



Enhanced Agricultural and Industrial Fuel Substitution Module in FSSAT

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Acronyms, Initialisms, and Abbreviations

AAEE – Additional Achievable Energy Efficiency

AAFS – Additional Achievable Fuel Substitution

Ag – Agricultural

AMI – Advanced Metering Infrastructure

ARCHES – Alliance for Renewable Clean Hydrogen Energy Systems

CARB – California Air Resource Board

CEC – California Energy Commission

CPUC – California Public Utilities Commission

Elec – Electricity

EIA - Energy Information Administration

FS – Fuel Substitution

FSSAT – Fuel Substitution Scenario Analysis Tool

GHG – Greenhouse gas

H₂ – Hydrogen gas

IEPR – Integrated Energy Policy Report

Ind - Industrial

NAICS – North American Industry Classification System

NPMS - National Pipeline Mapping System

MOU – Memorandum of Understanding

PiCS – Programs and Incremental Codes and Standards

SMR – Steam Methane Reforming

U.S. DoT – United States Department of Transportation



Background of FSSAT Ag & Industrial Module

- FSSAT has an Ag & Industrial module
- Not fully developed and used until the [2023 Demand Scenarios Project](#)
- Development and Expansion in 2024-2025
 - Individual NAICS code industries
 - Hydrogen fuel substitution potential
- New industrial load shapes using AMI data
- Not to be used in the 2025 IEPR





FSSAT Ag & Industrial Module Process

IEPR Ag & Ind Gas Baseline Demand Forecast



PiCS Additional Achievable Fuel Substitution Scenario
Reduces consumption of Ag & Ind gas



FSSAT Ag & Ind Fuel Substitution Module (Electricity or Hydrogen)

- Characterize and Split Ind thermal end uses
 - Process Heat-Low (electricity)
 - Process Heat-High (H₂)
 - Water Heating (electricity)
- Apply estimates from H₂ production & transport
- Calculate fuel substitution potential



PiCS Additional Achievable Energy Efficiency Scenario
Further reduces consumption of Ag & Ind gas



Hourly Outputs

Profiles based on NAICS codes



Annual Outputs

- Final demand forecasts
- Incremental electricity added from FS and onsite H₂ production
- Hydrogen demand
- Avoided gas consumption
- Net GHG emissions
- *Cost of substitution*



Overview of Agricultural Fuel Substitution

- Baseline Ag Demand for Electricity and Gas
 - Granularity: Forecast Zone, Gas Planning Area, Year, End Use, Energy Consumption
 - Electric and gas options exist for each end use
 - HVAC
 - Water Heating
 - Miscellaneous
- Ag FSSAT currently limited to additional electrification of end uses
 - Potential revisions in the future



Overview of Industrial Fuel Substitution

- Baseline Industrial Electricity and Gas Demand Forecast
 - Granularity: 46 NAICS Sub-sector Industries, forecast zone, planning area, Year, End Use, Energy Consumption
- Industrial End Uses: Motor, Process Cooling, Thermal, HVAC, Lighting, Elec/Cogen, Miscellaneous
 - Gas consumption is utilized in thermal applications for most NAICS industries
 - Thus, FS is primarily focused on thermal end uses
- FSSAT Hydrogen Substitution
 - Industrial thermal end uses: Water Heating, Process Heat-Low, and Process Heat-High
 - Proportional assignments by NAICS code based on wide review of NAICS literature
 - Process Heat-High remains the toughest to electrify



Example FS Approach in the Industrial Sector

For each NAICS code and End-Use, apply defined scenario FSSAT penetration

Industry Applicability (NAICS)	End-Uses for Fuel Substitution	Type of Fuel Substitution
Generic	Non-Thermal End Use	Gas → Electricity
Generic	Process Heat-Low	Gas → Electricity
Generic	Water Heat	Gas → Electricity
Generic	Process Heat-High	Gas → H ₂
211, 212 (Oil & Gas Extraction)	Process Heat-High	Gas → H ₂
3272 (Glass)	Process Heat-High	Gas → H ₂
3273 (Cement)	Process Heat-High	Gas → H ₂



Modeling Localized Production or Pipeline Movement of Hydrogen

- No statewide hydrogen distribution system
- FS probability increases with proximity to H₂ production facilities
- User-defined time-series of hydrogen supply and transport method for each NAICS industry in each electric and gas planning area

Hydrogen User Inputs within FSSAT

Transport Methods	Hydrogen Production Methods
■ Onsite Production ■ Pipeline ■ Trucking – Short Distance ■ Trucking – Long Distance	■ Electrolysis – Grid – Standard ■ Electrolysis – Renewable ■ Steam Methane Reforming – No Carbon Capture System

Thank You!

Questions? Comments?



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Selected FSSAT Ag & Industrial Input Data Sources

FSSAT Ag & Industrial Inputs	Current Data Source	Future Data Source
Industrial Adoption Potential	Public-Facing CARB Mandatory GHG Reporting Regulation (MRR) Data	Same as current
Industrial Hydrogen Supply	Public-Facing CARB Mandatory GHG Reporting Regulation (MRR) Data	CEC-CARB MOU Mandatory GHG Reporting Regulation (MRR) Data
H ₂ Pipeline Capacity	National Pipeline Mapping System (NPMS)	Same as current
H ₂ Production Methods	Energy Information Administration (EIA) - Production of Hydrogen	Same as current
Hourly Industrial Load Shapes	ADM Associates (Circa 2017-2019)	CEC's AMI Generated Load Shapes