

System-of-Systems Interfacing Issues: the role of Life Cycle Assessment

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Biomass sourcing for the Yakama

- **Goals**

- forest restoration, employment, income, etc.

- **Barriers**

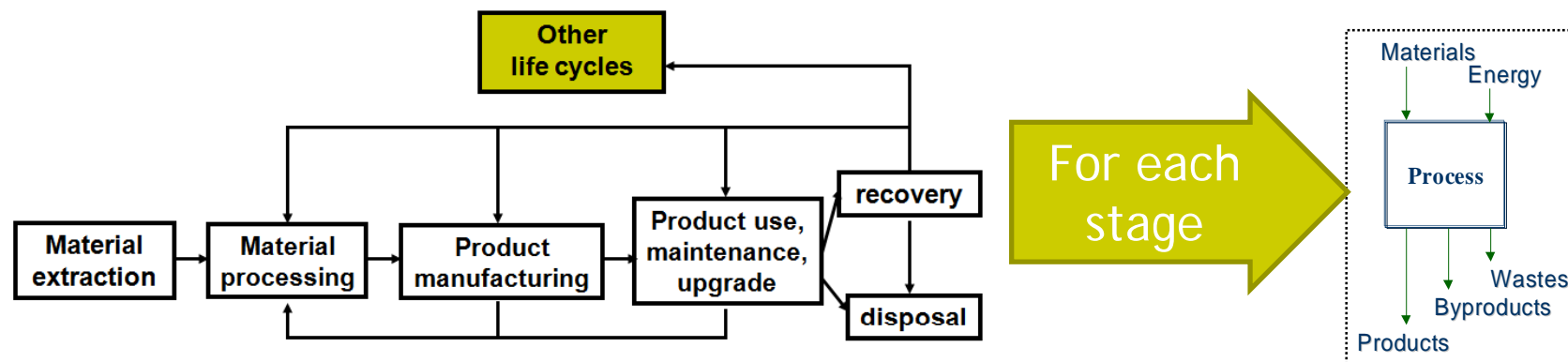
- friction interfacing between economic, environmental, political, and social systems

- **Life Cycle Assessment (LCA) provides a protocol to identify opportunities to meet goals and overcome barriers**



What is LCA?

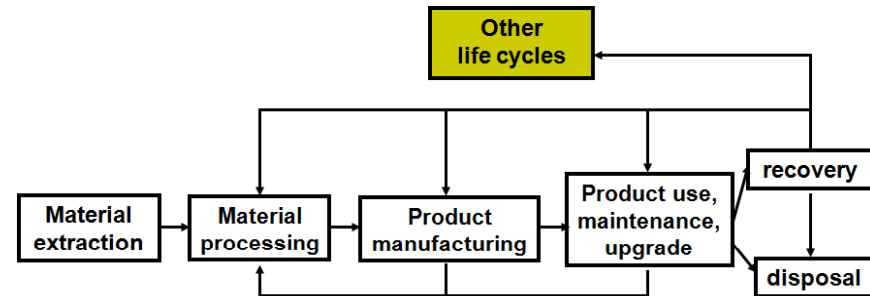
- Life Cycle Assessment (LCA) is a protocol, standardized by the ISO, for quantifying the impacts of industrial systems



- Although developed with a focus on quantifying environmental impacts, the protocol is well suited to provide insights into life cycle economic and societal impacts

Advancements in LCA

- protocol standardization
- changes in inventory and impact assessment data availability
- the dissemination of well-defined computational methods and advanced software tools
- integration of market information in system identification and analysis
- integration of LCA in R&D
- interdisciplinary efforts

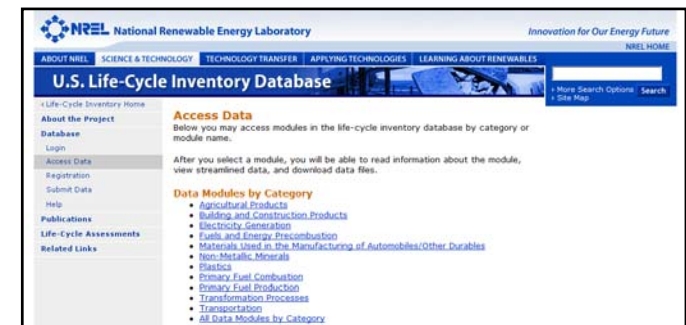


As demonstrated by the UW
Bioresource-Based-Energy IGERT

Changes in inventory and impact assessment data availability

- Early databases were privately, expensive, and had substantial publication restrictions
 - This causes two problems:
 - 1st: method transparency and study results could not be verified
 - 2nd: lack of data was a barrier to entry for new LCA practitioners

Today, data are much more publicly available and reviewed, leaving us with a focus on **ensuring the data are of good quality & applicable to the decisions at hand**



A list of national database projects can be found at <http://faculty.washington.edu/cooperjs/Research/database%20projects.htm>

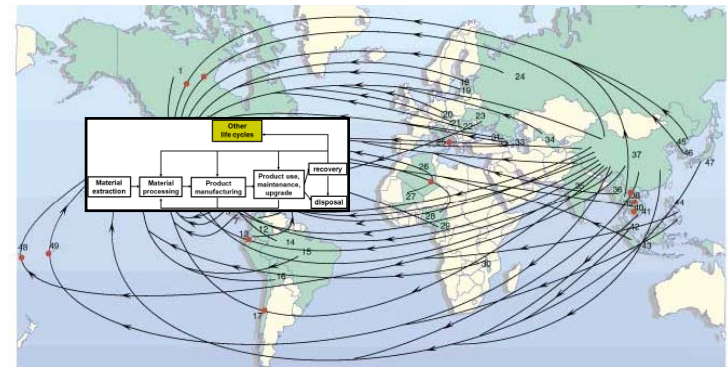
Dissemination of well-defined computational methods and advanced software tools

- **Computational methods**

- Process-based LCA
- Economic Input-Output LCA (EIO/LCA)

- **Advanced software tools**

- For the assessment of any system
 - EIO/LCA (on-line) and process-based tools such as SimaPro and GaBi
- System specific tools
 - **BEES**[®] for buildings and soon for **bioproducts** (NIST/USDA)
 - **REET** (DOE-Argonne) for fuels and vehicles



Questions and sub-questions LCA allows one to answer

- **Question:** How might the expanded use of conventional biomass-to-energy technologies impact the environment, economy, and society?
- **Sub-question:** What are the life cycle impacts of dissemination?



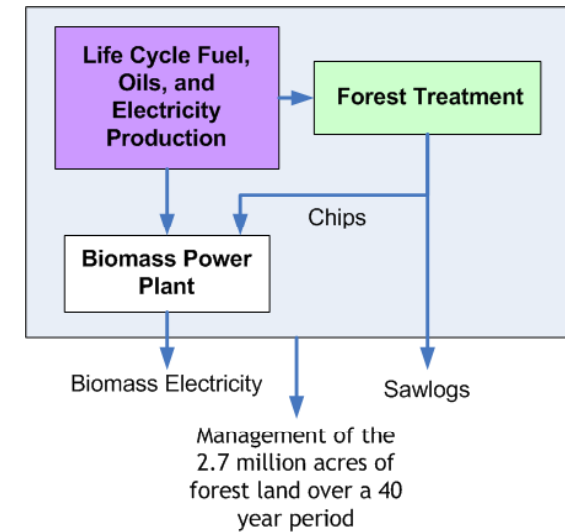
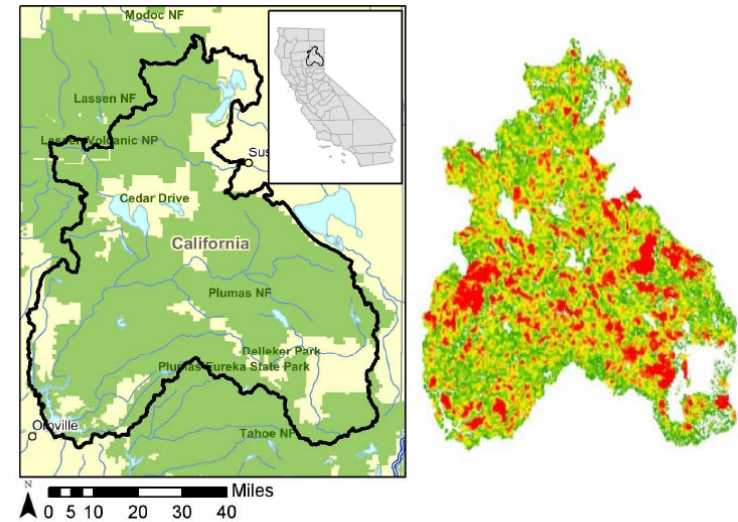
- Consider for example **forest residuals to electricity in California**



- **Contribution to climate change**, acidification, smog, criteria pollutants, eutrophication, toxic impacts,...
- Energy-return-on-energy-invested (EROEI)
- Changes in resource/commodity use (including land and water) at regional and international levels
- Job creation & elimination by type & location
- **Income**

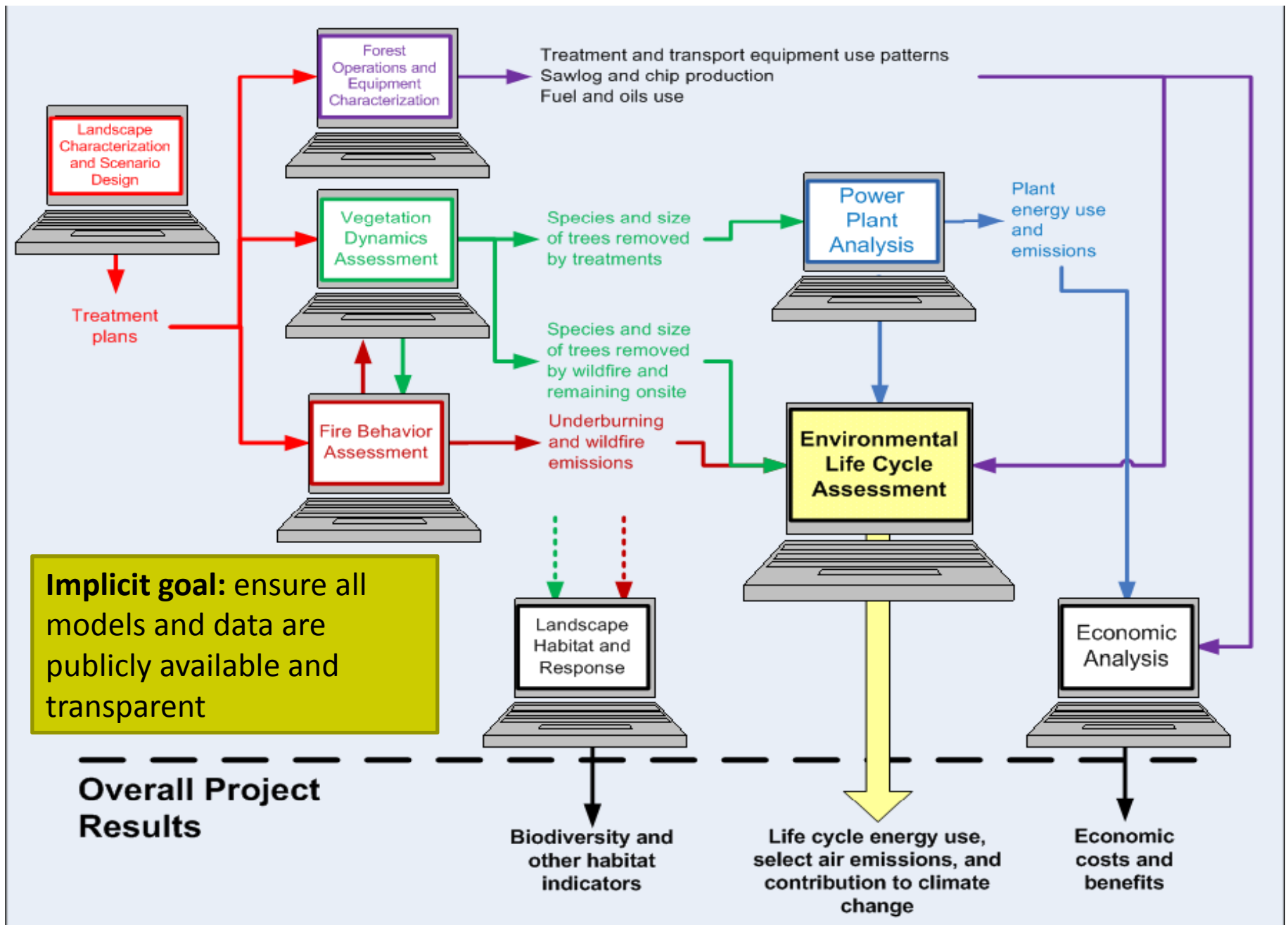
Producing Electricity from California Forest Wildfire Fuels Treatments

- Project goal
 - To construct a set of interconnected forest management and response and industrial process models to identify and analyze social, economic, and environmental costs and benefits of **using biomass removed during forest wildfire treatment to generate electrical power for specific sites throughout California.**



Funded by the California Energy Commission's PIER program, over 65 cooperators from over a dozen institutions participated

Project Models



Project outcomes: the Test Scenario (thinning, transporting, and converting biomass into electrical power) yielded the following results when compared to the no-treatment case:

- **Economic Assessment**

- \$1.58 billion in power revenues
- \$246 million savings in avoided wildfire damage to assets
- \$18 million savings in avoided fire suppression costs
- A significant economic gap between the cost of biomass fuel at \$68 per bone-dry ton and the 2006 financial analysis of greenfield power plant development (under which maximum fuel costs would have to be less than \$8.20 per bone-dry ton in order to build the project)

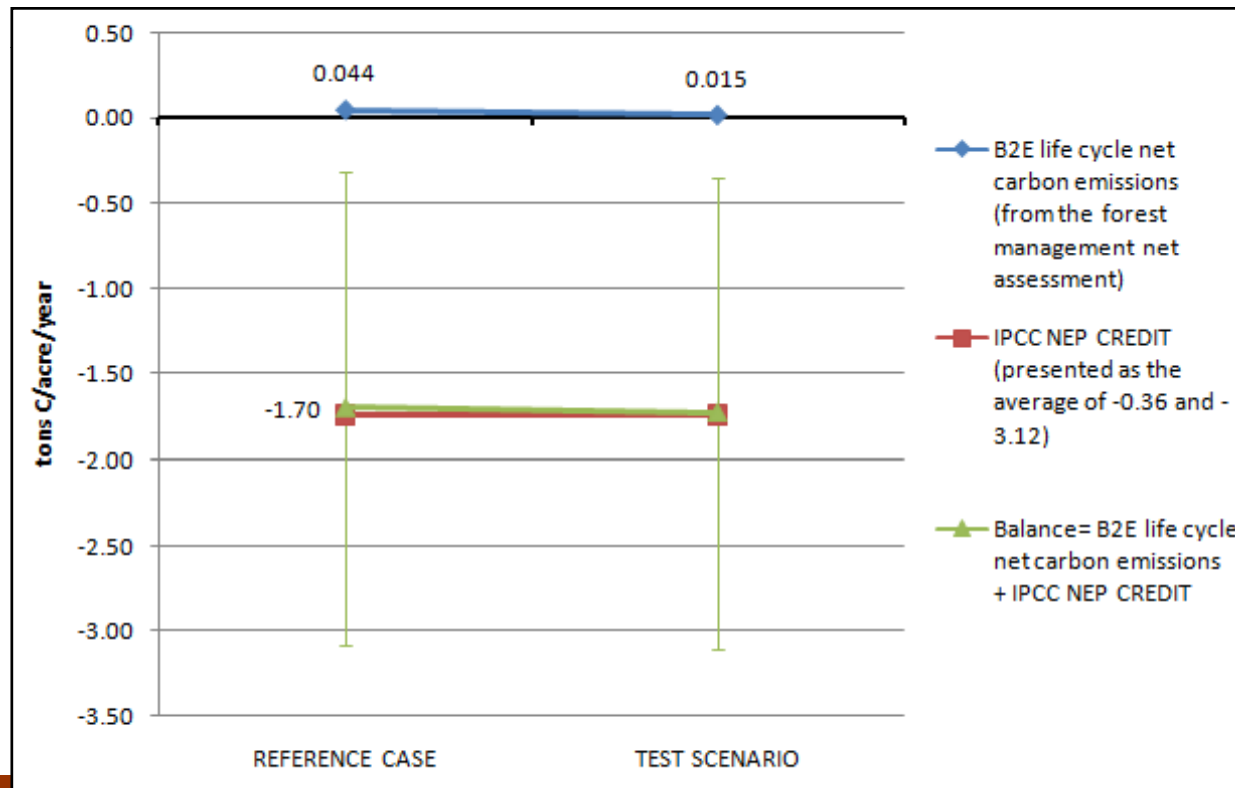
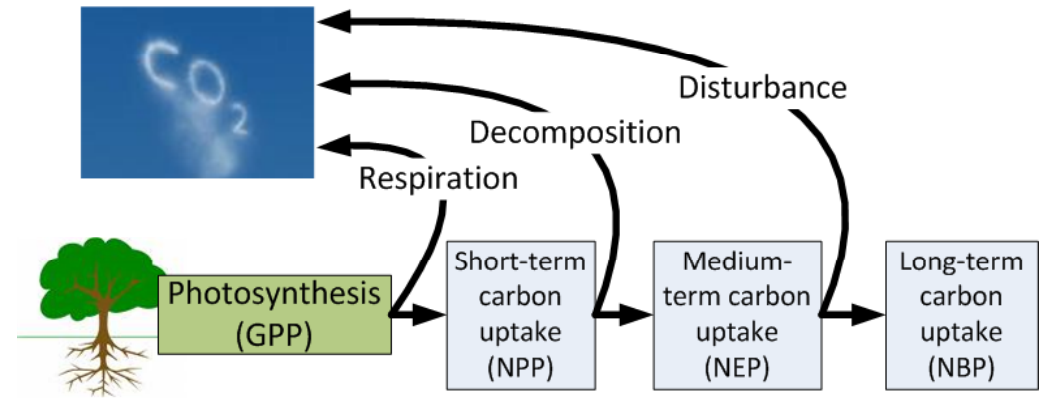


- **Environmental Assessment**

- A 22% reduction in the number of acres burned by wildfires
- A substantial reduction in the fossil fuel consumed
- Negligible impacts on habitat suitability and minimal cumulative watershed effects
- **A 65% net reduction in life cycle greenhouse gas emissions**



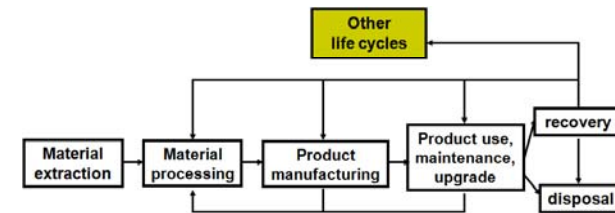
A 65% net reduction
in life cycle GHG
emissions?



The Status of LCA

Advancements: -2009

- protocol standardization
- changes in inventory and impact assessment data availability
- the dissemination of well-defined computational methods, advanced software tools (general & sector-focused)
- integration of market information in system identification and analysis
- integration of LCA in R&D
- interdisciplinary efforts



Issues: 2009+

- **Management of co-products**
 - Bioenergy, jobs, and income are co-products of Yakima forest management
- **Climate change**
 - The role of landuse change
 - US Energy Independence and Security Act of 2007
- **A push towards easy-to-use LCA tools**
 - Does this really make sense?