



Environmental and Social Justice Considerations in a Circular Economy

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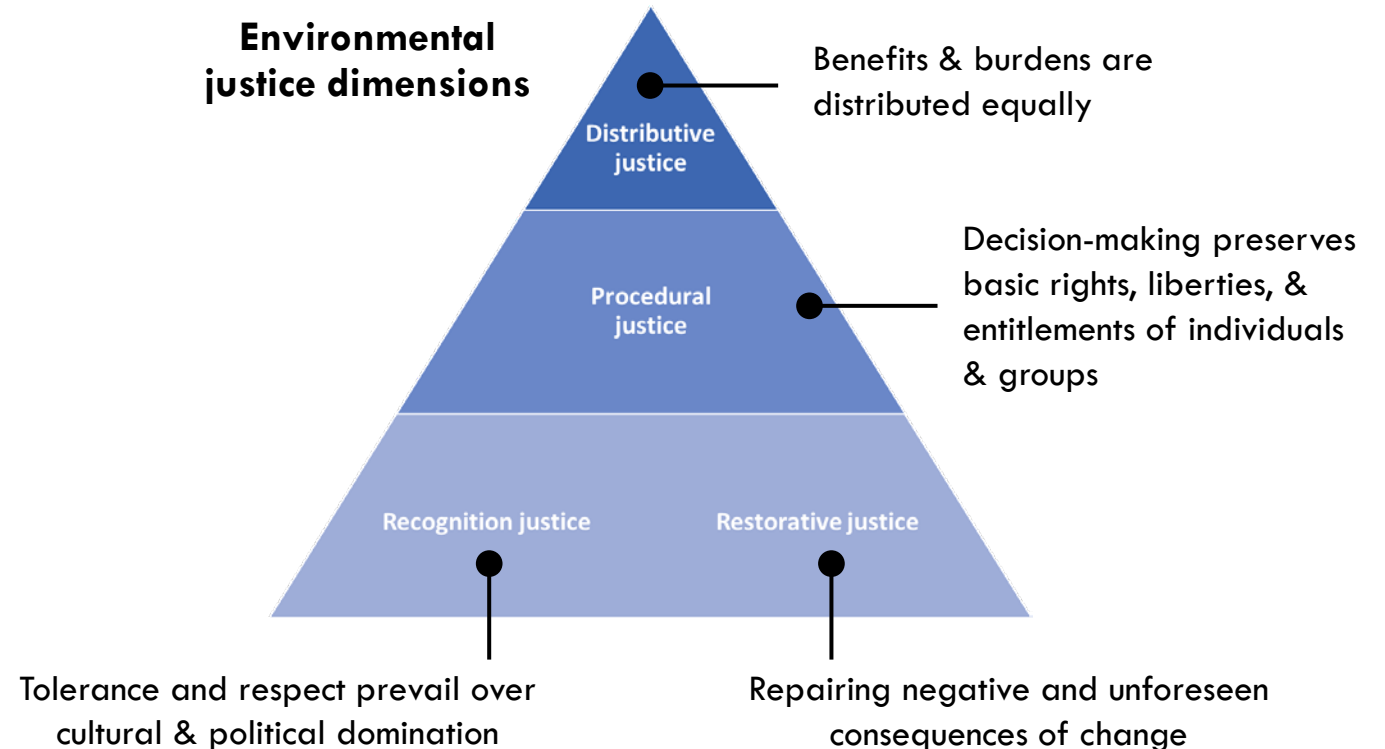
November 28th, 2023

What are EJ and SJ?



Photo Credit: Unsplash Tim Mossholder

- **Environmental Justice (EJ)** = fair treatment and meaningful involvement of all people in the development, implementation, and enforcement of environmental laws, regulations, and policies.
- **Social Justice (SJ)** = fair and equitable division of resources, opportunities, and privileges in society.



Why EJ and SJ?

- EJ and SJ are a **basic human right** → allows everyone to have agency over decisions that impact their lives.
- Without EJ and SJ, technologies may:
 - Jeopardize people's lives and sustainability
 - Cause damage that must be mitigated or repaired
 - Face social acceptance issues

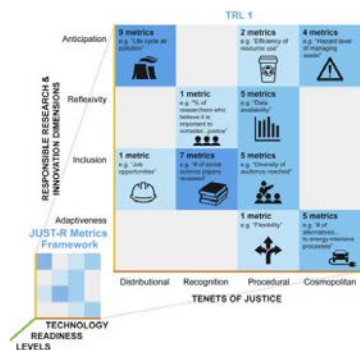


Protest against Louisiana's "Cancer Alley" where 150+ petrochemical facilities release toxic air emissions, disproportionately affecting minority and low-income communities.

<https://www.rollingstone.com/politics/politics-features/louisiana-cancer-alley-getting-more-toxic-905534/>

Existing indicators and frameworks

- Sustainability frameworks have **too many** social indicators:
 - Social Life Cycle Assessment (S-LCA) → 150+
 - Global Reporting Initiative (GRI) → 150+
 - Sustainable Development Goals (SDGs) → 200+
 - Many indicators are similar across frameworks.
- EJ tools require location so are only suitable for **deployed** technologies:
 - DOE's [EJ dashboard](#) / EPA's [EJScreen](#): 12 environmental indicators, 7 socioeconomic indicators
 - [CalEnviroScreen 4.0](#): 13 environmental indicators, 8 socioeconomic indicators

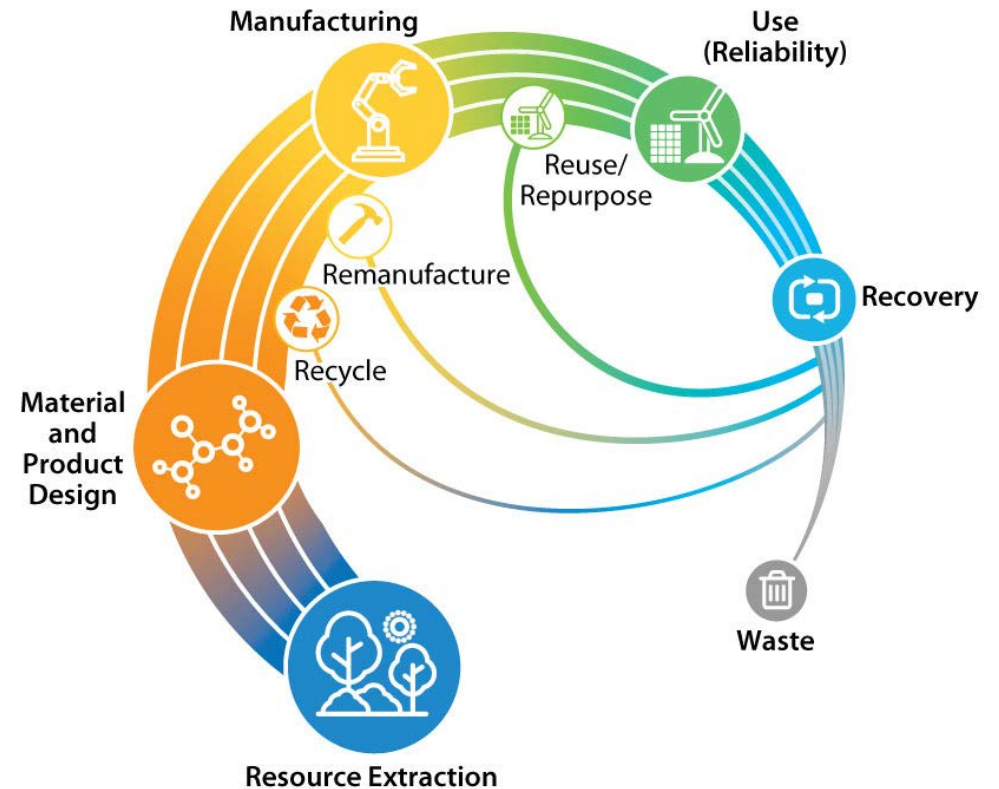


Stay tuned for Nikita Dutta's talk on the JUST-R framework for energy justice!

Modelling for Sustainable Development Goals (SDGs), <https://op.europa.eu/en/publication-detail/-/publication/d87691a0-433c-11eb-b27b-01aa75ed71a1/language-en>

Why consider EJ and SJ in a circular economy?

- **Circular economy** = a system where materials never become waste
- Waste management suffers from low wages, poor working conditions, air and water emissions to predominantly disadvantaged communities, and more.
- **Our objectives:**
 - Develop a simple analysis framework to include EJ and SJ for early to mid technology readiness level (TRL) innovations in the circular economy space
 - Pilot this framework with a plastic recycling case study
 - Guide technological choices towards **more just and equitable outcomes**



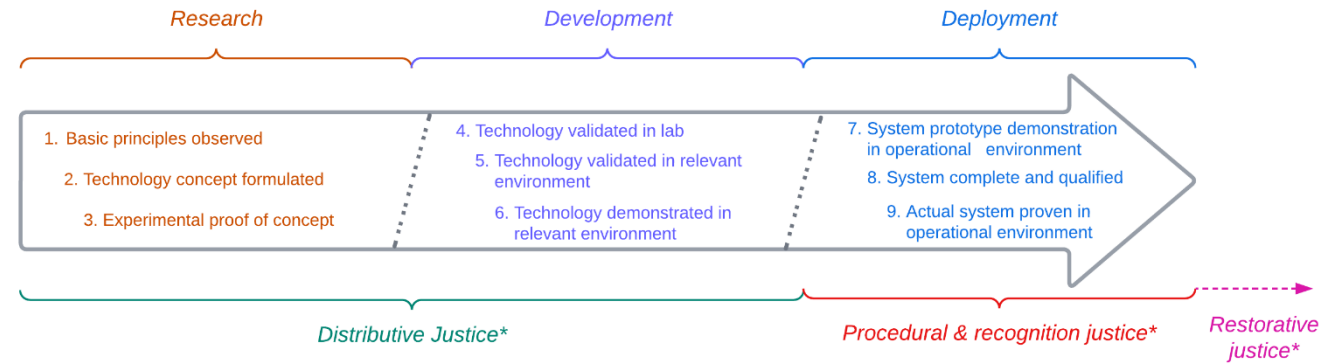
<https://www.nrel.gov/research/circular-economy.html>

Framework overview

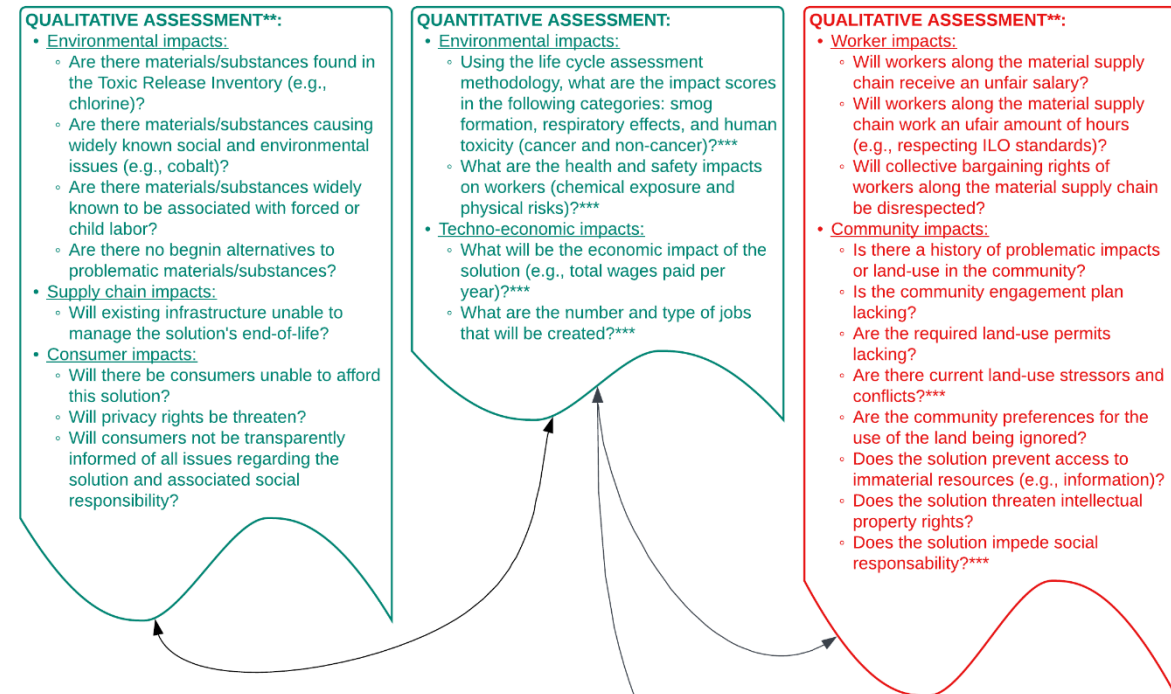
- The framework uses questions to establish the EJ/SJ profile of a technology.
- Low TRL (1-3):
 - Qualitative
 - “First pass” on the main materials within the product/technology
- Mid TRL (4-6):
 - Techno-economic analysis (TEA) and LCA to inform quantitative EJ/SJ indicators
 - “Second pass” assessment that includes all materials
- High TRL (7-9):
 - Localized impacts
 - Communities involved in the development process



Technology Readiness Level



Environmental Justice Considerations



*Environmental justice dimensions:

- Distributive justice: ensures that a solution benefits and burdens are distributed equally.
 - Procedural justice: fairness of institutional processes through which decisions are made.
 - Recognition justice: ensures legitimacy and respect so that individuals & groups can take part and adequately represent their interests.
 - Restorative justice: repairing negative and unforeseen consequences of a solution.
- **Qualitative assessments should be answered by YES, NO or UNKNOWN. A “yes” or “unknown” answer to a qualitative assessment question should prompt further investigation.

***Those questions may require additional expertise (e.g., a life cycle assessment analyst or a social scientist).

QUANTITATIVE ASSESSMENT:

- Community impacts:
 - What is the budget for community relations?
 - What are the community demographics?
 - How does the solution affect local access to material resources (e.g., regional water depletion can be assessed with AWARE)?***

Early-TRL methodology

Recommended for lab-scale researchers to facilitate social-conscious technology development, and for LCA practitioners to help put their work into an EJ/SJ context.

1. Draw a simple process flow diagram
2. Qualitatively answer questions with freely-available resources
3. Consider how to avoid or minimize potential problem(s)
4. Iterate

1. Does your process use materials or substances that are found in the Toxics Release Inventory (TRI)?

Procedure: Search (Ctrl + f) your chemicals in the EPA TRI database. In some cases, you may need to use a proxy for your material (e.g., lead rather than lead iodide).

https://www.epa.gov/system/files/documents/2022-03/ry-2021-tri-chemical-list-03-07-2022_0.pdf



If your answer is No, continue to Question 2.

If your answer is Yes, list the chemical(s):

Could the above chemical(s) be replaced with non-TRI alternative(s)?

If your answer is Yes, list the alternative(s), conduct the same TRI search procedure, and include the results here:

If your answer is No, why must the chemical(s) be involved?

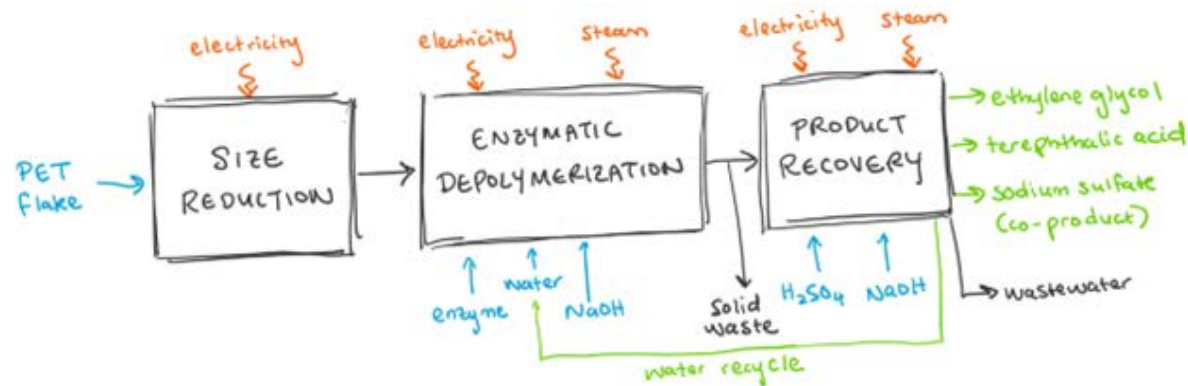
What are some management strategies for preventing the release of the chemical(s)?

Reflection Space: How will you take the above results into consideration when designing your process?










Why are we asking this question? When your process is upscaled, the use of hazardous chemicals will directly affect the safety of workers at your facility. If these chemicals are not managed properly and escape the facility, they will impact the health of local communities and environments. It is also important to plan for proper safety and regulation as they will increase the cost of your process.

Case study: Enzymatic recycling of PET into TPA

- Enzymatic recycling uses an enzyme, mild temperatures (60°C), and neutral pH (8) to break down polyethylene terephthalate (PET) bottles into the monomers terephthalic acid (TPA) and ethylene glycol.
- Classified as a mid-TRL (in scale-up) “chemical recycling” technology.
- Full TEA and LCA available.



Early-TRL results & impact

Question	Why ask this?	Method	Response
 Use of substances with widely known environmental or social issues?	 Health and Environment Widely known social or environmental issues serve as a “sanity check”	 <i>Google search</i>	NO
 Use of substances associated with child labor?	 Jobs and Worker Rights 160 million children are engaged in child labor worldwide ¹	 <i>Bureau of International Labor Affairs database²</i>	NO
 Product manageable in existing end-of-life infrastructure?	 Health and Environment Reduce landfill and incinerator burdens on local disadvantaged communities	 <i>EPA Wastes & Recycling³</i>	N/A

[1] International Labor Organization, *Child Labour: Global estimates 2020, trends and the road forward*, https://www.ilo.org/wcmsp5/groups/public/---ed_norm/---ipec/documents/publication/wcms_797515.pdf.
 [2] <https://www.dol.gov/agencies/ilab/reports/child-labor/list-of-goods-print>;
 [3] <https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling>;

Early-TRL results & impact

Question



Use or formation of hazardous chemicals?



Generation of hazardous waste streams?



Health and Environment

Hazardous material emissions impact the local environment



Jobs and Worker Rights

Hazardous materials affect the safety of workers

Method

*Toxic Release Inventory (TRI)*¹

*Code of Federal Regulations,*² *TRI*¹

Response

YES, sulfuric acid and ethylene glycol

YES, ethylene glycol emissions to wastewater

Action

- Capture more ethylene glycol, which is a co-product
- Explore TPA separation strategies that don't require acidifying the solution

Insight

- Point to new “hotspots” not identified as problematic in LCA/TEA!

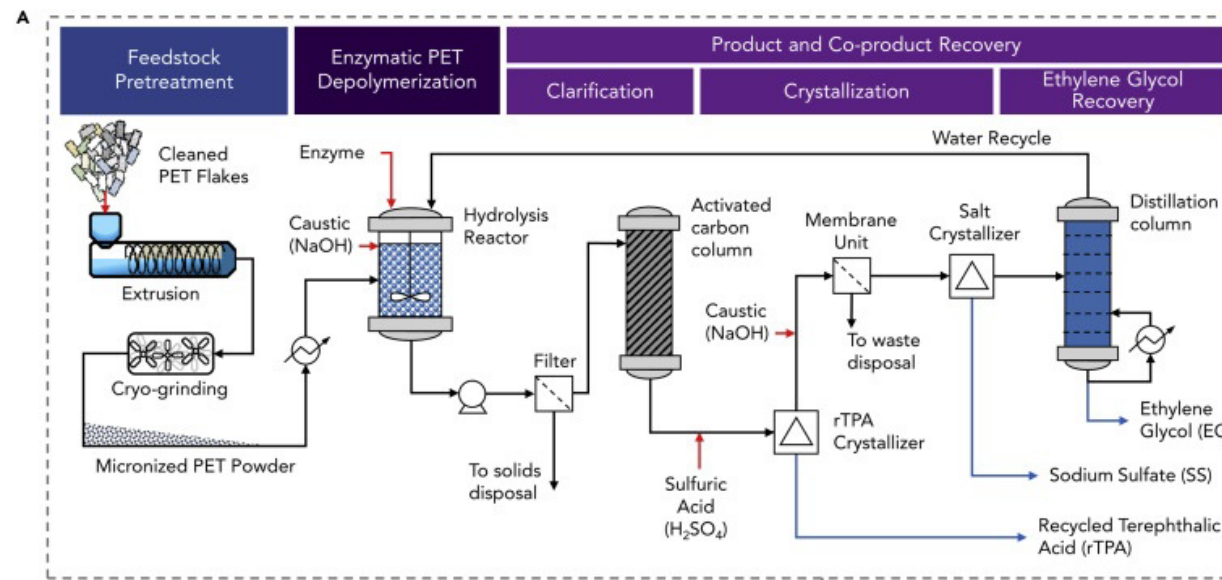
[1] <https://www.epa.gov/toxics-release-inventory-tri-program/tri-listed-chemicals>;

[2] <https://www.ecfr.gov/current/title-40/chapter-I/subchapter-I/part-261/subpart-D>;

Mid-TRL methodology

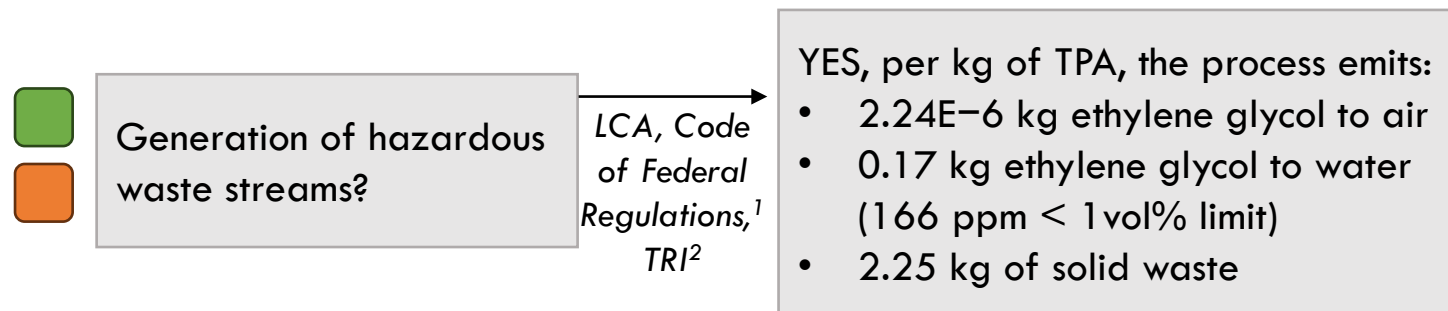
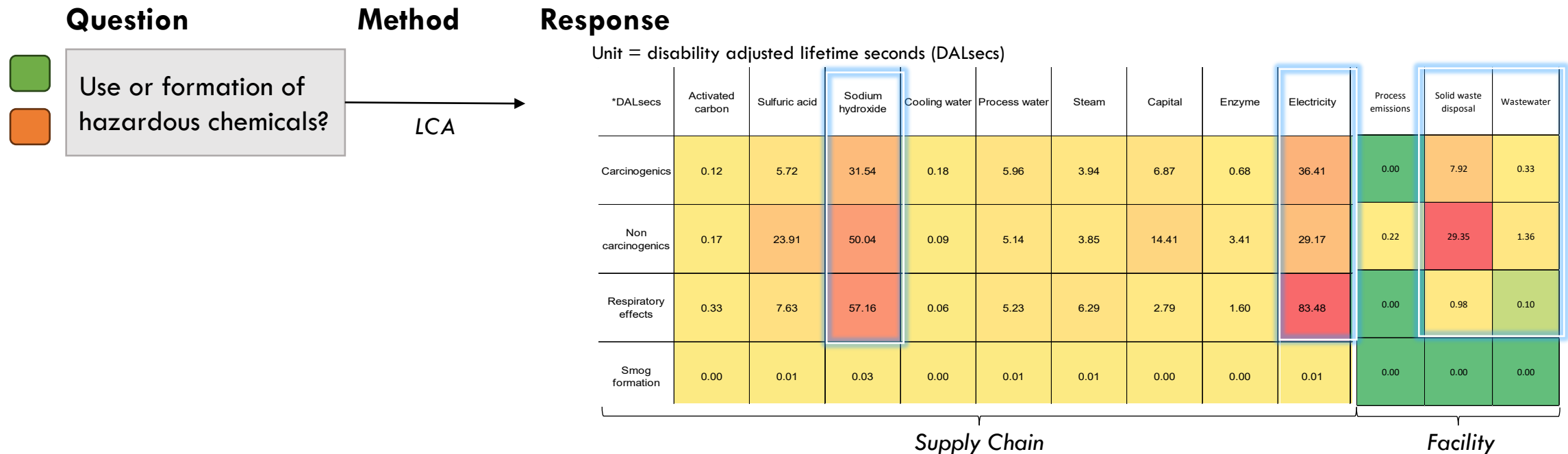
Recommended for lab-scale researchers in collaboration with TEA/LCA practitioners to strengthen social-conscious technology development, and for TEA/LCA practitioners to help put their work into an EJ/SJ context.

1. Conduct a TEA/LCA
2. Revisit early-TRL questions and answer new mid-TRL questions quantitatively
3. Consider how to avoid or minimize potential problems
4. Iterate



Mid-TRL results & impact

Revisiting the early-TRL questions and answering quantitatively:



Action

- Consider methods to reduce sodium hydroxide and electricity use to lower impacts on communities near those plants
- Improve yields to lower waste production and implement suitable controls

[1] <https://www.ecfr.gov/current/title-40/chapter-I/subchapter-I/part-261/subpart-D>; [2] <https://www.epa.gov/toxics-release-inventory-tri-program/tri-listed-chemicals>.

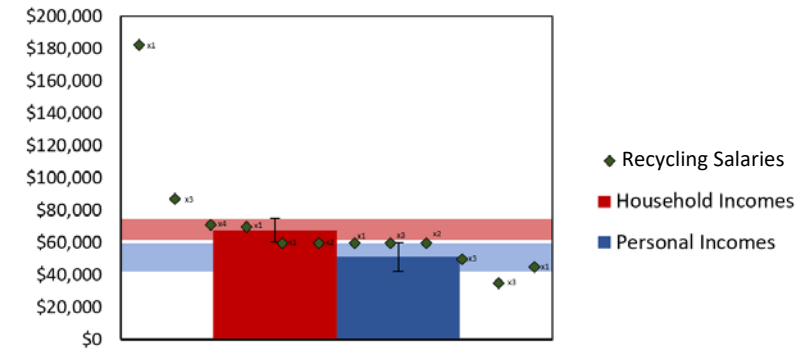
Mid-TRL results & impact

Quantitatively answering new mid-TRL questions:

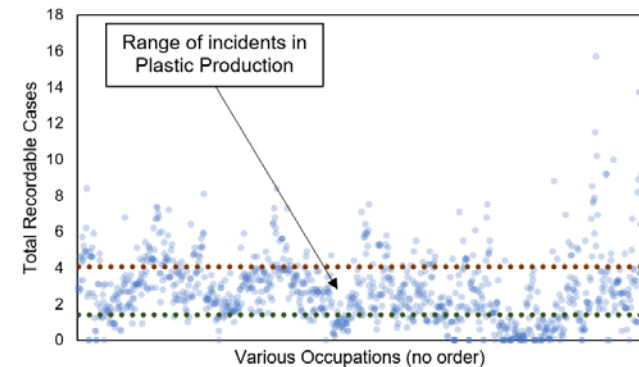
Question	Method	Response
Will consumers be able to afford the solution?	TEA	Recycled TPA is 2x more expensive than virgin TPA
What are the number, type, and salary of jobs that will be created?	TEA, Bureau of Labor Statistics ¹	25 jobs; salaries fall within or above U.S. personal and household income averages
What are the health and safety impacts for workers?	Department of Labor ²	Accident rates in plastic production fall within average of all job types

Action

- Leverage TEA to identify opportunities to reduce costs so that recycled plastic can be accessible to more communities



Random Scatter of Incidence Rates from BLS, US Dep. of Labor



[1] <https://www.bls.gov/iif/nonfatal-injuries-and-illnesses-tables/table-1-injury-and-illness-rates-by-industry-2021-national.htm>;

[2] <https://data.bls.gov/cgi-bin/srgate>.

Try it yourself!

We have developed a guiding framework for evaluating EJ/SJ in early to mid-TRL technology development.

- Try out our worksheet for exploring EJ/SJ in early-TRL technologies
- Please provide comments and feedback on the questions or the process to help us refine it and make it more usable and useful! Contact us at taylor.uekert@nrel.gov



EJ/SJ Worksheet



<https://docs.google.com/document/d/1dAmjPVXX2szegX0utHzbOpE6o5YY8k8e/edit?usp=sharing&oid=104157144537897841442&rtpof=true&sd=true>

Thank you!

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