

Reference - Research Project List

The following section outlines a number of possible research projects within the STEPS program. Refer to the figure on the first page for an overview of what the Threads and Tracks represent. This list is not meant to capture all of the projects to be accomplished in the program. It represents possible projects that have been identified by the research leaders for each category.

Cross-Comparison “Threads”

Thread 1: Markets and Behavior (Ken Kurani)

Scope: Provide meaningful insights into differing (across fuel pathways) and changing (over time) citizen/consumer response to different ways of fueling mobility

Project ideas:

- Multiple year, large-sample tracking study
 - Literature review, survey design, administration, analysis, reporting
 - Adjunct goal to identify participants for small sample studies
 - For example, people who shopped for HEV but did not buy
 - Household interviews, focus groups, demos and trials,...
- Fuel economy: What do people know, what do they do?
 - Literature review, survey design, administration, analysis, reporting
 - How does citizen/consumer response affect the other threads and relative effectiveness of the four pathways?
- The meaning of green
 - Does the meaning of green differ across the pathways, and will that change?
 - Can the meaning of “green” be captured in the market, for each fuel pathway?

Thread 2: Infrastructure Modeling (Chris Yang, Yueyue Fan, Joan Ogden)

Scope: Develop detailed understanding (models) of production facilities and infrastructure at different scales for

- Biofuels, electricity, hydrogen, conventional and unconventional liquid fuels
- Include assessment of key inputs: water, energy resources, electricity, land

Project ideas:

- Fuel and electricity interaction: To study alternative fuel infrastructure electricity demands, as well as opportunities for co/poly generation of fuels and electricity.
 - Grid dispatch model (in multiple regions) to analyze marginal generation utilized for electricity demands associated with various alternative fuel options
 - Optimal charging profiles for EVs (cost vs emissions) as a function of existing grid composition
 - Co-production analysis of conventional and unconventional liquid fuels, biofuels, hydrogen and electricity
- (Close interaction with Thread 3)

Thread 3: Energy, Environment, & Cost Analysis (Mark Delucchi)

Scope:

Project ideas:

- AVCEM modeling
 - Add PHEVs (collaborate with A.Burke and Thread 5)
 - Revise models of battery cost and performance (collaboration with A.Burke)

- Finish updating treatment of FCVs and AFVs (1 student with good energy and engineering modeling skills, 3 mos @ 50%)
- Finish revision and updates of estimates for social costs (1 student with advanced training in env econ & C/B analysis, 3 mos @ 50%)
- Perform cross-comparisons with AVCEM (1-3 students, 2 years, multiple cases)
- LEM modeling
 - Add HEVs and PHEVs to LEM
 - Revise & expand treatment of unconventional oil (incorporate J.Wang's research)
 - Improve treatment of biofuel LCAs (collaboration with J.Six & post-doc from Plant Sciences Dept)
 - Add new biofuel lifecycles (1 student with biofuels background, 6 mos @ 50%)
 - Add price effect relationships (one post-doc or adv econ student 6 mos @ 50%)
 - Perform cross comparisons (1-3 grad students, 2 years, multiple cases)
- Social Cost Calculator (SCC)
 - Update and expand estimates of external costs, for use in AVCEM (1 adv econ student, 6 mos @ 50%)
 - Perform cross comparisons (multiple cases, 1 year)

Thread 4: Policy & Business Strategy (Chris Knittel)

Scope: To study public policies that effectively encourages a transition to a more sustainable energy pathway. And to study how business strategies will have to adapt under particular transition paths

Project Ideas:

- What “market failures” exist, or may exist, under each “track” that would inhibit us from adopting this technology even if it were the most efficient?
 - Examples of market failures: market power, negative externalities, indirect network effects, information asymmetries
- How does current consumer and firm behavior inform us about potential market failures in other tracks?
- How will the industrial structure vary across the different tracks?
 - Will firms be more or less vertically integrated?
 - Which types of firms are poised to dominate?
- How should existing firms expect to adapt to transitions to each track?

Thread 5: Vehicle Design (Andy Burke)

Scope: Develop models of the driveline components and simulate advanced vehicle operation on appropriate driving cycles. Assess the effect of fuel requirements and availability on advanced vehicle development, including alternative biofuels and hydrogen.

Project ideas:

- Study differences in advanced vehicle performance, utility, and cost from various fuels
- Compare technical and cost tradeoffs between battery electric vehicles (BEVs) vs. Hydrogen fuel cell vehicles (FCVs)
- Compare hydrogen FCVs vs. combustion engine hybrid electric vehicles (HEVs) using fuels from fossil and bio-mass sources
- Study impacts of advanced vehicle design on fuel infrastructure req's from various fuels
- Study differences in the development timelines for advanced vehicles from various fuels
- (Interaction with AVCEM model in Thread 3)

Thread 6: Case Studies and Scenarios (Marc Melaina)

Scope: “Scenario planning is not about predicting the future. It is about exploring the future. If you are aware of what could happen, you are more likely to be able to deal with what will happen.” (BREFI Group Website)

Project Ideas:

- Develop region-specific case studies
 - California, Midwest, U.S., China, Norway, etc.
- Develop optimization and full cost accounting scenarios
 - Facility location, system resilience, life cycle impacts/costs
- Consider competition and interaction scenarios
 - Market dynamics, dominance & lock-in, innovation, strategy
- Create decision-support scenarios
 - Investment options, policy evaluation, technology choices
- Create dynamic “evolution” or “planning” scenarios
 - Changes over time, uncertainty, contingency

Interdisciplinary “Tracks”

Track 1: Hydrogen (Joan Ogden, Chris Yang, Marc Melaina)

Project Ideas:

- How does H2 interact with the rest of the system: merchant H2 & refinery, electricity, natural gas infrastructure
- Policy and Business strategy
 - How are decisions made during a transition to an H2 infrastructure? Consumer behavior, energy companies, auto companies, competition among firms, policy
- Case studies and scenarios:
 - How does the timing of H2 infrastructure growth interact with other fuel systems?
 - What are interactions (synergies/competition) between H2 and other fuel/vehicle pathways? How do fuel/vehicle pathways compare?
 - What are the potential impacts on H2 implementation if large advances occur in hydrogen storage and/or FCVs?
 - What are the best transition paths toward low cost, zero carbon regional hydrogen systems

Track 2: Biofuels (Bryan Jenkins, Rob Williams)

Project Ideas:

- Bio-refinery systems modeling (integration, efficiency, input/outputs, \$),
- Regional system analysis: feedstock supply, transport, refinery location, fuel distribution
- Energy and environmental impacts:
 - Land-use and resource evaluations
 - Fuel blend performance and impacts on air quality (emission factors)
 - Sustainable crop and soil growth, carbon and nitrogen cycles
- Policy and business strategy:
 - E85 station entry – implications for alternative fuel policy and firm strategy
 - E10 blend national policy – implications for California’s environment & economy

Track 3: Electricity (Tom Turrentine)

Project Ideas:

- Develop predictions of when consumers will charge their vehicles (time of day), study how varying times affect power production emissions, grid capacity, etc

- What is the consumer's willingness to pay for a plug-in hybrid electric vehicle (PHEV)? What vehicle attributes are necessary for the consumer to choose a PHEV?
- Are there robust markets for vehicle-to-grid interactions? Will this be important to initiate a market for PHEVs?
- What public policies are important to encourage the development of low-carbon electricity if transportation electricity becomes a noticeable part of the market?

Track 4: Fossil Fuels (Cynthia Lin)

Project Ideas:

- Policy and Business strategy
 - Strategic behavior in petroleum production (1-2 grad students, 2-3 years)
 - Investment decisions of energy companies: R&D, renewable energy (2-3 grad students, 3-4 years)
 - What is the optimal rate of R&D in fossil fuels vs. alternative? What incentives are needed? (1-2 grad students, 1-2 years)
 - Energy and how it affects economic growth (2-4 grad students, 3-5 years)
 - Petroleum production case studies: CA reserves, ANWR, etc