Research Ideas: Transportation Fuel Infrastructure Vulnerability and Resiliency to Climate Change

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Sustainable Transportation Energy Pathways (STEPS)
Integrated Assessment Modeling =>
Elec. Drive, Low-C Fuels Play Major Role in 2° Scenario

**Figure 13.18**
Global portfolio of technologies for passenger LDVs

**Key point**
In the Improve case, electric, PHEV and FCEVs together account for nearly three-quarters of new vehicle sales in 2050.

Source: International Energy Agency Energy Technology Perspectives 2012
Infrastructure Implications of 2º scenario

TRANSPORTATION TAPS INTO EVOLVING ELECTRIC GRID (w/increasing % variable renewable power)
• EV charging, power-to-gas, power-to-liquids

NEW FUELS =>
• Adapt/use existing infrastructure, (Drop-in biofuels? Blend H2 w/ NG? Smart elec. grid)
• New dedicated infrastructures

NEW INFRASTRUCTURE FOR CARBON MANAGEMENT
• Carbon Capture (Chemical Process or Atmospheric)
• CCS (pipelines and storage)
Northern California Energy Infrastructure

- ADAPTATION TO IMPACTS OF CLIMATE CHANGE
- EVOLUTION TOWARD LOW CARBON ENERGY SUPPLY
CA Climate Change Projections

- Air and Water Temperature Rise
- Decreasing water availability
- Increasing intensity of storms, sea level rise, storm surge
- Increasing intensity and frequency of flooding
- More frequent and severe wildfires
- Changes in precipitation timing and decreasing snowpack

=> potential impacts on energy system

- Less efficient electric gen and T&D d.t. high temperature
- Wildfire damage
- Flood damage
- Storm damage
- Increased risk of physical damage and disruption to power and fuel facilities
- Disruption of rail and barge transport of crude oil, petroleum products
- Increased summer A/C and NG demand; less heat in winter

IMPACTS ARE GEOGRAPHICALLY SPECIFIC
• Conduct Regional Case Studies
  – Develop spatial/time scenarios for evolution of fuel supply system
  – Consider Adaptation + transition to clean energy
• Identify key vulnerabilities for energy infrastructure
• Optimize systems for resiliency
  – Operation of existing fuel systems
  – Buildout of new systems for low carbon fuel supply
• Capture risks, dynamics caused by evolving infrastructure and climate, and system interdependence.
<table>
<thead>
<tr>
<th><strong>ELEC. GEN.</strong></th>
<th><strong>CA Climate Projection</strong></th>
<th><strong>Potential Risk/Impact</strong></th>
</tr>
</thead>
</table>
| **Thermo-electric power plants (NG, coal, geothermal, CSP, nuclear)** | • Increasing air & water temp.  
• Decreasing water availability  
• Increasing intensity storms, sea level rise, storm surge  
• Increasing intensity and frequency of flooding | • Reduced plant efficiencies & available generation capacity  
• Increased risk of exceeding thermal discharge limits  
• Impacts on coal, NG, and nuclear fuel supply chains  
• Increased risk of physical damage & disruption to power facilities |
| **Hydropower** | • Increasing temps & evap. loss  
• Changes in precipitation timing and decreasing snowpack  
• Increasing intensity and frequency of flooding | • Reduction in available generation capacity & changes in operations  
• Increased risk of physical damage and changes in operation |
| **Solar** | • Increasing air temperatures  
• Decreasing water availability | • Reduction in potential peak generation capacity (PV and CSP) |
| **Wind** | • Variability of wind patterns | • Net impact generation uncertain |
| **ELEC. T&D** | • Increasing air temperatures  
• More frequent and severe wildfires  
• Increasing intensity of storms  
• Increasing intensity, frequency of flooding | • Reduction in transmission efficiency and available transmission capacity  
• Increased risk of physical damage  
• Substations subject to flooding |
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<td><strong>FUELS</strong></td>
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| Natural Gas fuel processing, storage, pipelines | • Decreasing water availability  
• Increasing intensity of storm events, sea level rise, and storm surge  
• Increasing intensity and frequency of flooding |
| Petroleum Production, Refineries, Transport | • Impacts on drilling and production  
• Increased risk of physical damage and disruption to coastal facilities  
• Increased risk of physical damage to inland facilities |
| Bio-refineries; Bioenergy | • Decreasing water availability  
• Increasing intensity of storm events, sea level rise, and storm surge  
• Reduction in river levels  
• Increasing intensity and frequency of flooding |
|                             | • Increased irrigation demand; risk of crop damage from extreme heat events  
• Increased biomass production  
• Decreased biomass production  
• Increased risk of crop damage |
# Climate change Implications

## ENERGY DEMAND

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<tr>
<th><strong>Electricity</strong></th>
<th>Increased demand for summer A/C; reduction of winter space heat demand; demand side management and/or storage to match supply and demand.</th>
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<td><strong>Natural Gas</strong></td>
<td>Reduction of winter space heat demand; more NG needed by power plants to compensate for lower efficiency at summer peak times.</td>
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<td><strong>Transportation Fuel</strong></td>
<td>Depends on mix of fuel/vehicle types in light and heavy duty sectors, aviation, freight. Low Carbon Futures require higher efficiency vehicles, lower carbon fuels: Electricity, H2; biofuels; RNG</td>
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