# Global Hydrogen Systems Analysis

# International Energy Agency (IEA) Hydrogen Implementing Agreement (HIA) Task 30

**IPHE Steering Committee Meeting**

**Vancouver, Canada**

**May 13-14, 2011**

**Co-operating Agents: Susan Schoenung (USA) and Jochen Linssen (Germany)**

# Task 30 Goal and Objectives

*HIA Theme: Analysis that Positions Hydrogen*

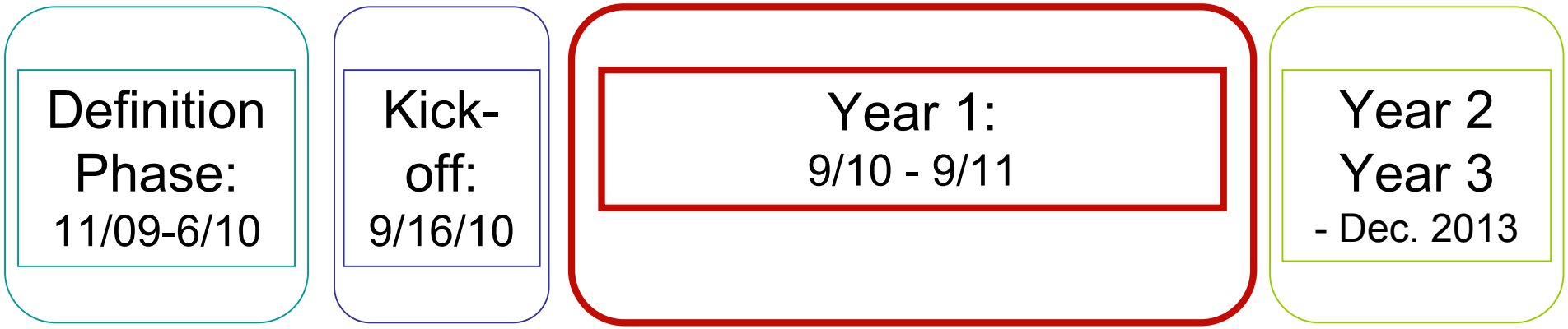
General objectives within task 30:

- build up a body of systems analysis expertise within the HIA
- collaboration with the IEA Analysts in order to support the IEA World Energy Outlook (WEO) and IEA Energy Technology Perspectives (ETP) with technical, economical data

Specific efforts of Task 30:

- Perform comprehensive technical and market analysis of $H_2$ technologies and resources, supply and demand related to projected use of $H_2$ in a **sustainable low-carbon energy world.**
- Assessment of $H_2$ technology maturity and $H_2$ projections to support preparation of authoritative analysis.

# Task 30 Timeline




**Task definition meetings**
-Seville, 11/09
-Paris, 2/20/09
ExCo approval, 5/23/10
Kick-off, Julich, 9/16-17/10

**Experts Meetings**
Subtask C Paris mtg, 12/2/10
Experts mtg Paris, 3/22-23/11
Experts mtg DC, 9/28-29/11
---
On-going analysis
Quarterly webconferences
Interim outputs
---
ExCo meeting - Istanbul
BSEC workshop 11/11

Systems Analysis
Database completion
Collaboration w IEA
Reporting
Outreach
Expert meetings
ExCo meetings

# Task 30 Subtasks and Participants

## Subtasks

- Subtask A: Detailed analysis of global hydrogen resources

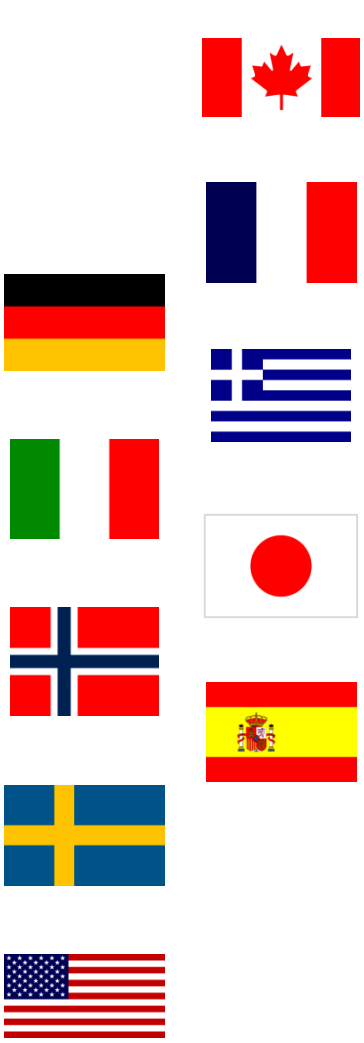
  **Dr. Susan Schoenung, Longitude 122 West, Inc.**

- Subtask B: Updating and harmonizing the database of $H_2$ technologies

  **Mr. Jochen Linssen, Research Center, Jülich**

- Subtask C: Collaboration with IEA analytics team

  **Ms. Kari Aamodt Espegren, Institute for Energy Technology, Norway**



## Participants:

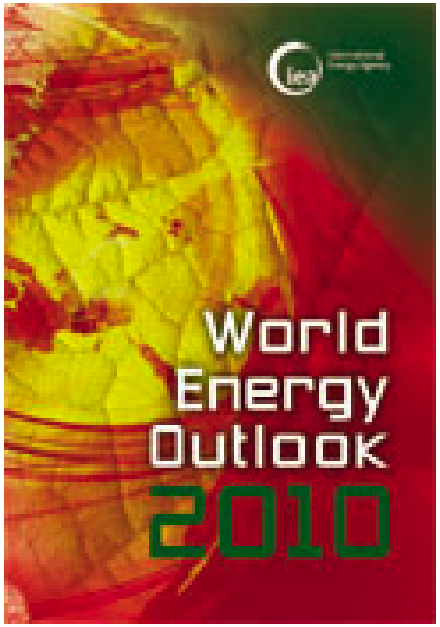
- Canada
- France
- Germany
- Greece
- Italy
- Japan
- Norway
- Spain
- Sweden
- United States
- ----------
- Australia
- Korea
- Denmark
- United Kingdom

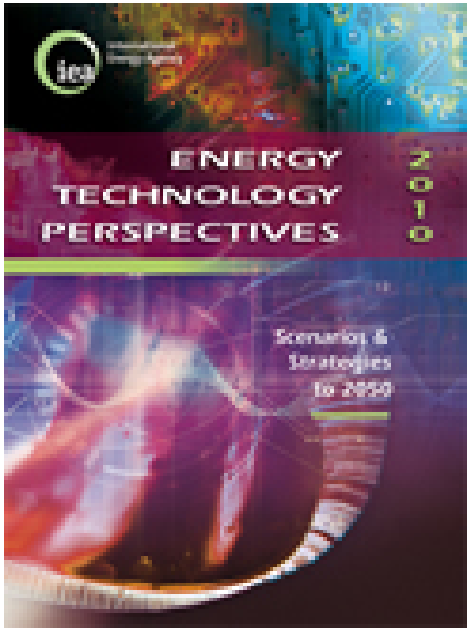
# Subtask C: Collaboration with IEA

Objective: Share most up-to-date hydrogen and fuel cell information; review assumptions

IEA Analytic Reports

- World Energy Outlook, which goes to 2030
- Energy Technology Perspectives, builds on the WEO and goes to 2050

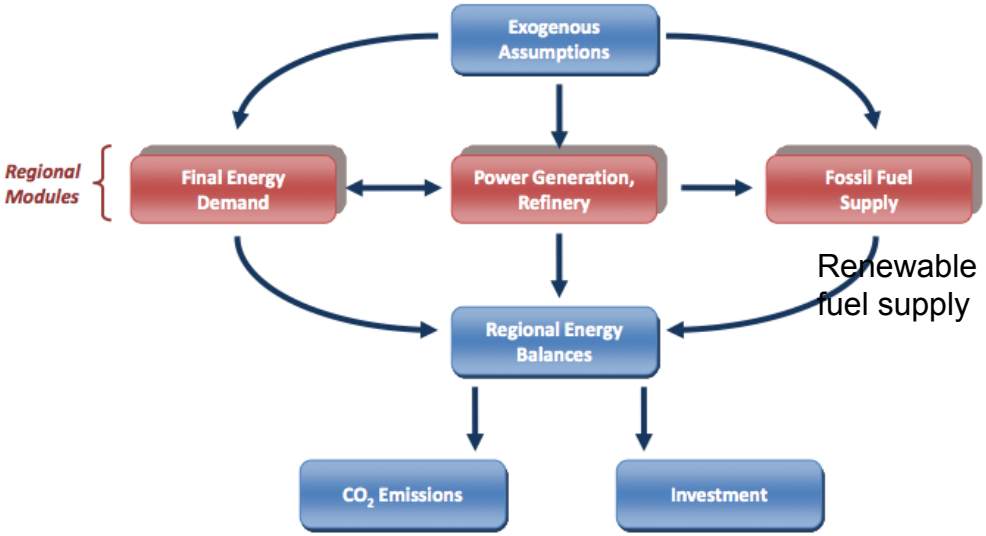


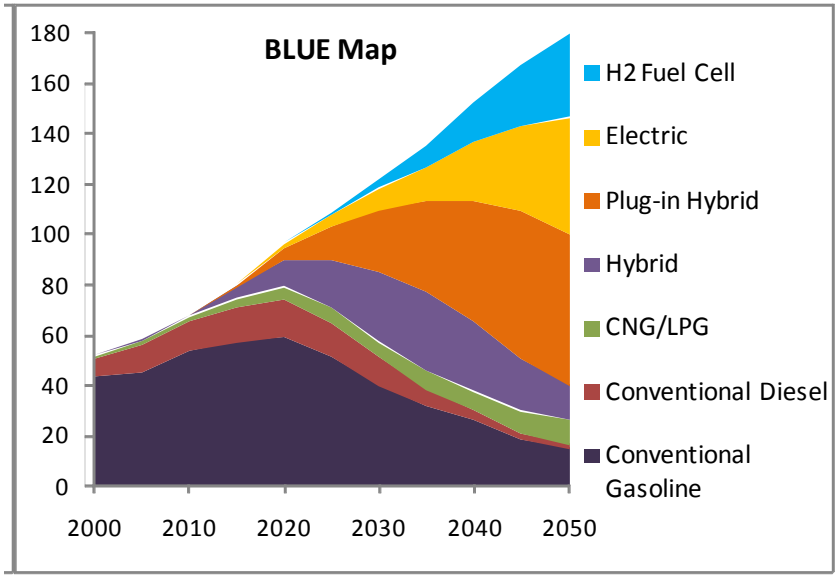
# Subtask C: Accomplishments - Collaboration

December 2010: First meeting with IEA analysts in Paris
Information exchange, data access, contacts established

March 2011: Second meeting with IEA analysts in Paris - WEO, ETP and Mobility Model analysts; **ongoing exchange**




World Energy Outlook Model



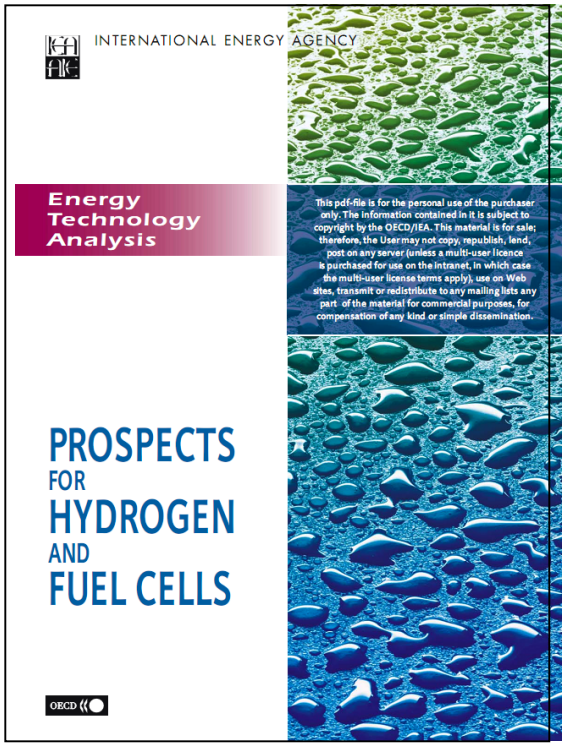

ETP Model Results

# Subtask B: Update and Harmonize $H_2$ Knowledge

Objective: Update the assessment of $H_2$ **technology maturity**

Activities:

- Cross-border collaborations with other HIA tasks and IEA analysts regarding data and R&D progress
- Collection and preparation of relevant data for a comprehensive energy systems analysis in collaboration with other tasks and subtasks
- Data evaluation and technology gap analysis

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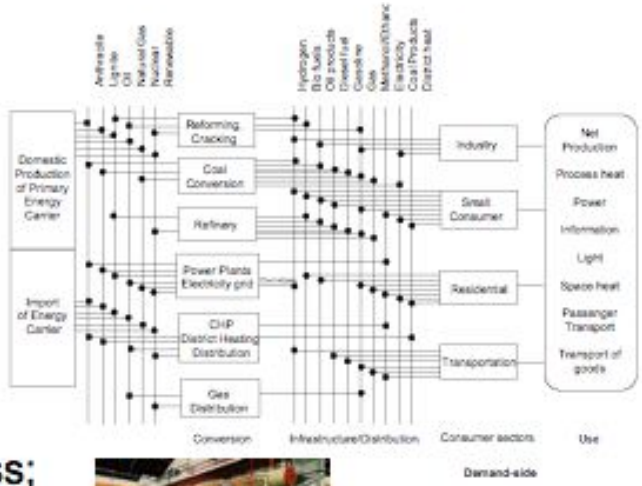
# Subtask B: Accomplishments - Data Structure

- **Hydrogen as Part of an Energy System**
  - The role of hydrogen
  - Transition Strategies
  - Targets in RD&D

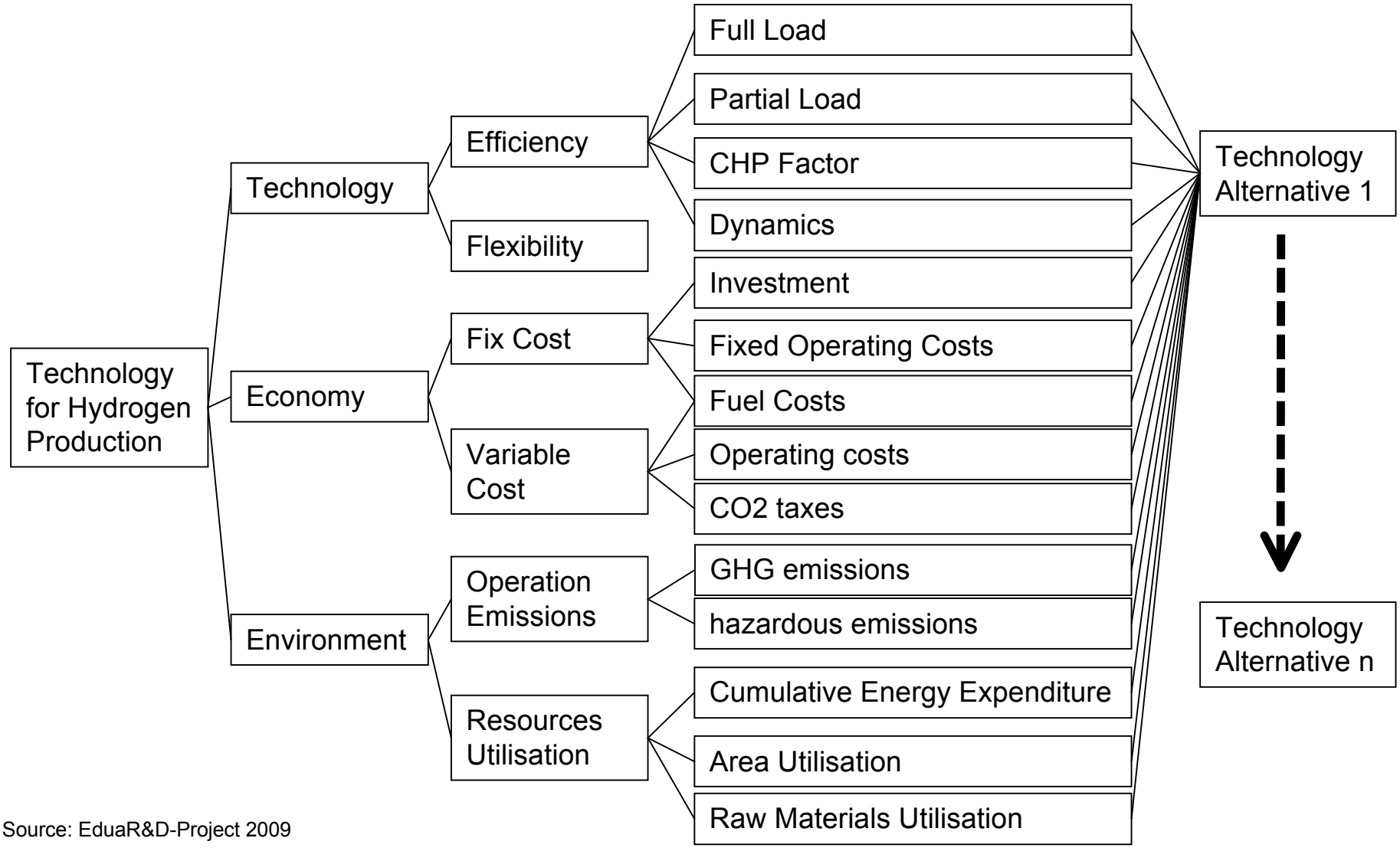



- **Hydrogen production**
  - electrolysis, reforming fossil fuels and biomass; water splitting by nuclear and solar
  - hydrogen production cost

- **Hydrogen transportation and distribution**
  - Transportation pipeline, truck or ship
  - Large scale hydrogen storage
  - Hydrogen refueling stations

- **Mobile On-board hydrogen storage**
  - Gaseous, liquid, solid storage
- **Hydrogen Applications**
  - Fuel cells
  - Internal Combustion engines
  - Chemical Feedstock
  - other hydrogen end-use technologies

# Subtask B: Accomplishments - Data Structure



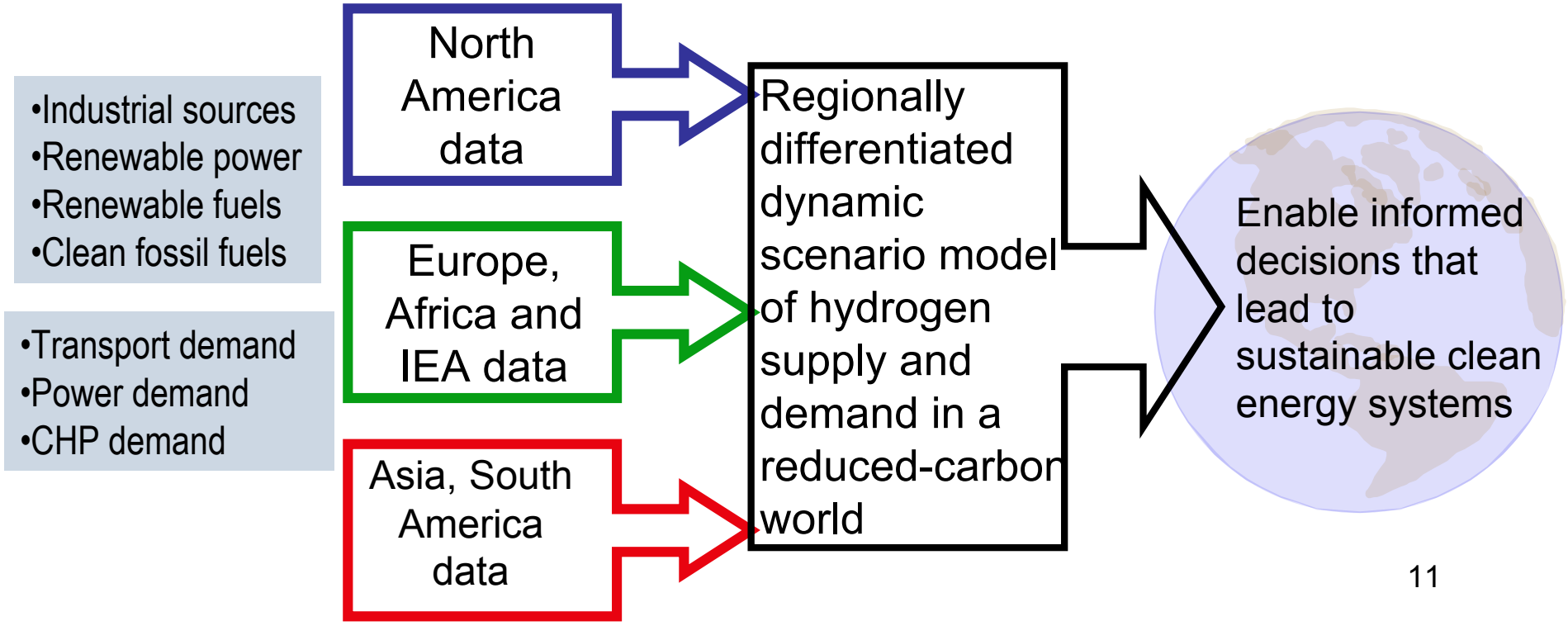

Source: EduaR&D-Project 2009

# Subtask B: Accomplishments - Expert Review of ETP assumptions

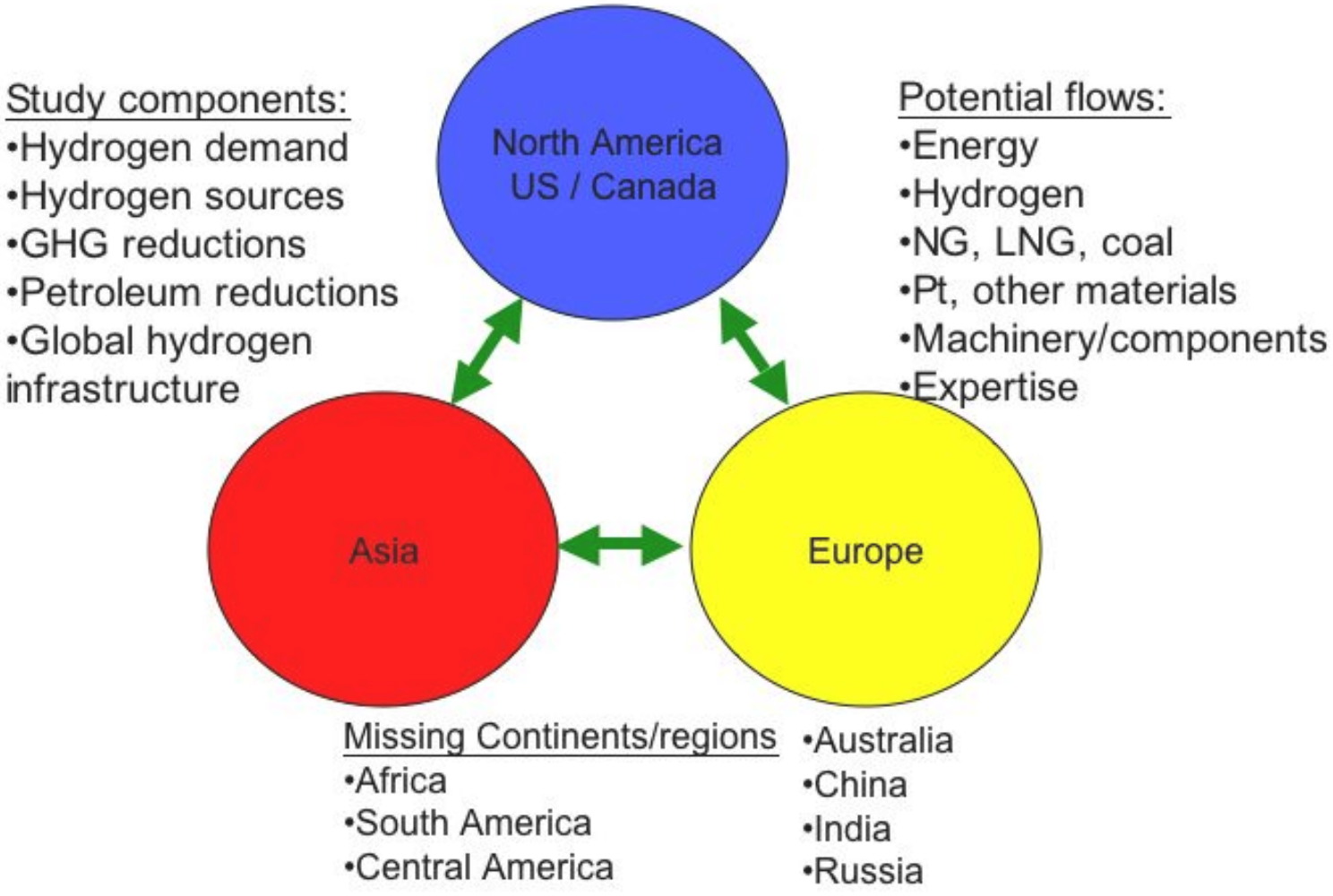
| Technology | Who | Status | Comments |
|---|---|---|---|
| Coal gasification<br>with & w/o CCS | Jay<br>Javier | Finished<br>In progress | Currently internal to Task 30 members |
| Natural gas reforming<br>with & w/o CCS | Jay,<br>Javier | Finished<br>Finished | |
| $H_2$ from Nuclear & solar | Javier | In progress | |
| Biomass gasification | Bengt | Finished | |
| Electrolysis | Elli | In review | |
| Transportation | Sam | In progress | |
| Refueling | Sam | In progress | |
| Infrastructure technologies | Marcel<br>(Task 28) | In progress | |

# Subtask A: Global Hydrogen Resource Study

- Objective: Explore trends, impacts, consequences, flows
- **Regional differentiation is key**
- Activities: data gathering, modeling, authoritative analysis
- Deliverables: data sets, model, reports, papers



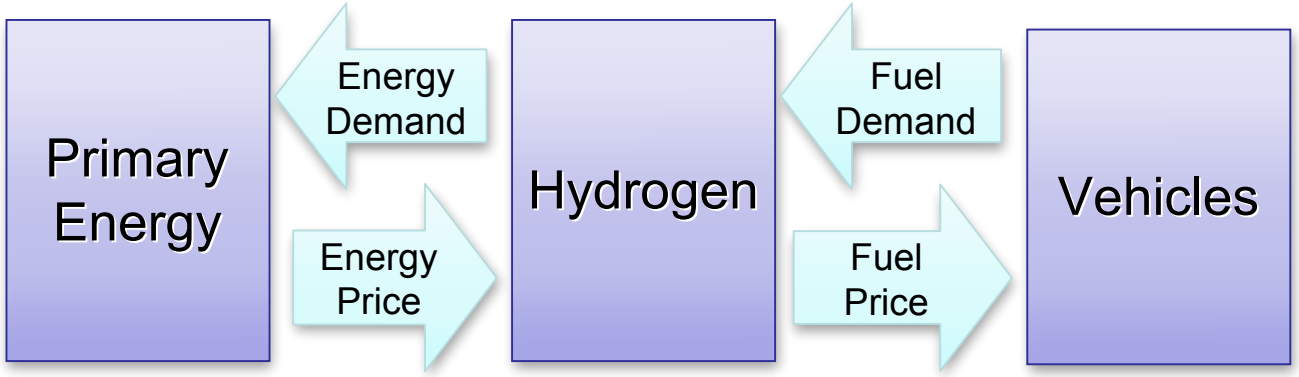
# Global Impacts: What flows between nations?



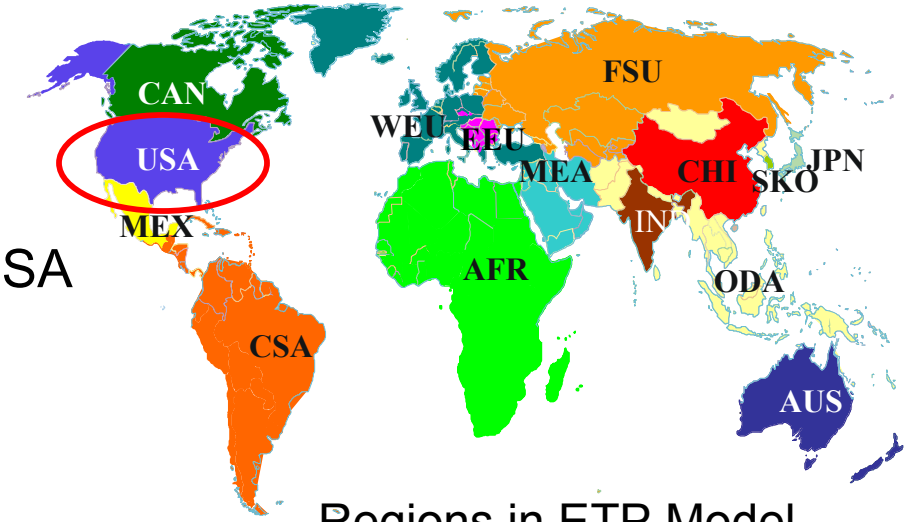
# Subtask A: Accomplishments - Modeling

## *Initial* analysis for light duty vehicles

Systems Dynamic Modeling using PowerSim

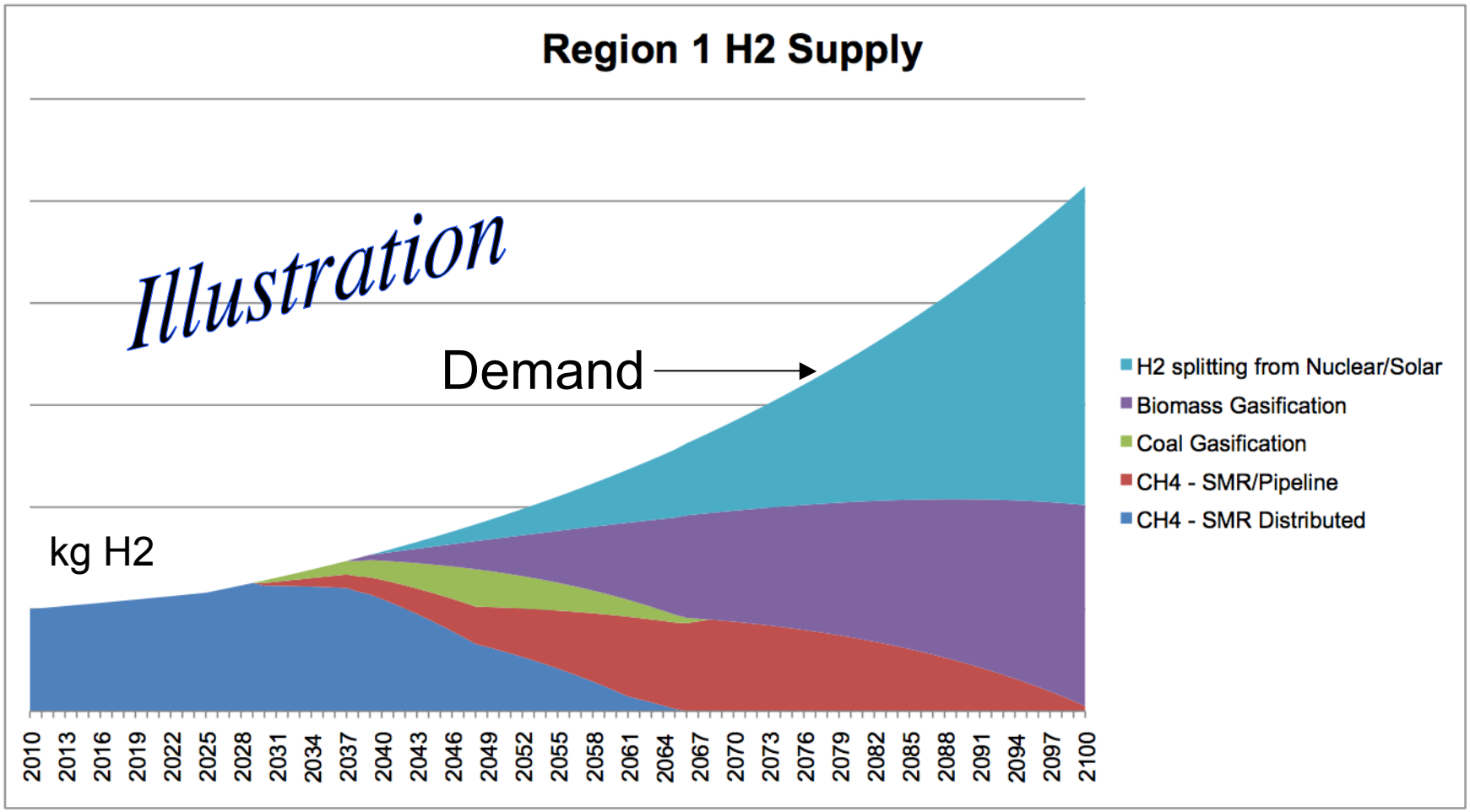



US DOE / SNL talk focuses on USA
Will be expanded to Global.

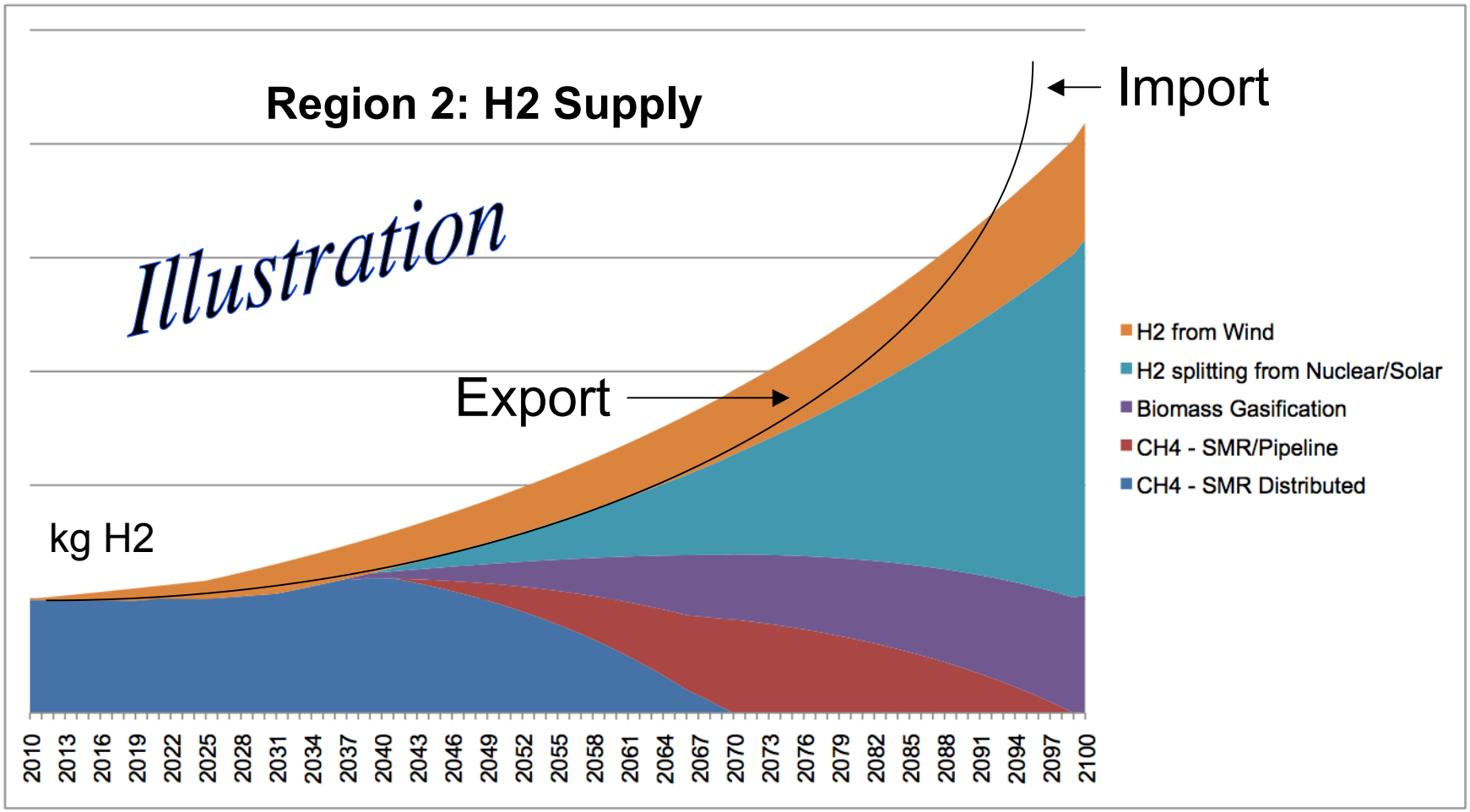



Regions in ETP Model

# Example 1: $H_2$ Supply = $H_2$ Demand (for vehicles)



# Example 2: Supply > or < Demand



# Subtask A: Analysis Inputs

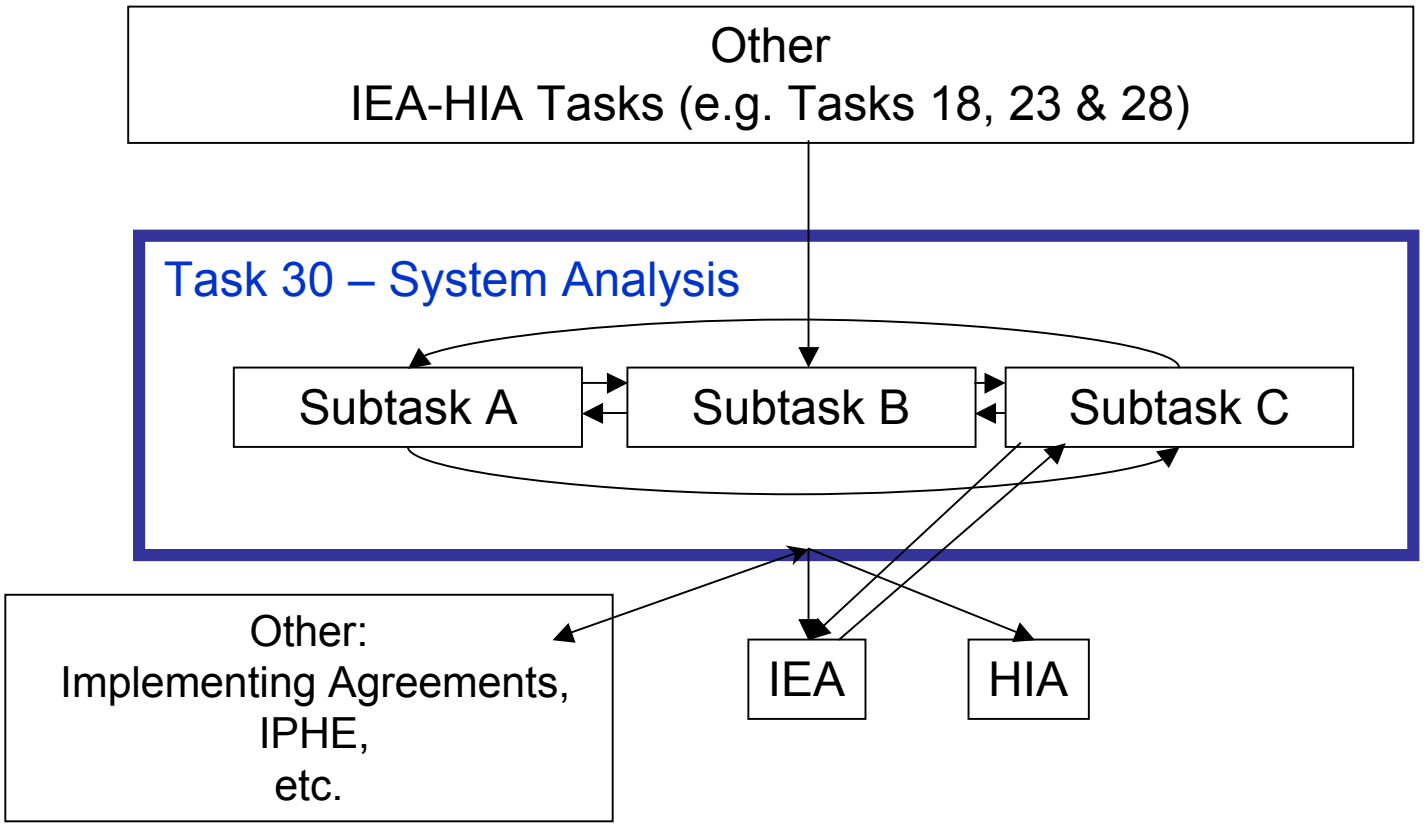
| Input | Parameters |
|---|---|
| Hydrogen production, kg/year | Over time, from 2010 – 2050 |
| - Industrial | -Expected |
| - from renewable sources | - projected or potential |
| - from fossil fuel sources<br>- from nuclear | -projected or potential<br>- projected or potential |
| Cost of hydrogen for vehicle fuel | Over time, from 2010 - 2050 |
| - from various sources, as above | |
| Cost of hydrogen infrastructure | - domestic delivery, etc. |
| Hydrogen demand for vehicle fuel, kg/year | National plan or projection to 2050 |
| Hydrogen demand for stationary applications, kg/yr | Projections |
| GHG emissions | National goals to 2050 |
| | |

# Subtask A: Accomplishments - Data

| | Resources, kg/yr | Time dependence | Costs | Demand, kg/yr | Time dependence |
|---|---|---|---|---|---|
| Spain | ✓ | ✓ | ✓ | ✓ | ✓ |
| France | ✓ | ✓ | | ✓ | ✓ |
| Norway | ✓ | ✓ | ✓ | ✓ | |
| Germany | ✓ | ✓ | | | |
| Canada | ✓ | ✓ | | ✓ | ✓ |
| US | ✓ | ✓ | ✓ | ✓ | ✓ |
| Greece | In progress | | | | |
| Sweden | ✓ | ✓ | | ✓ | ✓ |
| Italy | In progress? | | | | |
| Japan | ✓ | ✓ | | ✓ | ✓ |

Korea - adding information; UK - possible

# Task 30 Interactions



# HIA Task 30
# Global Hydrogen Systems Analysis

## Concluding Remarks

- Task 30 is underway with 3 active Subtasks
- Data and analysis input from participating HIA members
- Good working relationship with IEA Analysis group
- Next experts meeting Washington DC area in Sept 2011

- Our goal of delivering authoritative, knowledge-based analysis to the HIA and world hydrogen community will be realized.

- *More input is always better!*

# Thank you!

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