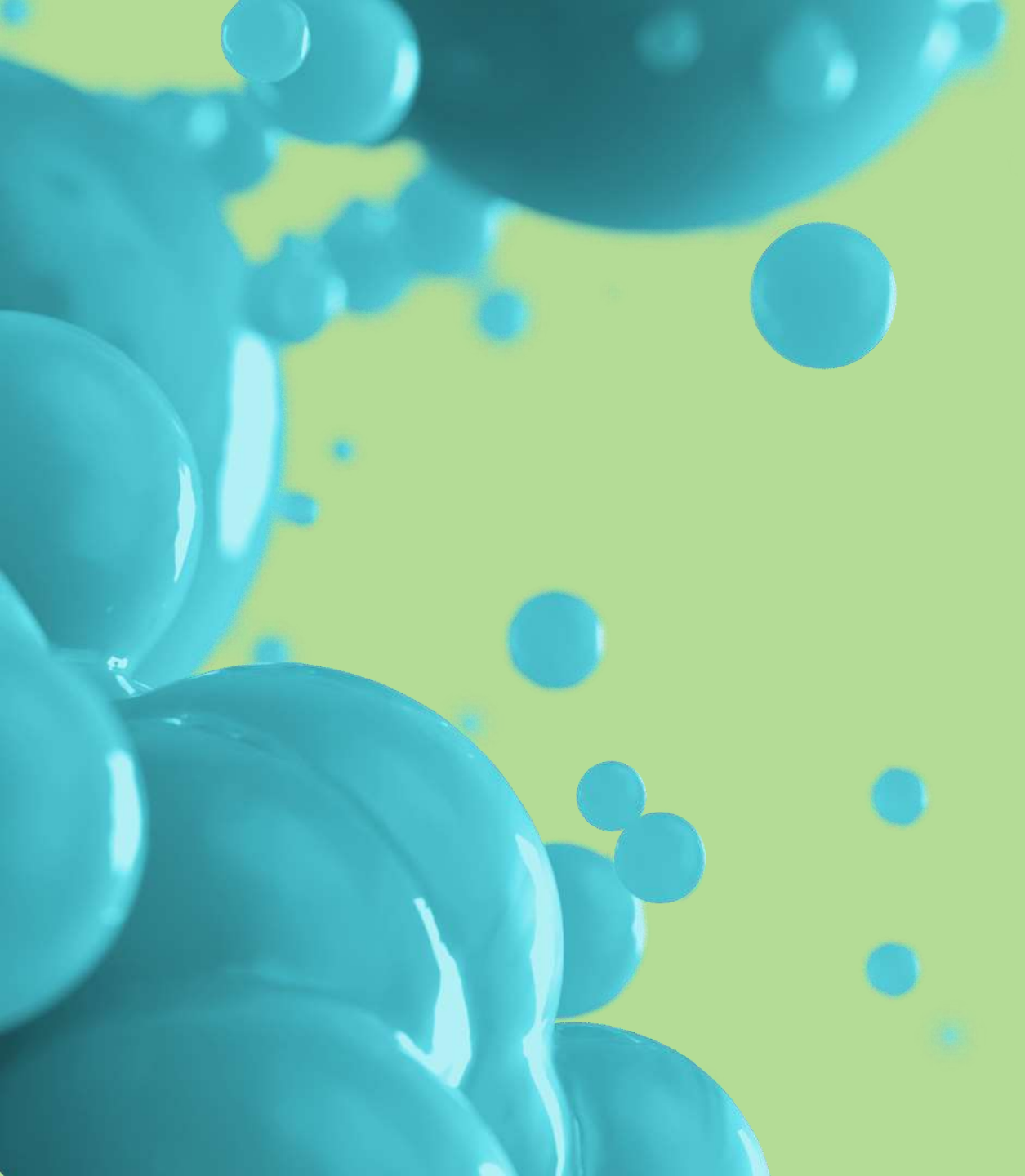
MERCK



Solvents were optimized for **performance**, not **impact.**



Sustainability hasn't been designed into chemical workflows



Solvents dominate
mass,
volume and
Scope 3 emissions

The challenge: greener solvents without changing the science



The 12 Principles of Green Chemistry give us the framework

- **Developed in 1991 by John C. Warner** and **Paul T. Anastas**, an organic chemist working in the Office of Pollution Prevention and Toxins at the EPA
- **Goal:** reduce chemical-related impact on human health and virtually eliminate contamination of the environment through dedicated prevention programs

12 Principles of Green Chemistry


#1 Waste Prevention (R)


#2 Atom Economy (R)


#3 Less Hazardous Chemical Synthesis


#4 Designing Safer Chemicals


#5 Safer Solvents and Auxiliaries


#6 Design for Energy Efficiency


#7 Use of Renewable Feedstocks


#8 Reduce Derivatives


#9 Catalysis


#10 Design for Degradation


#11 Real-time Analysis for Pollution Prevention


#12 Inherently Safer Chemistry for Accident Prevention

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Greener Alternative Products
Sustainability embedded in product development, not added later

We have **embedded SHAPE, our design for sustainability framework** into our PDP, taking a holistic, **life-cycle approach** to increase product sustainability and innovation.

1. **Brainstorm life cycle impacts, opportunities and customer voice**
2. **Assess and select target criteria**
3. **Develop the product and assess improvement**

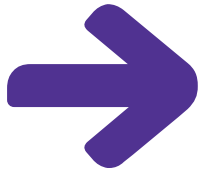
→ **Greener Alternative Products**



Greener Alternative Products
Bio-based solvents

We're expanding our **bio-based solvent portfolio** to help achieve climate targets, meet tightening regulatory action, and **help you reduce your footprint** while accomplishing your science.







Solvent	**Traditional**	**Bio-based**	**% CO_2e reduction**
Acetone	3.61 kg CO_2e/L	1.39 kg CO_2e/L	-61%
Butanol	3.73 kg CO_2e/L	1.43 kg CO_2e/L	-61%
Ethanol	2.39 kg CO_2e/L	0.41 kg CO_2e/L	-83%

Greener Alternative Products
Bio-based solvents

Cyrene™ solvent

Made of **cellulose fibers** like sawdust and woodchips from construction industry waste **for a circular economy**. Cyrene™ serves as a greener alternative for DMF and NMP.

Exclusively available from Merck.

Aligns with Principles of Green Chemistry:	Environmental benefit
#5 Safer Solvents and Auxiliaries	In replacing NMP alone across all its applications, Cyrene™ could eliminate over **850,000 tons of CO_2 annually** when produced at the same scale as NMP.

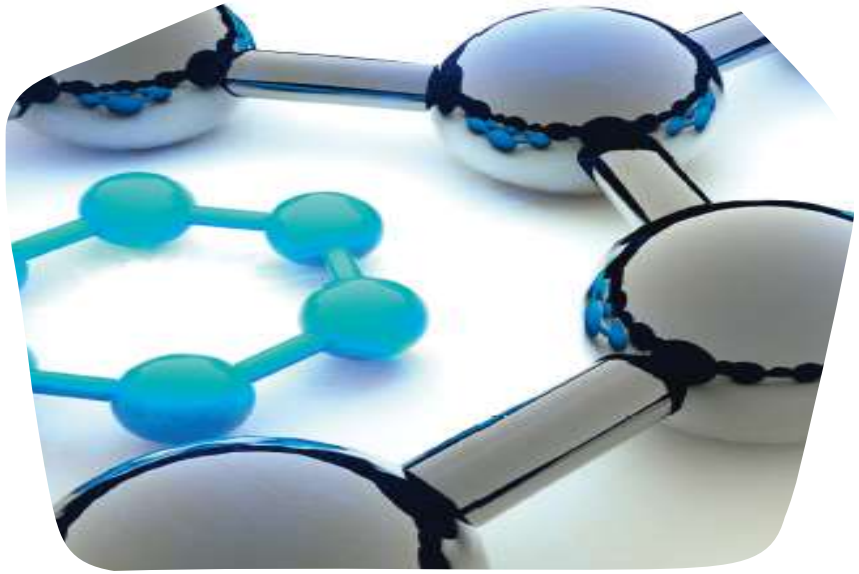


Cyrene™ blends
Expanded applications

Superior Graphene production

Compared to NMP, Cyrene™ produces **larger, less defective Graphene flakes** because of its:

- Higher viscosity
- Optimum polarity



Increased applications

We developed **two novel Cyrene™ blends:**

- Cyrene™ γ-Valerolactone
- Cyrene™ 2-MeTHF



Cyrene™ bio-based blends offer:

- Lower viscosity
- Retained performance and yields
- Easier application in automated processes and common reactions

Bio-based Solvents
NEW Bio-based HPLC and LCMS Solvents



A significant advancement in laboratory Sustainability

Developed from renewable feedstocks

- Provide same chromatographic resolution, reproducibility, baseline stability
- No analytical method redevelopment required
- Bio-carbon content certification by ASTM D6866
- **Reduced CO_2** emissions compared to fossil fuel-based solvents

Product	Description	CAS No.	% CO_2e reduction vs. fossil fuel-based
104771	**Acetonitrile, BioRenewable, gradient** grade for LC	75-05-8	**-28%**
106188	**Methanol, BioRenewable, gradient** grade for LC	67-56-1	**-29%**
106176	**Methanol, BioRenewable**, hypergrade for **LC-MS**	67-56-1	**-29%**
117480	**Ethanol, BioRenewable,** hypergrade for **LC-MS**	64-17-5	**- 17.6%**

Greener Alternative Products
Bio-based solvents

By 2030, we aim to **convert** our conventional solvents **to bio-based** alternatives in our portfolio wherever feasible.

Greener solvents developed:

- Cyrene™ blends: alternatives for DMF & NMP
- Pinene: alternative for DCM & THF
- Alternatives for: hexane, cyclohexane, DMSO, pyridine, T-Butyl Methyl Ether

Through academic partnerships:

York: Developed toluene alternative

DTU: Developing acetonitrile alternative

Johns Hopkins: ensure we avoid regrettable substitutions

28%

Reduction

CO2eq emissions vs. 2020 solvents baseline

* Assumptions: Drop-in replacements achieve a minimum of a 40% reduction; Processing or purification steps do not significantly impact emissions.

Q&A

