AN 035

Employment Impacts of Infrastructure Development for Hydrogen and Fuel Cell Technologies

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Argonne NATIONAL LABORATORY

Overview

Timeline

Start date: October 2012

End date: Project continuation and direction determined annually by DOE

Budget

FY13 DOE Funding: $150k

Planned FY14 DOE Funding: $200k

Total Project Value: $350k

Barriers

- Lack of Readily Available, Objective, and Technically Accurate Information (A)
- Regional Differences (E)
- Difficulty of Measuring Success (F)

Partners

- Argonne National Laboratory
- RCF Economic & Financial Consulting
- Stakeholder review, validation, testing

Relevance

Benefit estimation

- Analyze economic impact of hydrogen and fuel cell deployment
- Provide input for evaluating R&D and deployment targets

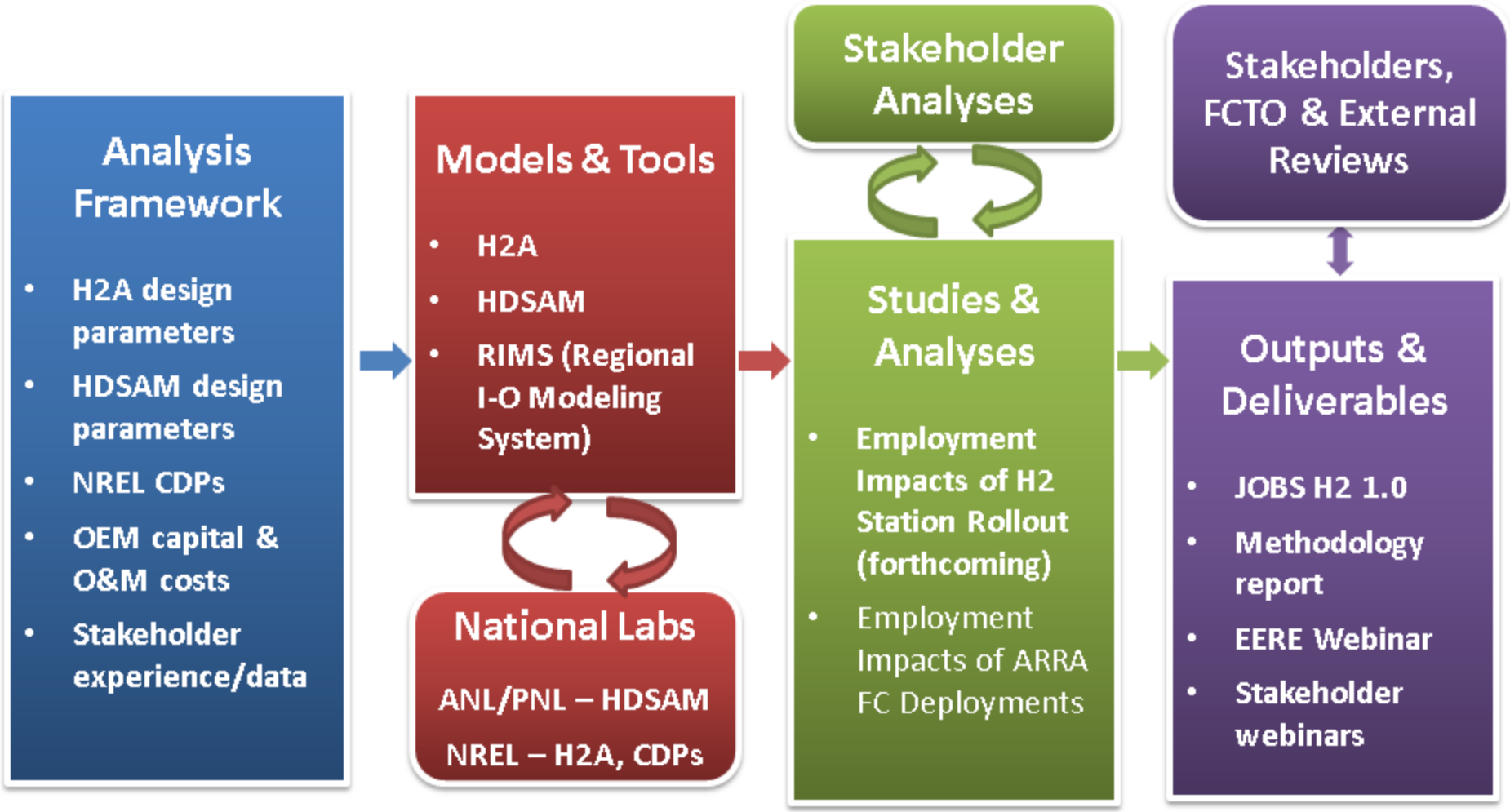
Platform development

- Develop consistent framework for evaluating economic impacts of hydrogen infrastructure deployment
- Compare alternative hydrogen station rollout scenarios

Stakeholder support

- Working with stakeholders to develop robust, user-friendly tools with appropriate functionality
- Provide web-based training and support to enable economic impact analyses of hydrogen infrastructure deployment

Employment Impacts of Infrastructure Development for Hydrogen and Fuel Cell Technologies

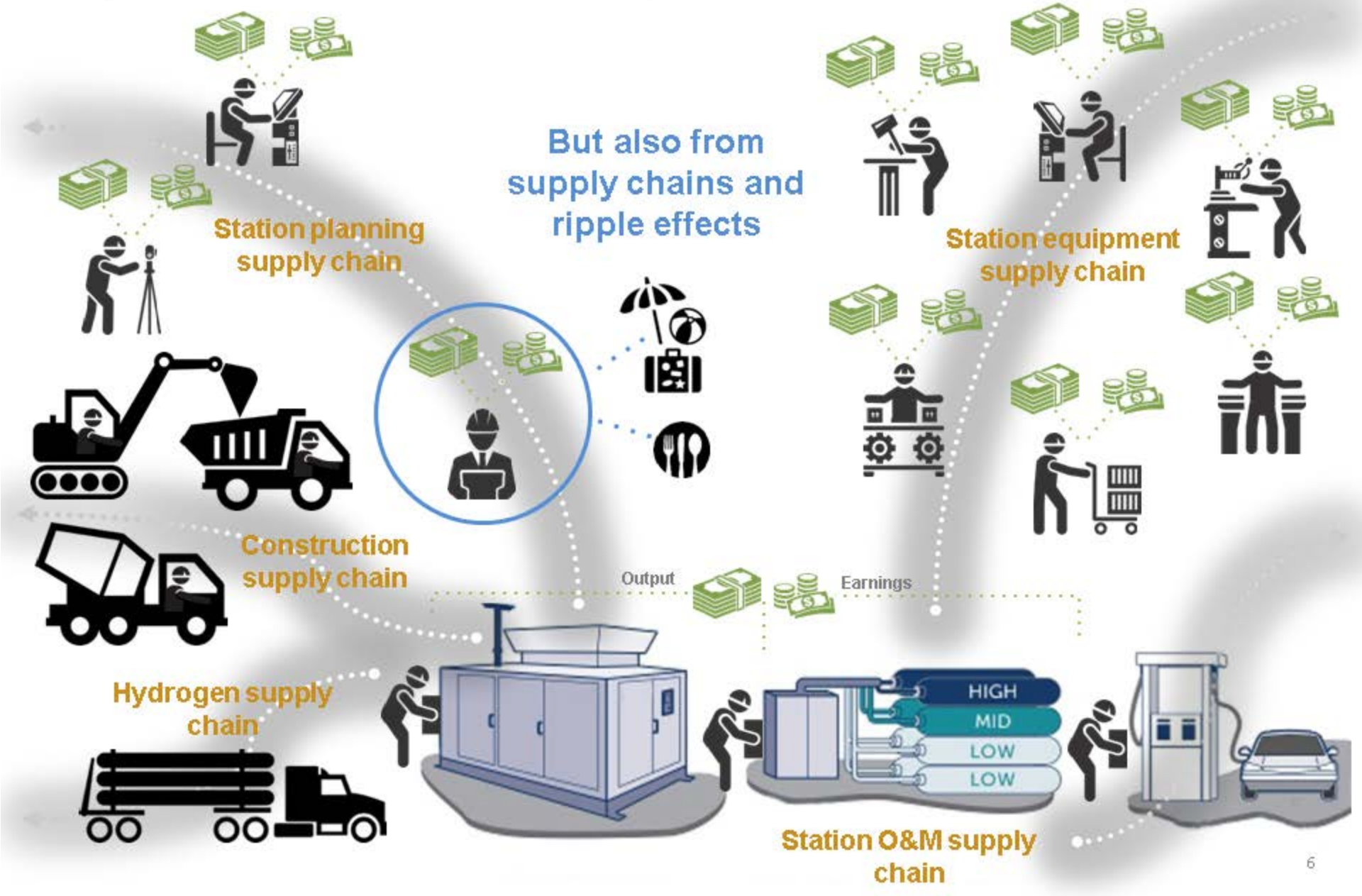


What is JOBS H2?

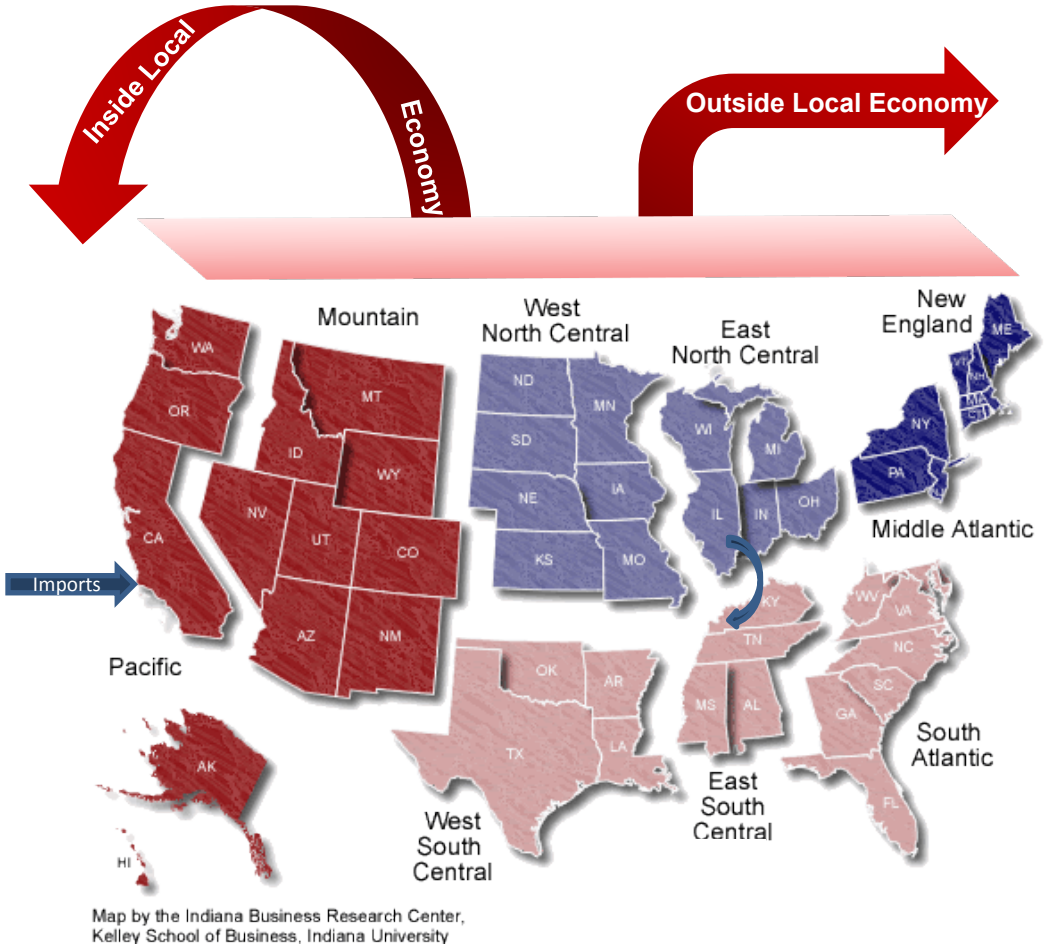
- JOBS and economic impacts of Hydrogen (JOBS H2) is a spreadsheet-based tool to estimate economic impact of user-defined scenarios
- Models economic impact via supply chains & induced effects
- Can be run with default values or user inputs
- Uses input-output methodology to convert dollars spent into economic impacts using relationships from USDOC/BEA Regional Input-output Modeling System (RIMS)

Jobs are created from equipment production/installation, station construction, and fuel supply chains (direct + indirect jobs) as well as from ripple effects (induced jobs).

H_2 stations create jobs not only on site



JOBS H2 facilitates regional analyses



Map by the Indiana Business Research Center, Kelley School of Business, Indiana University

- RIMS multipliers for 60 different geographies reflect variations in overall size & composition.
- In-region or local shares (LS) of expenditures account for variations in sourcing H2 fuel, equipment, and station development expenses.
- Site prep, installation, O&M and retailing have > LS.
- H2 fuel, permitting, station design/engineering, equipment production have < LS.

Jobs occur where expenditures occur. High LS of station development & operation expenditures create most jobs.

FY 2014 milestones

Milestone	Status
JOBS H2 Methodology & documentation	✓
JOBS H2 Webinars and Beta Test	✓
JOBS H2 1.0 Launch	✓
Rollout scenario analysis	9/30/14

JOBS H2 user interface defines scenarios

Step 1 - Station Capacity

Notes: Please enter a value for the maximum total station capacity. This entry impacts various default station expenses and other values used in the model.

Category	*User-specified value*	Default	Notes	Value used in model
Maximum total station capacity (kg/day)		200	Default station expenses and other model values based on 100-400 kg/day	200

Step 2 - Project Development Timeframe

Notes: Please enter the number of years station development expenditures are incurred.

Category	*User-specified value*	Default	Notes	Value used in model
Project development timeframe		2	Value can be 1 or 2 years.	2

Step 3 - Number of New Stations Completed Each Year

Notes: Please enter the number of new stations which will be completed by the end of the given year. (Example: If two stations will begin construction in 2013 but will be completed in 2014, please enter "2" in the cell corresponding to 2014.)

Year	*User-specified value*	Notes	Value used in model
2014		The current total per station development expense including pre-construction development, construction, installation, equipment, and shipping expenses in 2014$ is: **$2,145,600**	-
2015	25		25
2016	25		25
2017	25		25
2018	25		25
2019	25		25
2020	25		25

STATION DEVELOPMENT RELATED EXPENSES

All dollar values are in 2014$. All user-specified entries must be entered in 2014$.

Step 4a - Station Equipment Expenses (uninstalled) and Quantities

Notes: In this step specify the expenditure and quantity for each equipment category. To enter detailed information on the Dispenser, please use the "Dispenser-INPUTS" sheet. Equipment expenses are in 2014$ and should not include the costs for shipping and installation. Shipping expenses can be specified in Step 4b. Installation and other station development expenses can be specified in Step 5. If per unit expenses or quantites are specified in Step 4a, these entries will supercede Total Equipment Expense values in Step 4 for that piece of equipment.

Equipment Category	Equipment Expense ($/unit)	Equipment Quantity (units/station)	Equipment Expense ($/unit)	Equipment Quantity (units/station)	Equipment Expense ($/unit)	Equipment Quantity (units/station)
	User-specified value	*User-specified value*	Default	Default	Value used in model	Value used in model
Dispenser	$85,200		$85,200	1	$85,200	1
Refrigeration System			$115,700	1	$115,700	1
Compressor			$189,300	3	$189,300	3
Electrical Equipment		1	$139,100	1	$139,100	1
Cascade		1	$210,300	1	$210,300	1

INFO | USER GUIDE | DISCUSSION OF DEFAULT VALUES | START | **Station Development-INPUTS** | Dispenser-INPUTS | Stations Dev

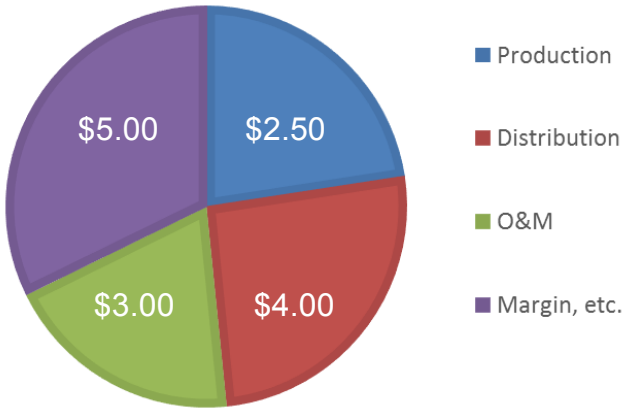
Illustrative scenario demonstrates model capabilities

Illustrative Scenario Inputs

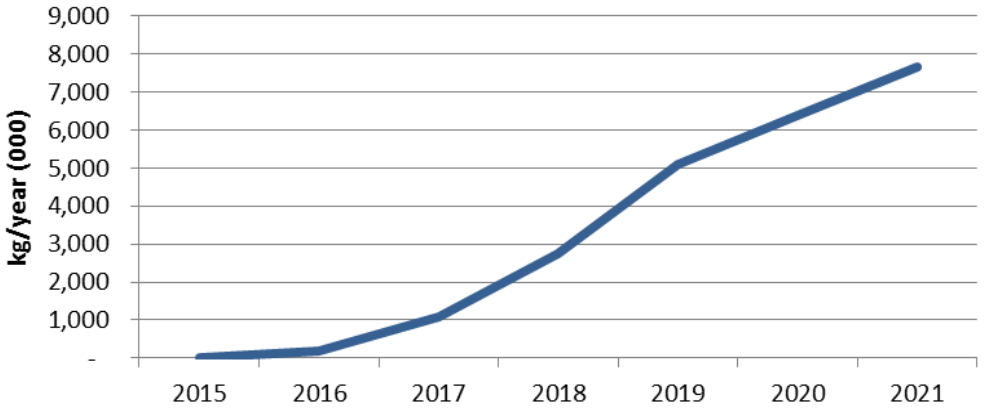
Region = US	New 200 kg/d stations completed	Stations in operation	Utilization (%)	Local share (LS)* of expenditures
2015	25		--	100
2016	25	25	10	100
2017	25	50	30	100
2018	25	75	50	100
2019	25	100	70	100
2020	25	125	70	100
2021	--	150	70	100

*Excluding 700-bar dispenser nozzles, all of which are assumed to be imported.

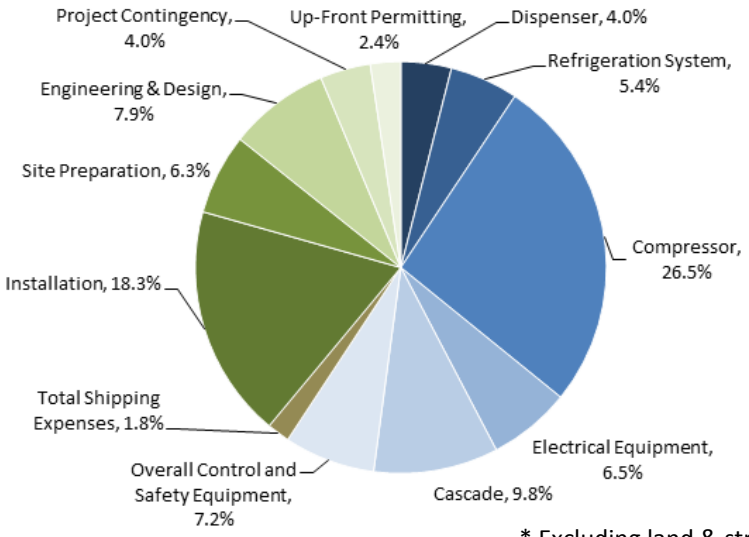
Hydrogen retail price



Resulting H2 fuel sales

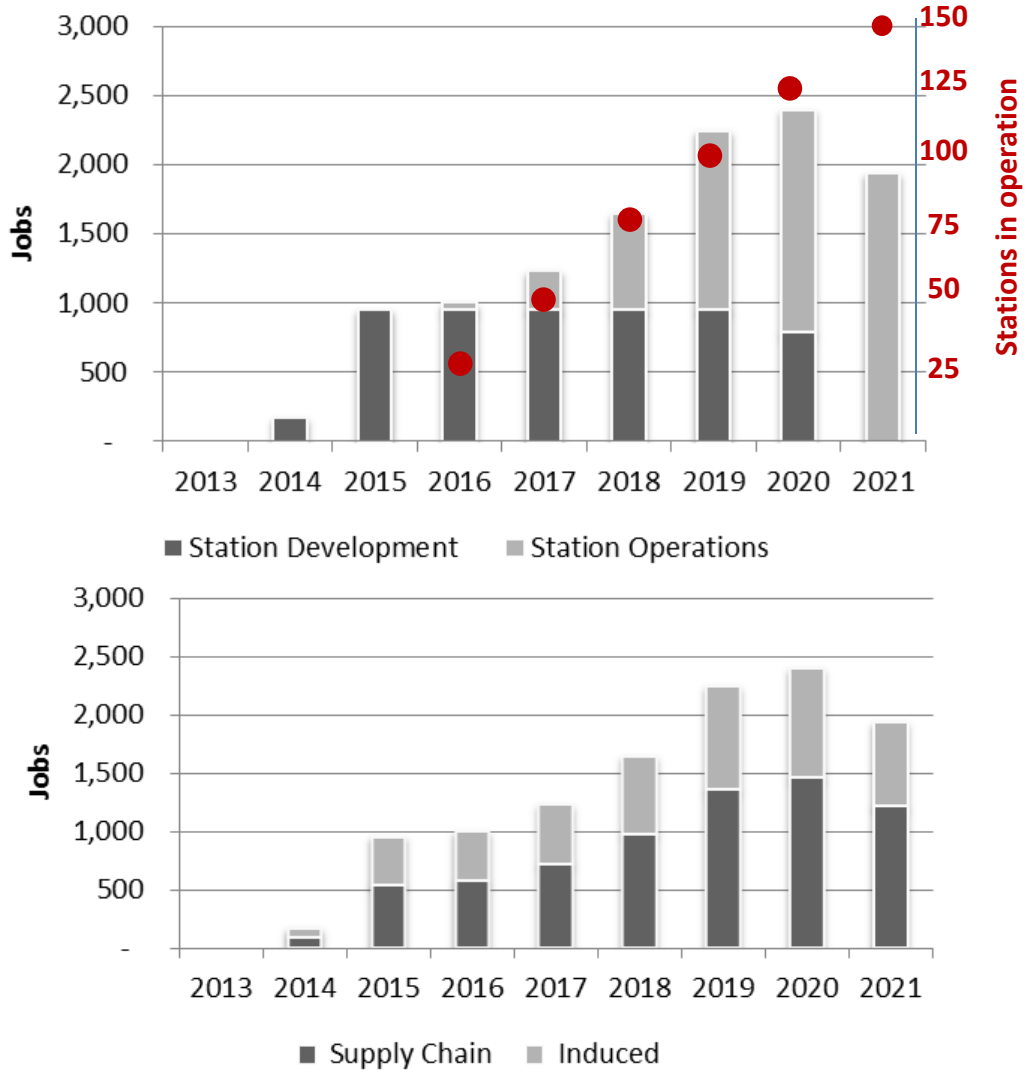


Total Station Expenditures ($2.1m)*



* Excluding land & structures.

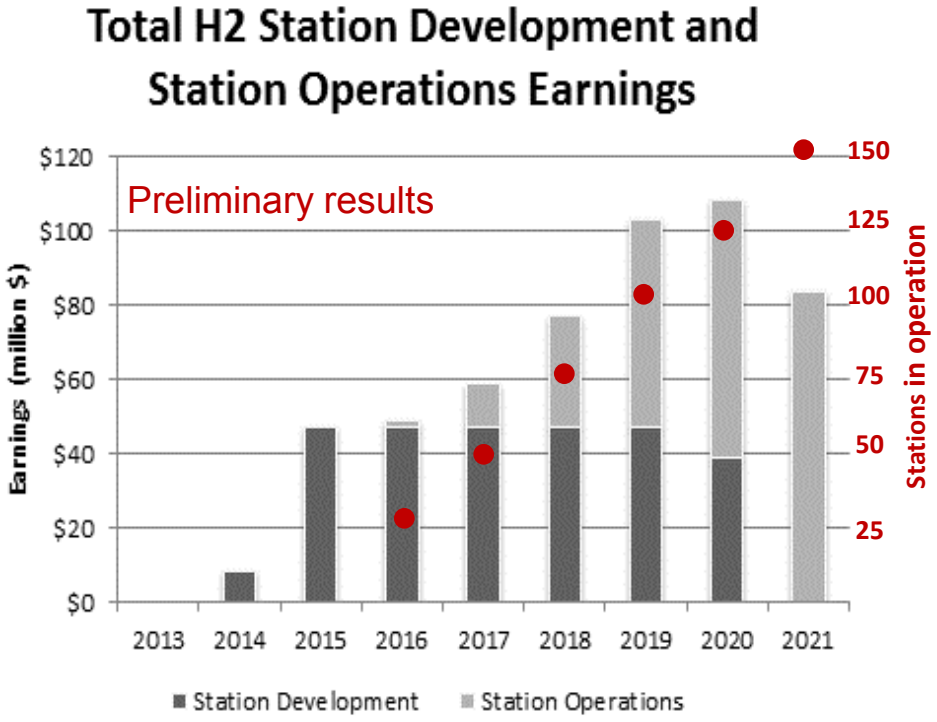
In illustrative scenario, initial jobs come from station development, then from station operation

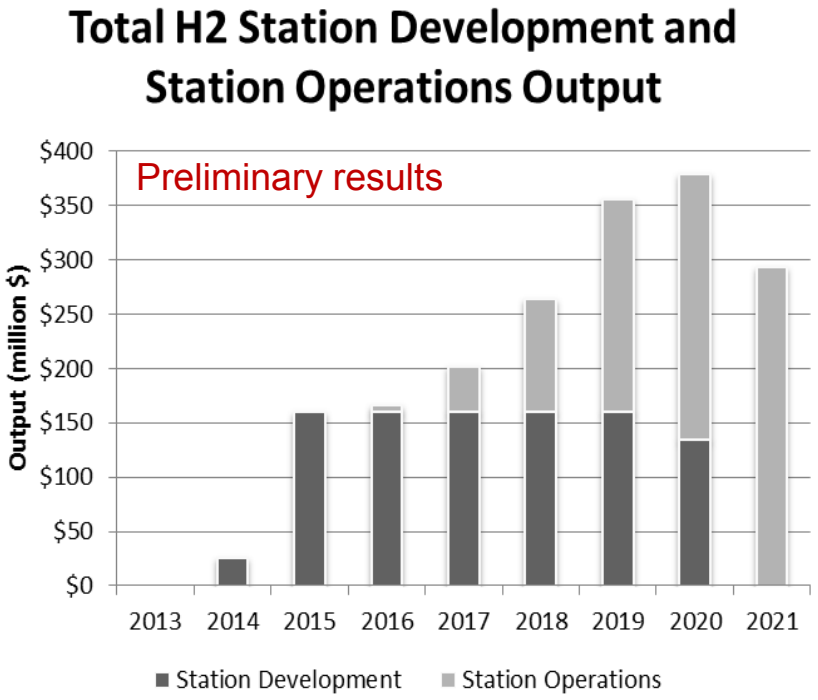


- Developing 25 stations/year results in ~1000 jobs/year for planning, construction, equipment production, installation, etc.
- Total jobs peak at ~2400 when last stations are completed
- Nearly 2000 jobs associated with operating 150 stations continue indefinitely
- Induced jobs account for ~40% of total in pre-operation, somewhat less during operation

Earnings and output in illustrative scenario show a similar pattern

- Earnings grow to over $100 million in the final year of station completion (2020)
- Gross output grows to over $375 million in 2020
- In the illustrative scenario all impacts associated with station operation continue at the same level beyond 2021





*Station development jobs are most sensitive to local share (LS) of expenditures**

Base case for sensitivity analysis:

- (100) 200 kg/day stations
- Census Region 5-South Atlantic
- Middle scenario (fewer stations, different region & years of operation than illustrative scenario)

Base Case (2080 jobs):

LS 100%: installation, site prep

50%: eqpt, contingencies, design/engineering

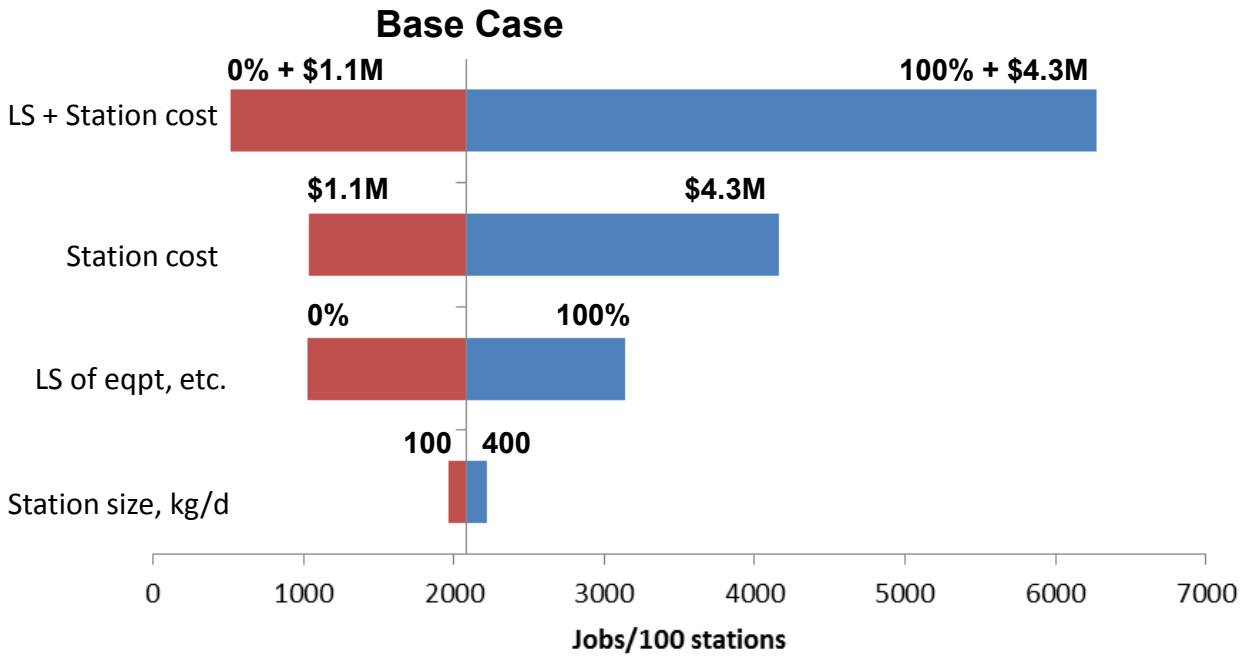
Station size: 200 kg/d

Station cost: $2.1M

Preliminary results

Station development jobs:

- 1-2 year duration
- Planning, construction, equipment production, installation supply chains + induced
- High local share and high cost put most $ into economy & create most jobs
- In JOBS H2, default 100 kg/d station costs nearly as much as 200 kg/d



LS = Share of expenditures to suppliers within region.

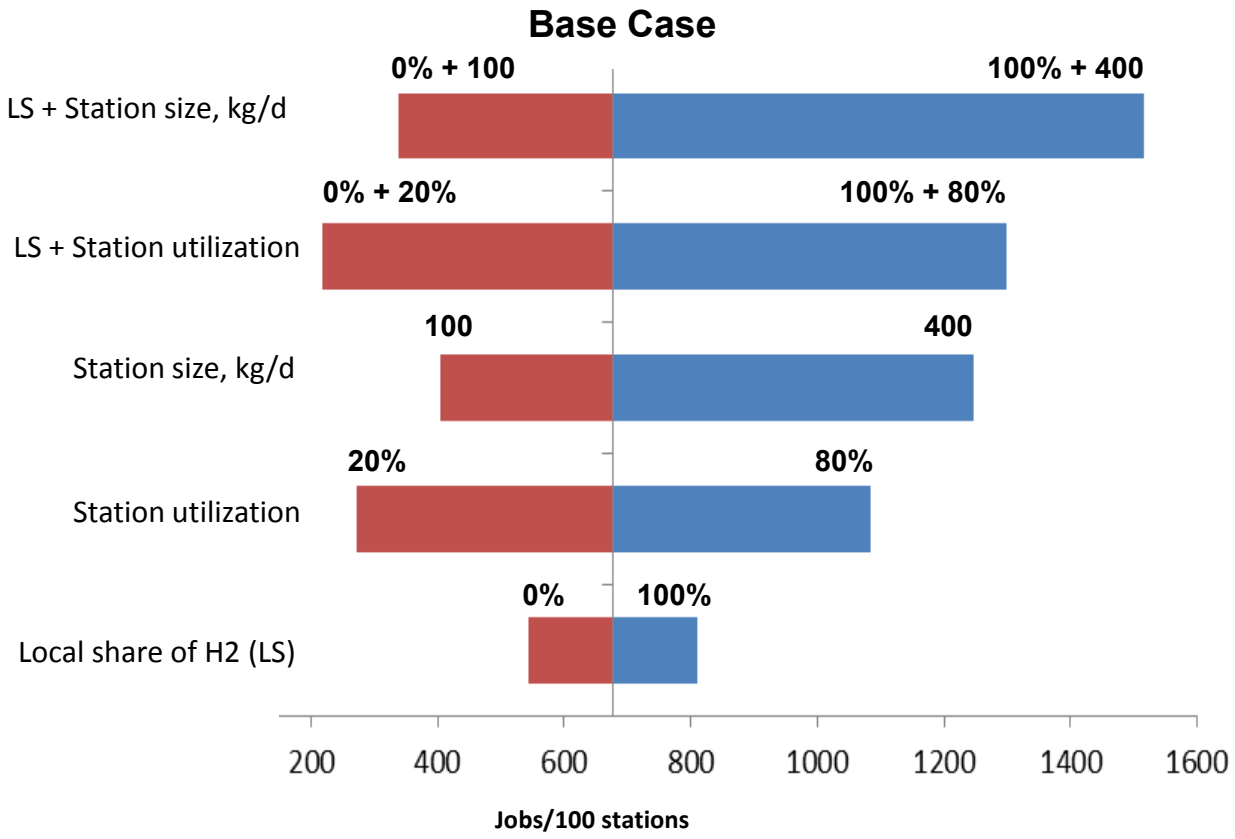
Station operation jobs are most sensitive to station throughput

Station operation jobs:

- Multi-year duration
- Associated with H2 production & delivery, station O&M supply chains + induced
- High throughput stations with high local share (LS) put most $ into local economy & create most jobs
- Less sensitive to local share because all cases assume local O&M expenses

Base Case (680 jobs):
LS 100%: O&M, retail
50%: H2
Station size: 200 kg/d
Station utilization: 50%

Preliminary results



LS = Share of expenditures to suppliers within region.

Stakeholders provide key advice/expertise

JOBS H2 Advisory Group

- Public agencies
- Station developers
- H2 and FC industry
- Fuel suppliers
- Researchers

Assistance/role

- Defaults (data/analyses)
- Functionality/granularity
- Future directions/needs
- Beta testing
- Validation

Sample comments:

- *Downtime due to learning, availability of spare parts can be significant…*
- *Which parameters are results most sensitive to? How might that change with new technology?*
- *Installation costs can vary greatly from one station to another….*

Parameter	Stakeholder input (default)			
Stn size (kg/d)	100-400	(200)	multiple	500, 1000
Pressure (bar)	350	(700)	500 for trucks	
Analysis years	(2014-2021)	2014-2023		
Local shares (%)	(stn eqpt = 0) 0-100	(stn dvpmt = 0) 0-100	(H2 fuel = 0) 0-100	(O&M/other = 100) 0-100
Utilization (%)	(annual average)	(10, 30, 50, 70)	0-100	
Stn development	1 year	(2 years)	Part years	

() = JOBS H2 1.0 default xxx= not in JOBS H2 1.0

JOBS H2 development and analysis

Dec-2013 June-2014 Sept-2014

JOBS H2 methodology & illustrative case → **JOBS H2 1.0** → **LH2 delivery & rollout analysis**

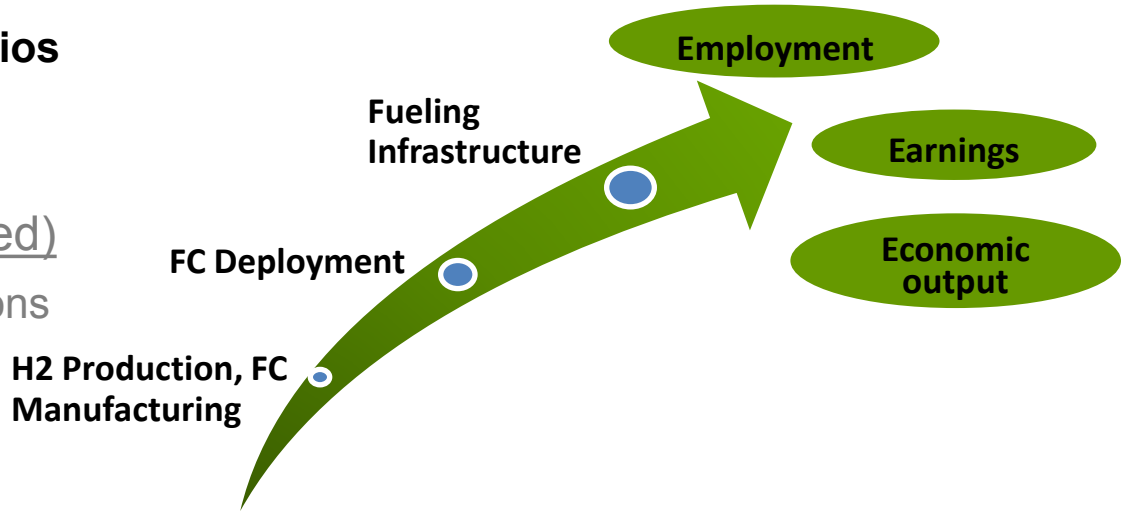
User Training, Model and Data Validation and Documentation

Planned model expansions/analyses:

- **LH2, 400+ kg/d**
- **Alternative rollout scenarios**
- **Uncertainty analysis**

Future possibilities (not funded)

- Novel station/pathway options
- Distributed H2 production
- FC applications in vehicles



Summary

- **Relevance:** Provide a consistent platform to analyze employment and other economic impacts of hydrogen and fuel cell investments. Assist DOE and stakeholders with analyses of economic impact of deploying hydrogen infrastructure in early markets.
- **Approach:** Use input-output economic modeling within the context of a user-friendly interface to calculate supply chain and induced employment, earnings and economic output associated with fuel cells and H2 station deployment.
- **Collaborations**: Active partnership between ANL & RCF. Extensive stakeholder interaction.
- **Technical accomplishments and progress:**
  - JOBS H2 1.0 development, beta test and launch
  - Formation of stakeholder Advisory Group with internal webinars
  - Launch webinar scheduled for June 24th in conjunction with EERE
  - Website development (http://JOBSmodels.es.anl.gov).
- **Future research**:
  - Expand JOBS H2 to include LH2 and larger stations
  - Analyze H2 station rollout scenarios and alternative station and pathway options
  - Continue to validate and refine defaults and improve model functionality
  - Add uncertainty analysis