Future Scenario Modeling to Evaluate the Environmental Impacts of a New Technology

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Abstract: Estimating environmental impacts of a system at an early design stage provides insights into the overall impact of a new technology and offers the greatest opportunities for improvement. Unfortunately, products at an early stage of development lack sufficient data to perform a traditional life cycle assessment (LCA). There has been significant research on the diffusion of innovations to understand potential market penetration of a new technology, adopter characteristics, and displacement effects. Diffusion of innovation concepts are useful when constructing scenarios for consequential LCA and understanding how different policy or design choices may affect overall technology adoption and market penetration. The consequential approach is often necessary for emerging systems since a new technology displacing a technology with poor environmental performance has different effects on the system than if it displaces an environmentally beneficial technology. This work uses Bayesian statistical methods to estimate parameter distributions for future scenario creation. With similarities to agent-based modeling, the method uses adoption probabilities to simulate technology adoption over time, and the resulting environmental impact of different adoption scenarios. This method is applied to a bioenergy case study, showing how switchgrass may have fundamentally different life cycle results depending on who chooses to adopt switchgrass and where it is grown.