

Global Greenchem
Innovation & Network Program

Oil and Environment: Can Green Chemistry Bridge the Gap?

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Oil has been the backbone of global industrialization.

Oil continues to hold a critical position in the fields of energy, transportation, and petrochemicals.

Crude oil is a source of raw materials for production of plastics.





COST?

Contamination with oil and its derivatives is still significant in all parts of the world.

Parts of the oil pollutants can persist in the environment for years.

Existing plastic waste requires better management.





Chemicals / Natural products

Crude oil is a **natural product**, however, its normal residence is deep the underground in the subsurface reservoirs and deposits, where it was originally created and accumulated.



At the surface of the Earth

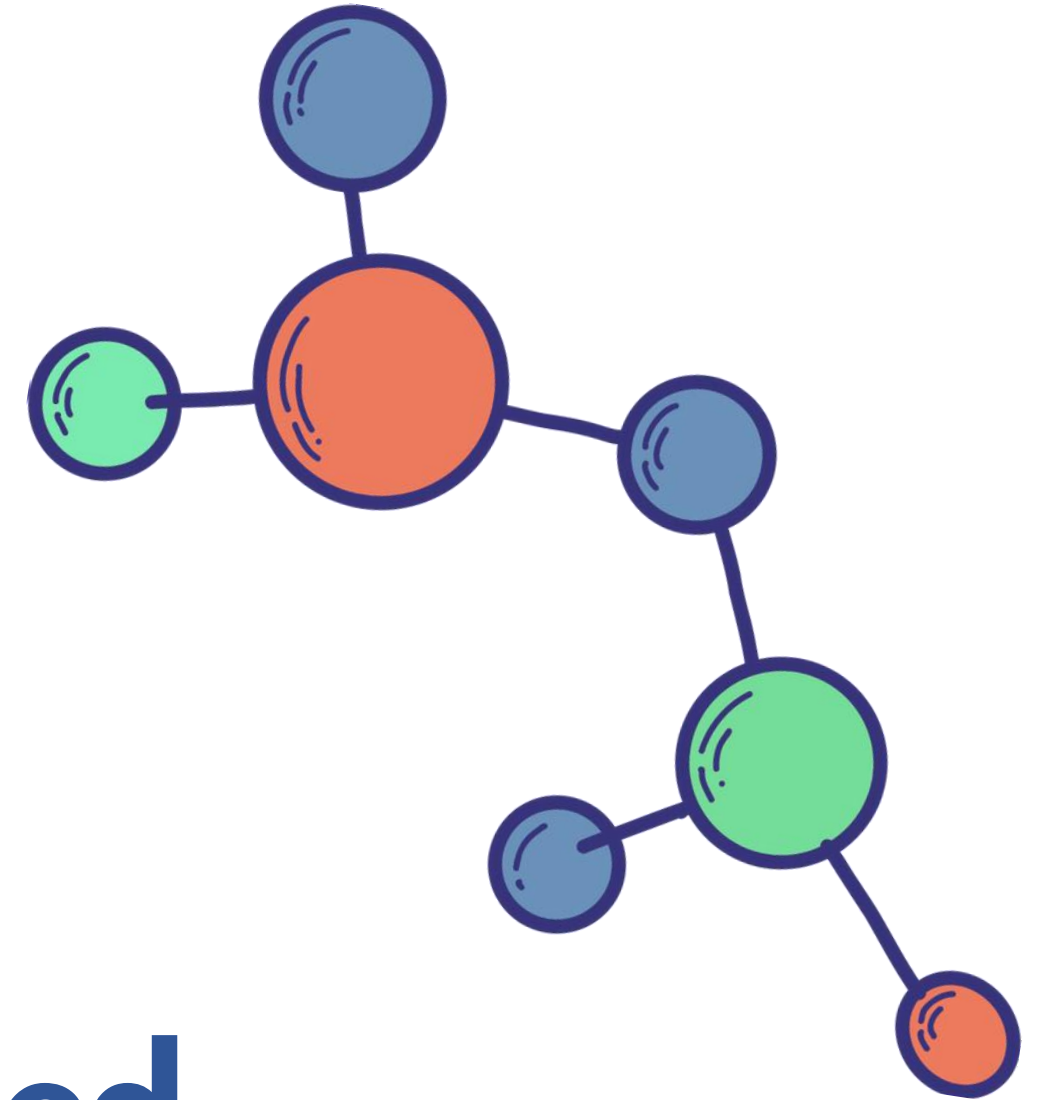
Environmental pollutant





Can green chemistry provide solutions that balance these realities?





**How many petroleum-based
chemicals you're in contact with right
now?**



Over 96% of all
manufactured products
are in some way “touched”
by chemicals during their
development or
production.

MORE THAN
96%

of all
manufactured
goods are
directly
touched by
the business
of chemistry.¹

Synthetic
fabrics



Electronics



Food
packaging



Medicine



Aerospace
equipment



Automotive
parts



70K+
CHEMICAL
PRODUCTS
IN TOTAL



The chemical industry represents one of the largest global sectors, encompassing petrochemicals, pharmaceuticals, agrochemicals, paints, coatings, and related fields.





GREEN CHEMISTRY

the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances.

(Anastas & Warner, 1998)

Yale University, USA

The 12 Principles of
GREEN CHEMISTRY

Green chemistry is an approach to chemistry that aims to maximize efficiency and minimize hazardous effects on human health and the environment. While no reaction can be perfectly 'green', the overall negative impact of chemistry research and the chemical industry can be reduced by implementing the 12 Principles of Green Chemistry wherever possible.

- 1. WASTE PREVENTION**
Prioritize the prevention of waste, rather than cleaning up and treating waste after it has been created. Plan ahead to minimize waste at every step.
- 2. ATOM ECONOMY**
Reduce waste at the molecular level by maximizing the number of atoms from all reagents that are incorporated into the final product. Use atom economy to evaluate reaction efficiency.
- 3. LESS HAZARDOUS CHEMICAL SYNTHESIS**
Design chemical reactions and synthetic routes to be as safe as possible. Consider the hazards of all substances handled during the reaction, including waste.
- 4. DESIGNING SAFER CHEMICALS**
Minimize toxicity directly by molecular design. Predict and evaluate aspects such as physical properties, toxicity, and environmental fate throughout the design process.
- 5. SAFER SOLVENTS & AUXILIARIES**
Choose the safest solvent available for any given step. Minimize the total amount of solvents and auxiliary substances used, as these make up a large percentage of the total waste created.
- 6. DESIGN FOR ENERGY EFFICIENCY**
Choose the least energy-intensive chemical route. Avoid heating and cooling, as well as pressurized and vacuum conditions (i.e. ambient temperature & pressure are optimal).
- 7. USE OF RENEWABLE FEEDSTOCKS**
Use chemicals which are made from renewable (i.e. plant-based) sources, rather than other, equivalent chemicals originating from petrochemical sources.
- 8. REDUCE DERIVATIVES**
Minimize the use of temporary derivatives such as protecting groups. Avoid derivatives to reduce reaction steps, resources required, and waste created.
- 9. CATALYSIS**
Use catalytic instead of stoichiometric reagents in reactions. Choose catalysts to help increase selectivity, minimize waste, and reduce reaction times and energy demands.
- 10. DESIGN FOR DEGRADATION**
Design chemicals that degrade and can be discarded easily. Ensure that both chemicals and their degradation products are not toxic, bioaccumulative, or environmentally persistent.
- 11. REAL-TIME POLLUTION PREVENTION**
Monitor chemical reactions in real-time as they occur to prevent the formation and release of any potentially hazardous and polluting substances.
- 12. SAFER CHEMISTRY FOR ACCIDENT PREVENTION**
Choose and develop chemical procedures that are safer and inherently minimize the risk of accidents. Know the possible risks and assess them beforehand.

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Can green chemistry provide solutions that balance these realities?





Cleaner refining: advanced catalysts, reduced by-products

Safer solvents and reaction media

Oil spill remediation: bioremediation and green dispersants

Chemical recycling and upcycling of plastics





BIOREMEDIATION

One of the most efficient strategies in cleaning the oil polluted environment

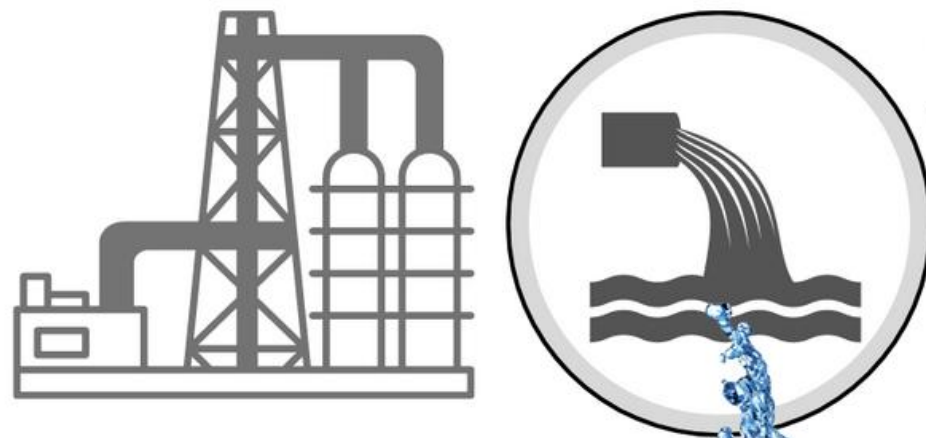
Relies on microorganisms and their system of enzymes as natural capacity of the Earth or self-cleaning by decomposing and removing harmful substances





BIOREMEDIATION

Crude oil is one of the main sources of energy in the World but it is also a widespread pollutant.



Bioremediation relies on the naturally-occurring microorganisms and their ability to metabolize and remove harmful substances.

The multidisciplinary approach of bioremediation techniques is important element which can help in integrated approach to achieving goals set by Agenda 2030 in cluster Planet.





- BIOREMEDIATION TECHNOLOGIES**
- MONITORED NATURAL ATTENUATION
- BIOVENTING
- AIR-SPARGING
- BIOSTIMULATION
- BIOAUGMENTATION
- LAND FRAMING
- COMPOSTING
- BIOPILES
- BIOREACTORS

SDG1: NO POVERTY
SDG2: ZERO HUNGER
SDG3: GOOD HEALTH AND WELL-BEING
SDG4: QUALITY EDUCATION
SDG5: GENDER EQUALITY

SDG6: CLEAN WATER AND SANITATION
SDG12: RESPONSIBLE PRODUCTION AND CONSUMPTION
SDG13: CLIMATE ACTION
SDG14: LIFE BELOW WATER
SDG15: LIFE ON LAND

GOAL 17: PARTNERSHIPS FOR THE GOALS



SDG7: AFFORDABLE AND CLEAN ENERGY
SDG 8: DECENT WORK AND ECONOMIC GROWTH
SDG9: INDUSTRY, INNOVATION AND INFRASTRUCTURE
SDG10: REDUCED INEQUALITIES
SDG11: SUSTAINABLE CITIES AND COMMUNITIES

SDG 16: PEACE, JUSTICE AND STRONG INSTITUTIONS





Life on land

Microbial populations play an important role in stabilization of soil ecosystem, they are key players in regulation of the nitrogen, phosphorus and sulphur levels in soil, as well as in decomposition of decaying organic matter

Bioremediation technologies, whether they are conducted *ex situ* or *in situ*, can be applied in land heavily contaminated with petroleum and derivatives, mud pit and heavy residual oil contamination.





Life below water

Marine microorganisms have a potential for biodegradation and they also have the potential to clean up the water. Their natural, innate abilities are used in bioremediation techniques to purify marine waters and to return the equilibrium of the ecosystems where they live.

Pseudomonas sp., Bacillus sp., Rhodococcus sp.





Climate action in order to combat climate changes

In recent years, one of the cheap, modern and promising solutions to decreasing GHGs emission into the Earth's atmosphere is the employment of certain bioremediation

The huge variety of the metabolic pathways employed by microorganism can be used for assimilation of methane, fixation of nitrogen, and in that way for bioremediation of pollutants





Ensuring sustainable consumption and production patterns

One of major researches in plastic decomposition is microbial degradation. Bioremediation of toxic plastic waste is a promising ecological strategy since it represents more sustainable process comparing with physical degradation and chemical degradation of plastics

Rhodococcus ruber

Aspergillus sp, Pseudomonas sp. Penicillium sp.





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Microbial bioremediation of the oil polluted environment and the sustainable development goals of pillar Planet of the Agenda 2030



Environment, Development and Sustainability
<https://doi.org/10.1007/s10668-024-04848-3>

REVIEW



Microbial bioremediation of the oil polluted environment and the sustainable development goals of pillar Planet of the Agenda 2030

Jelena Milić¹ · Jelena Avdalović¹ · Tatjana Šolević Knudsen¹

<https://link.springer.com/article/10.1007/s10668-024-04848-3>



A pair of hands is shown from a top-down perspective, cupping a small, healthy green succulent plant. The plant has thick, rounded, overlapping leaves and is growing out of a small amount of dark, rich soil. The hands are positioned symmetrically on either side of the plant, with the fingers slightly curled to support it. The background is a dark, textured surface, possibly a piece of fabric or paper, which makes the hands and the plant stand out. The overall image conveys a sense of care, protection, and environmental stewardship.

**The bottom line: Green chemistry in
action - bioremediation harnesses
nature's self-cleaning ability**

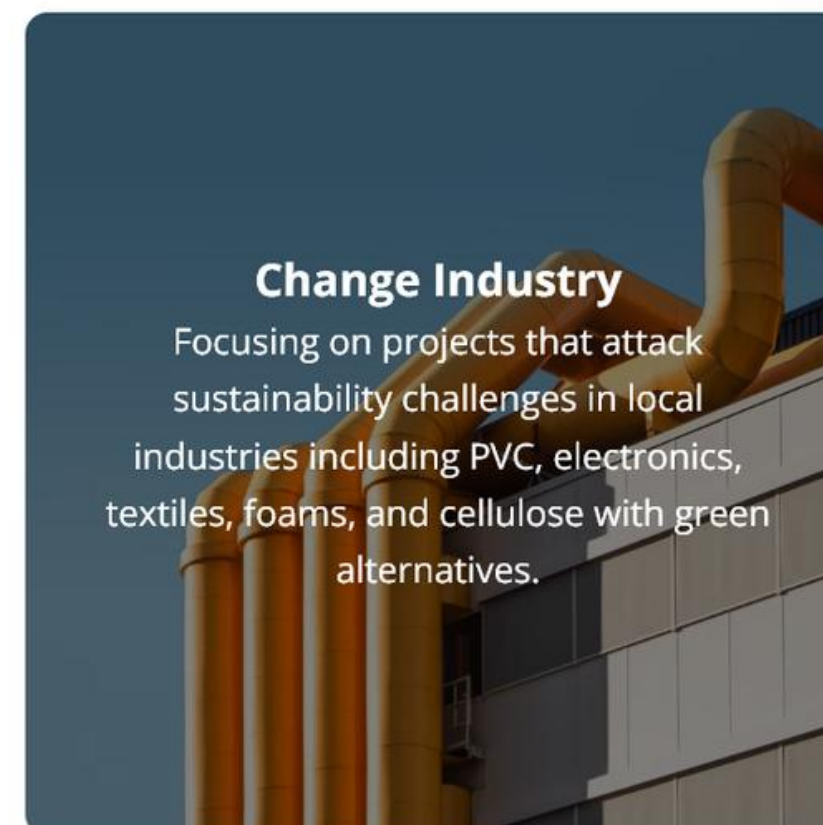
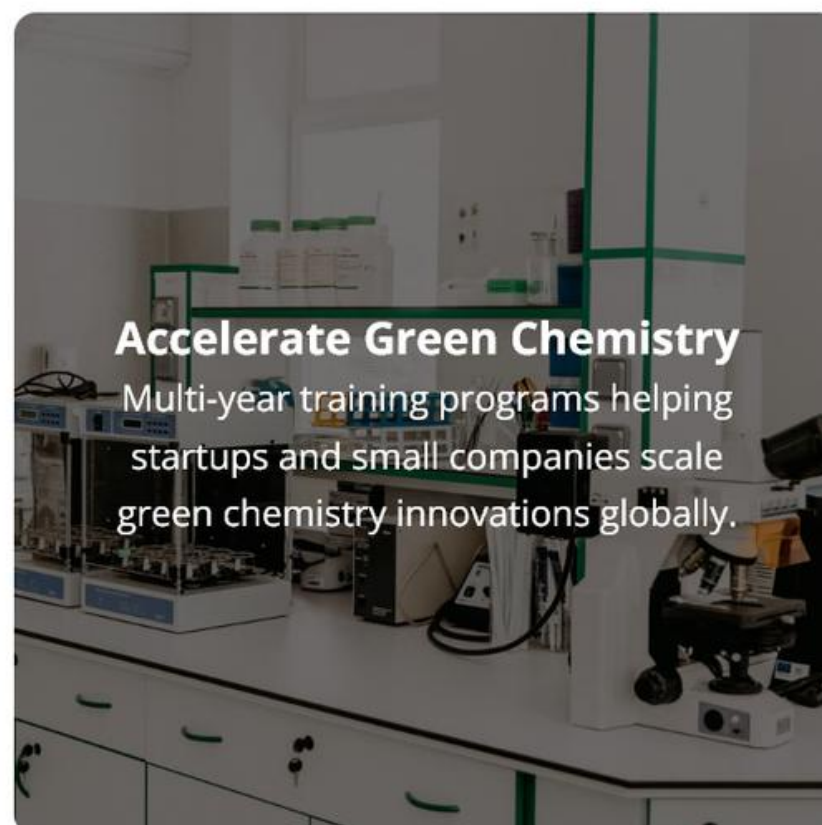
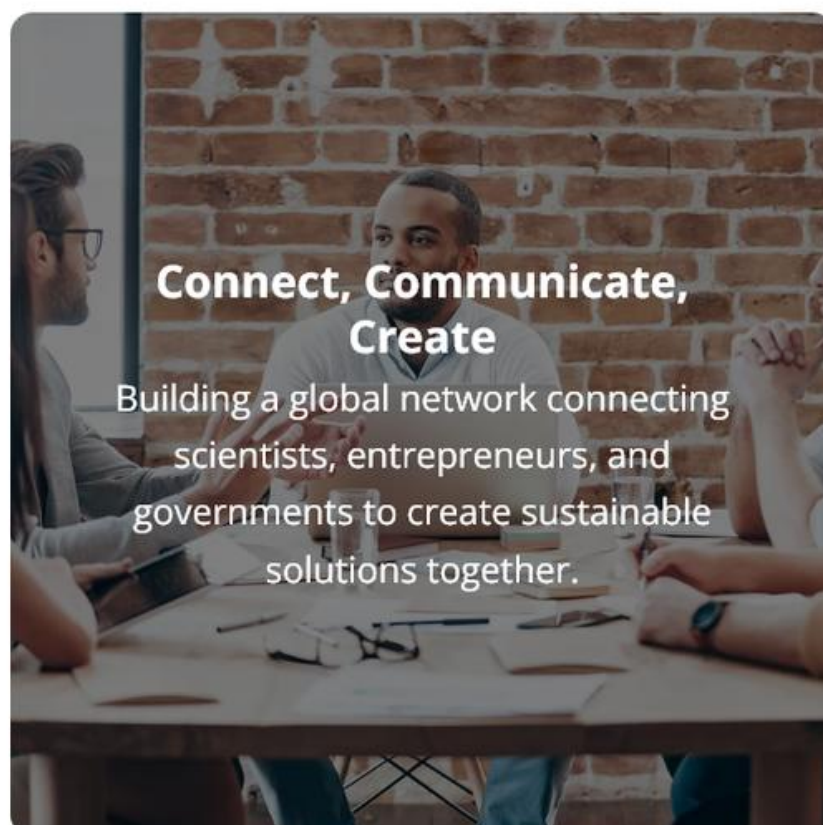


Global Greenchem Innovation & Network Program



Our Three-Component Program

Ambitious goals that are crucial for us, our environment, and our future through connecting the global green chemistry community





Global Greenchem Innovation & Network Program



LAST CALL

**PRIJAVE ZA GREENUP
AKCELERATOR SU U
TOKU!**

OTVORENE DO 15. 07. 2025.

Global Greenchem
Innovation & Network Program

ZELENI HAKATON 2024
S R B I J A

OTVOREN POZIV

Centra za čistiju proizvodnju Tehnološko-metalurškog fakulteta Univerziteta u Beogradu za **dvonedeljni Hakaton**.

IZAZOVI HAKATONA
Dva istraživačka izazova postavljena od strane kompanija:

- **Esensa** - Kreirati predlog zamene etanola kao alternativnog rastvarača propolisa za dečju proizvodnu kolekciju;
- **Wienerberger** - Predložiti rešenje za zamenu gipsa za kalupe u proizvodnji keramike, radi veće otpornosti i dugotrajnosti.

CILJ HAKATONA
Razviti inovativna rešenja u skladu sa izazovima koja će doprineti pozitivnom uticaju na životnu sredinu i zdravlje ljudi, kroz promovisanje principa zelene hemije.

NAGRADA za najbolje rešenje: **BRUTO 1.500,00 EUR**

23. novembar online

HAKATON DEMO DAN
7. decembar, Tehnološko-metalurški fakultet

KO SE MOŽE PRIJAVITI?
Tim istraživača, studenata, startapi, mikro i mala preduzeća.

Prijava putem linka ili QR koda:
<https://forms.gle/aYmfarLyIKmesB3z5>

Više informacija: <https://cpc-serbia.org> | greenchemistry@cpc-serbia.org | greenchem.accelerator@gmail.com



**GREEN CHEMISTRY
FOR SUSTAINABILITY**



A global community of researchers, leaders, and visionaries designing a sustainable future through green chemistry and engineering.

<https://chemistryforsustainability.org>







**Global Greenchem
Innovation & Network Program**

**THANK YOU
HVALA**

**We need Chemistry, but Green &
Sustainable**

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