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ENERGY POLICY ACT OF 2005

SEC. 1820. Overall Employment in a Hydrogen Economy

Presented to the Hydrogen Technical Advisory Committee (HTAC)
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Requirements

"Effects of a Transition to a Hydrogen Economy on Employment in the United States," Section 1820(b) of the Energy Policy Act of 2005 EPACT, P.L. 109-58

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- Perform a study of the likely effects of a transition to a hydrogen economy on the overall employment in the United States.
  - The study should consider the following:
    - The replacement effects of new goods and services;
    - The impact on international competition;
    - The requirements of workforce training and education;
    - Multiple fuel cycles (production pathways), including usage of raw materials;
    - Rates of market penetration of technologies; and
    - Regional variations based on geography.
- Issue a report describing the findings, conclusions, and recommendations of the study.

Approach and Methodology

Four Contractors, Industry Advisory Panel, Nationally Recognized Models

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- **Solicitation was issued for the study.**
  - RCF was awarded the contract
    - Supporting contractors:
      - TIAX LLC
      - Argonne National Laboratory
      - Jack Faucett Associates
      - Project utilized an advisory board which included:
        - Dr. John Johnston, ExxonMobil (retired)
        - Dr. Alan Lloyd, International Council on Clean Transportation;
        - Dr. Walter McManus, University of Michigan Transportation Research Institute
        - Mr. Gregory Morris, HydroGen LLC
        - Dr. Robert Rose, U.S. Fuel Cell Council
    - Study conducted over 3 months, July-October 2006
- **Recognized models were used for the study.**
  - National employment impacts were estimated from the IMPLAN inter-industry model.
    - Open source model developed and commercialized by Minnesota IMPLAN Group, Inc. ("IMpact analysis for PLANning")
    - 1500 active domestic and international users
  - DOE H2A models, developed with industry, for hydrogen technology and cost evaluation of production and delivery
    - After tax internal rate of return: 10%
    - Depreciation method: MACRS

Assumptions

High and Low Penetration Scenarios, DOE Program Goals For Technical Assumptions

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- **Time frame: 2020 to 2050**
- **Employment measure: The difference between a non-hydrogen scenario and two scenarios for market penetration of mobile and stationary hydrogen fuel use.**
- **Scenarios of penetration examined:**
  - Aggressive penetration scenario as defined by the Hydrogen Fuel Initiative (HFI) which estimated 11 MBPD oil savings in 2040
    - Fuel cell vehicles constitute 96% of the light-duty stock by 2050; oil savings of ~13 million B/D
  - Less aggressive penetration scenario as defined by the 2006 report for Government Performance and Results Act (GPRA) which factored in competition from multiple vehicles and fuels:
    - Fuel cell vehicles constitute 38% of the light-duty stock by 2050; oil savings of ~6.6 million B/D
- **The program elements have met their critical-path technology targets.**
  - Hydrogen produced at $2.00-3.00/gge
  - Fuel cell system at $30/kW
  - Hydrogen storage (target: >300 mile range)
- **Feedstock and technology data used in the analysis was derived from the DOE H2A Production and Delivery models.**
- **Regions selected for study: Upper Midwest, Lower New England and Upper Mid-Atlantic, California, Tennessee and Houston/Galveston**
- **Stationary and portable fuel cells were assumed to be co-manufactured with automotive fuel cells.**

Employment Creation & Replacement at the National Level

675 Thousand Net New Jobs by 2050

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U.S. Cumulative Gains and Losses from Shifts of Employment				
Scenario		**2020**	**2035**	**2050**
Numbers of Workers				
Upper Case: Hydrogen Fuel Initiative	**Net Effect**	**182,840**	**677,070**	**674,500**
	Gains	252,040	754,030	751,060
	Losses	*69,200*	*76,960*	*76,560*
Lower Case: 2006 GPRA Analysis	**Net Effect**	**58,010**	**184,560**	**360,740**
	Gains	126,680	242,820	417,390
	Losses	*68,670*	*58,260*	*56,650*
Percentage Effects on Total Employment				
Upper Case: Hydrogen Fuel Initiative	**Net Effect**	**0.13%**	**0.42%**	**0.37%**
	Gains	0.17%	0.46%	0.41%
	Losses	*0.05%*	*0.05%*	*0.04%*
Lower Case: 2006 GPRA Analysis	**Net Effect**	**0.04%**	**0.11%**	**0.20%**
	Gains	0.09%	0.15%	0.23%
	Losses	*0.05%*	*0.04%*	*0.03%*

Regional Variations in Employment – Aggressive Scenario Example

Lower New England and Upper Mid-Atlantic Region Most Strongly Affected

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- **Upper Midwest**
  - Projected to increase its 2050 employment by 0.06% of the national employment change of 0.37%
  - Scientific and technical services employment grow to support
    - Technical needs of hydrogen production
    - Technological changes in the automotive industry
  - Fabricated metals industry loses employment
- **Lower New England and Upper Mid-Atlantic Region**
  - Projected to increase its 2050 employment by 0.08% of the national employment change
  - Gains are primarily in production and delivery of hydrogen
  - Losses are in the corporate offices of upstream energy companies
- **California**
  - Projected to increase its 2050 employment by 0.04% of the national employment change
  - High-tech sectors participate in the development of the new hydrogen technologies such as carbon and graphite manufacturing
- **Tennessee**
  - Projected to increase its 2050 employment by 0.01% of the national employment change
  - Employment gains in hydrogen production
  - No significant employment losses
- **Houston/Galveston**
  - Projected to increase its 2050 employment by 0.004% of the national employment change
  - Refining industry suffers in the hydrogen market expansion, compared to the all-gasoline scenario,
  - Experience in variety of energy industries helps them gain employment in
    - Hydrogen production
    - Design and production of energy and chemical pipeline equipment

Effects on International Competition

$370 Billion/Year Reduction in Oil Imports by 2050

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- With or without hydrogen fuel cell vehicles, the report assumes the market share for domestic/foreign automobile production will not change.
- While auto parts manufacturing will continue to shift overseas, little overall impact of a hydrogen transformation on the international location of auto parts manufacturing is predicted.
- Hydrogen will be produced domestically.
  - ❖ Since hydrogen delivery is limited to truck and pipeline, hydrogen will be not be an internationally traded commodity.
- Oil imports will fall as gasoline is replaced with hydrogen.

Case	Oil Savings in 2050	Estimated Import savings*
Upper Case: Hydrogen Fuel Initiative	11 M BPD	$370 billion/yr.
Lower Case: 2006 GPRA Analysis	6.6 M BPD	$230 billion/yr.

*Oil price in 2050: $117/bbl without hydrogen; $66/bbl with hydrogen (upper case); $92/bbl with hydrogen (lower case).

- Natural gas is not projected to be a significant long-term feedstock for hydrogen production.
  - ❖ Essentially no effect of an expansion of hydrogen markets on gas imports is projected to occur; instead feedstocks are likely to be primarily coal, biomass and renewable electricity.

Education, Training, and Re-Training

Many New Skills Can Be Supplied by Normal Rate of Entry to Labor Force

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- The need for new skills will be spread over a number of years, for the most part tending to grow in proportion to the increase in the number of hydrogen vehicles.
- The replacement of gasoline-related skills with hydrogen-related skills will be substantial.
  - ❖ Primary need is associated with automotive manufacturing and service sectors.
- Most of the needs for new skills can be supplied by normal rates of entry into the labor force as new workers receive training in hydrogen-related skills.

Study Recommendations

- Develop training programs to ensure the U.S. workforce possesses the appropriate skills.
- Develop training in the after-market areas of repair and recycling.
- Continue education of the public to influence people to pursue jobs in hydrogen and fuel cells.

Summary Finding

- The projected increase in U.S. employment due to hydrogen technology commercialization is 0.20 – 0.37% by 2050.