**Rail Energy Efficiency**

There is an urgent need to improve the sustainability of how freight is moved. Technology choices for reducing the energy requirements of moving railcars are being advanced by many disparate commercial actors and policymakers. Progress on these developments can only be accomplished effectively through large-scale collaboration. It is time to transform how we collectively evaluate and commit resources to major new technology options.

**Core Question:**

**How can technology developers, railroads, investors, and policymakers make the wisest energy-efficiency decisions so that North American railroads contribute to lowering the emissions and resource requirements of freight movement? This includes a 50% reduction in overall carbon emissions by 2030.**

**General Questions**

1. What does ‘sustainable’ mean in the context of rail motive power?
2. What dynamics have to be considered when using multiple motive technologies across the system?
3. Are they compatible technologies, and can they be sensibly integrated?
4. What funding resources are currently available for each motive power choice?
5. What funding resources might be made available for each motive power choice?
6. What public incentives are currently available for the uptake of new power choices?
7. What public incentives might be made available for the uptake of new power choices?
8. What other governmental resources can be deployed to support new motive power choices?
9. How do railroad motive power choices need to be considered in relation to the various fuel pathways being evaluated within other transportation modes?
10. How might the United States National Labs support the evaluation and uptake of new motive power choices?
11. Is there internal railroad resistance to a move away from established (diesel) traction?

**Biodiesel**

1. What are the potential biodiesel feedstocks and production methods that would significantly increase the percentage of fuel blends within Class I railroads?
2. What has been the performance experience of the previous use of biodiesel for rail motive power?
3. What are the production challenges of supplying biodiesel fuel to the rail industry?
4. What are the logistical challenges of supplying biodiesel fuel to the rail industry?
5. What performance evidence do railroad mechanical personnel need to utilize biodiesel at higher percentage blends, especially in cold climates?
6. What grants and subsidies are available for railroad use of biodiesel?
7. What success measures are proposed?

**Internal Combustion with Compressed Natural Gas**

1. Given the costs of locomotive conversion, fuel tender acquisition, required infrastructure, revenue car space loss, and a limited carbon benefit, is it financially prudent to transition to natural gas power? What prior (limited) industry experience can be cited?
2. How much gas leakage during transportation, storage, and fueling is acceptable? What rules and regulations govern the use of this fuel?
3. What has been the prior experience of railroads using compressed natural gas?
4. What federal subsidies (CMAQ, etc.) are available to pay for conversion costs?
5. How does this compare with other fueling options in terms of energy efficiency and related capex/life costs/
6. How can infrastructure costs (e.g. – condensing and fueling stations at intermodal transload facilities) be shared with other entities?

**Fuel Cell**

1. Are fuel cells an overly complex technology for locomotives?
2. What is the environmental impact of hydrogen derived from natural gas?
3. How can hydrogen infrastructure developed for other freight modes be useful to rail?
4. Who can build new fuel cell locomotives?
5. What are the real capabilities of fuel cells in heavy long-haul applications?

**Steam**

1. Where does steam locomotive power fit in modern railroading?
2. How does a potential modern steam locomotive differ from historic models?

**Electrification – General Questions**

1. What is the per gallon price of diesel that would make electrification an obvious economic choice? Is this the key metric or only part of a more complex analysis?
2. How can the AAR’s Transportation Technology Center, Inc. facilitate the exploration, selection, and certification of technologies and manufacturers?
3. What can we learn from the history of rail electrification?
4. What can we learn from rail electrification in other countries?
5. How do the operating costs (besides fuel) compare with diesel locomotives?
6. How much faster are electric locomotives, and what difference does that make in track capacity?
7. How much lifecycle emissions reduction is gained from the use of electric locomotives?
8. How many fewer all-electric locos can be used compared to the same train using diesel-electric power?
9. How much cheaper is electricity as a motive fuel?
10. What effect will electrification have on ECP brake implementation?

**Locomotives**

1. How can locomotives be designed to take advantage of regenerative braking, vibration harvesting, and other waste energy capture methods?
2. What models of locomotives are candidates for conversion? Is this the most cost-effective option or an incremental approach?
3. What companies can perform the conversions?
4. What battery technologies are best attuned to railroad use on-board and trackside?

**Power Delivery**

1. How can power suitable for locomotives be drawn from very high voltage transmission lines?
2. What are each power delivery method’s costs and construction implications, i.e., overhead wire, third rail, induction from buried cable, etc.? Can a forensic and credible analysis demonstrate the variations, strengths, and weaknesses?
3. What is the experience with overhead catenary suffering pole and wire damage from shifted loads and/or damaged railcars? How can this risk be minimized?
4. How does the use of battery-powered locomotives impact the need for catenary? What are battery capabilities now and potentially in the future?
5. What are the lifecycle economics of using composite catenary poles versus steel poles?
6. What is the experience with catenary clearing double-stacked containers and other taller railcars?

**Electric Grid Synergy**

1. What are the needs of the electric industry for new transmission corridors?
2. What practical questions must be answered to evaluate the co-location of new transmission lines along rail rights-of-way? Are priorities compatible between rail and utilities?
3. How will rail electrification expand the market for the construction of new remote renewable power generation?
4. What is the value of grid-connected idle switching (and road) locomotives offering peak shaving, line conditioning, and backup electric power?
5. What potential benefits to trackside communities could be available from access to higher voltage?
6. What other elements could use grid electric power, such as reefer units and crossing signals?

**Implementation**

1. What differences, if any, from the international state-of-the-art catenary installation will North America require?
2. What portion of the North American rail network should be electrified?
3. How are target sections determined?
4. How should electrification be staged to secure maximum benefits?
5. How will electrification coexist with residual diesel-powered segments?
6. What companies can build the machines that build the catenary? Can the electrification process be “industrialized” to support rapid implementation?
7. How is the Benefit-Cost Analysis of the catenary and battery/hybrid balance determined?

**Financing**

1. How much of the power delivery infrastructure would electric transmission providers fund?
2. How can the remaining infrastructure costs be funded? Have capex and leasing models been considered?
3. How much and which electrification expenses should be borne by the government, and what are the implications of this?
4. What current Federal sources might be utilized for funding this conversion?
5. What new funding approaches can be established for new locomotives?
6. What new funding approaches can be established for construction?

**Hybrid and Pure Electric Vehicles and Maintenance Equipment**

1. How do hybrid or pure-electric drivetrains compare in TOC with ICE-only drivetrains? What is the evidence to support the findings?
2. What battery technology is or will be sufficient for providing power during a full work shift?

References: <https://www.etransenergy.com/>