

CO₂ EOR Market Dynamics

Virtual World:

A Project Proposal

CO₂ for EOR as CCUS

Collaborative Symposium

November 19-21, 2013

Institute for Energy Studies (IES)

Presentation Overview

- Objective: propose development of a CO₂ EOR Market Dynamics 'Virtual World'
 - to support research, education, and outreach
- Overview of Institute for Energy Studies
- Briefly introduce Virtual World Applications
 - What are they?
 - How are they used?
 - Who uses them?
 - What do people think of them?
- Open Discussion: *how can this technology help?*

Institute for Energy Studies (IES) Leadership

- Steve Benson
 - Director IES
 - Professor and Chair, Petroleum Engineering
- Srivats Srinivasachar
 - Technology Strategic Planning IES
 - Envergex, LLC
- Shanna Corbett, Resource Manager
- Scott Johnson
 - Research & Outreach IES
 - Instructor, Petroleum Engineering

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Mission: **Research**, Education, Outreach

- Multi-disciplinary
- Scientifically balanced research portfolio
- Accelerate implementation of energy production technologies:
 - Efficient
 - Clean
 - Affordable
 - Reliable

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Mission: Research, **Education**, Outreach

- Develop students into energy experts
- Cognizant of issues facing energy industry
- Focus on needs of world-wide community:
 - Technical
 - Social
 - Political
 - Environmental

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Mission: Research, Education, **Outreach**

- Engage stakeholders:
 - General public
 - Civic leaders
 - Industry leaders
 - Public officials
- Enhance education & research opportunities

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Representative Projects

- CACHYS™ Post Combustion CO₂ Capture:
 - Testing phase
 - Commercialization Strategy and Plan
- Underground Coal Gasification
- Well Flaring (proposal stage)
- Mercury Emission Control Taconite
- Oil and Gas Well Performance Forecasting

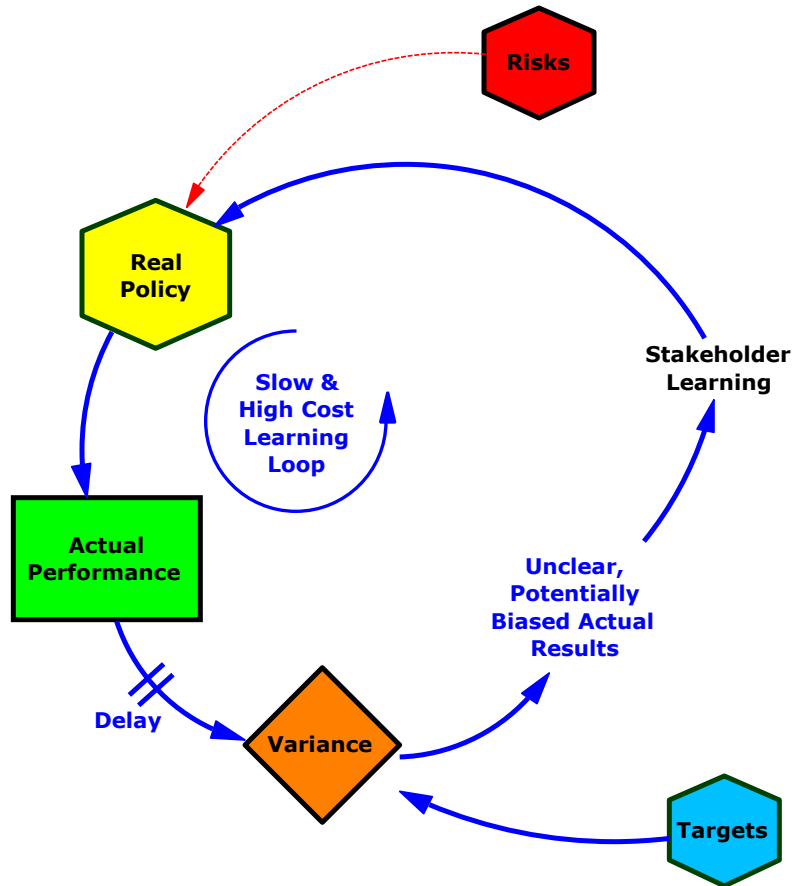
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Key Collaborations

- Petroleum Research School of Norway (NFiP)
- UND College of Engineering and Mines and Faculty of Social Sciences, University of Bergen (UiB), Norway for **System Dynamics**
 - Pål Davidsen, UiB
 - Erling Moxnes, UiB
 - David Wheat, UiB
 - Scott Johnson, UND

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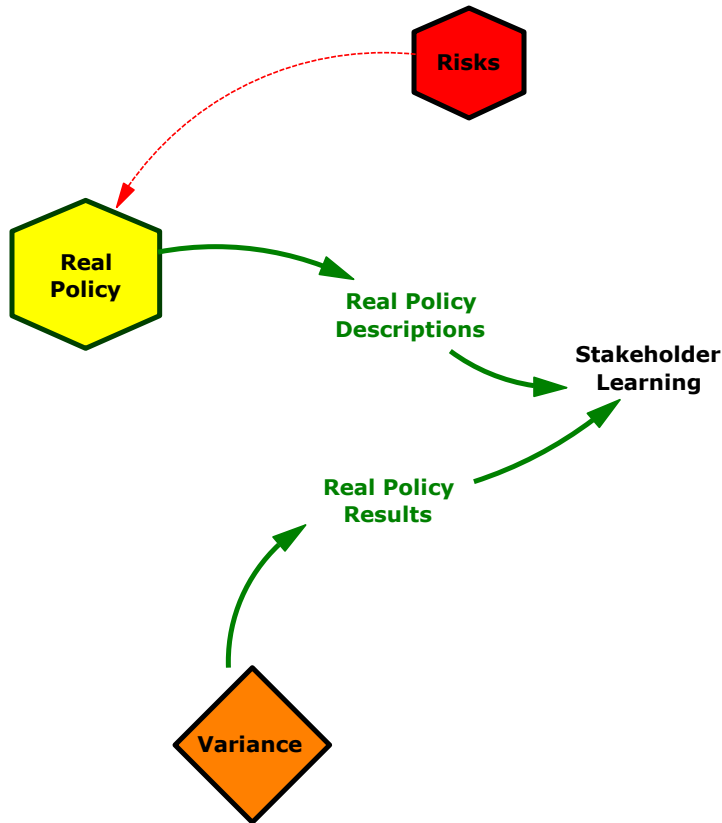
How do we learn about policy choices?



- Often slowly, over time
- Sometimes at a high cost
- Inconsistency across stakeholders(?)

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Step 1. – Develop policy descriptions.

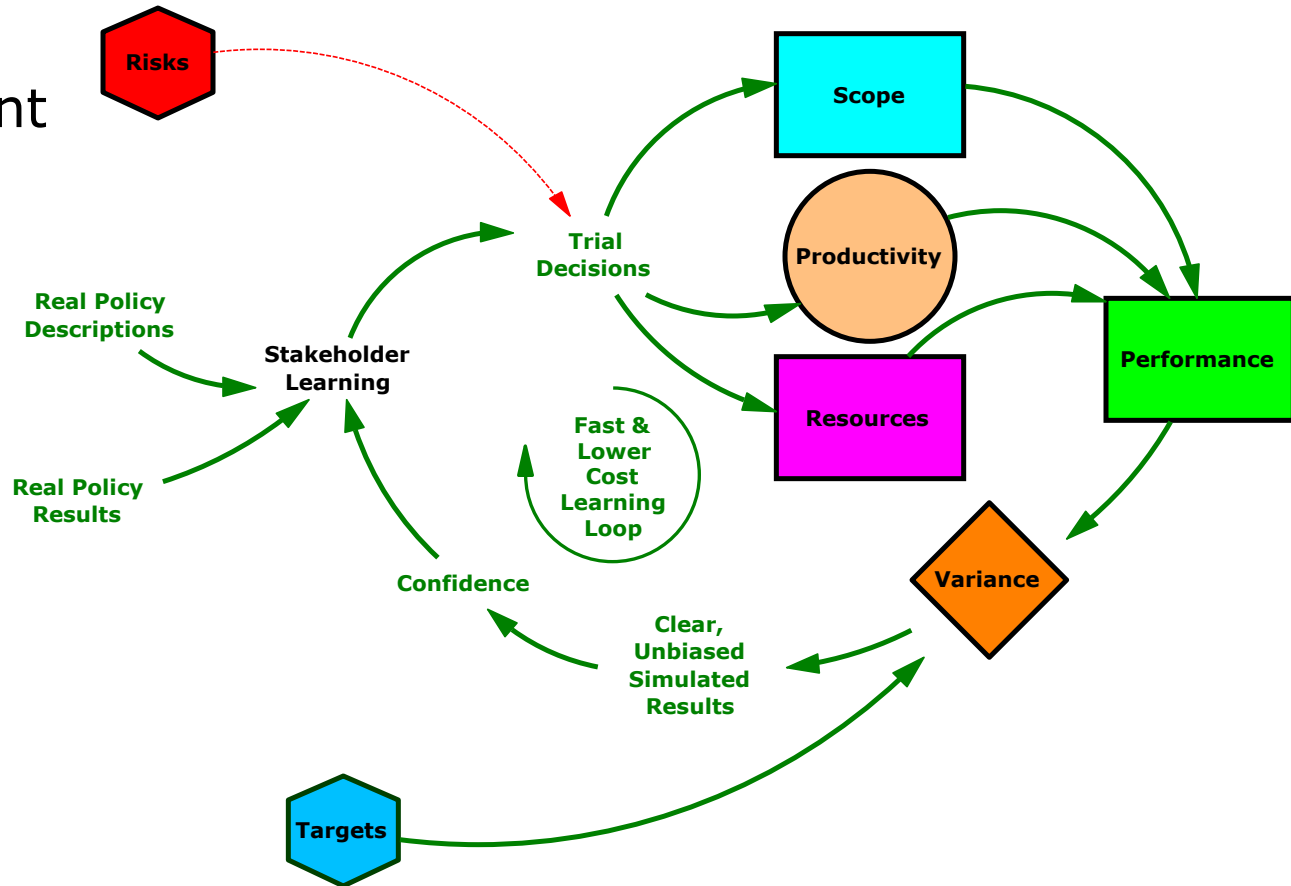


- Policy descriptions: structure & behavior
 - ✓ Goals
 - ✓ Constraints
 - ✓ Real world factors
 - ✓ Causality – what causes what
 - ✓ Key feedbacks
 - ✓ Reference modes
 - o Planned
 - o Feared
- Gather early policy results
 - ✓ Measure key variables
 - ✓ Compare time-series

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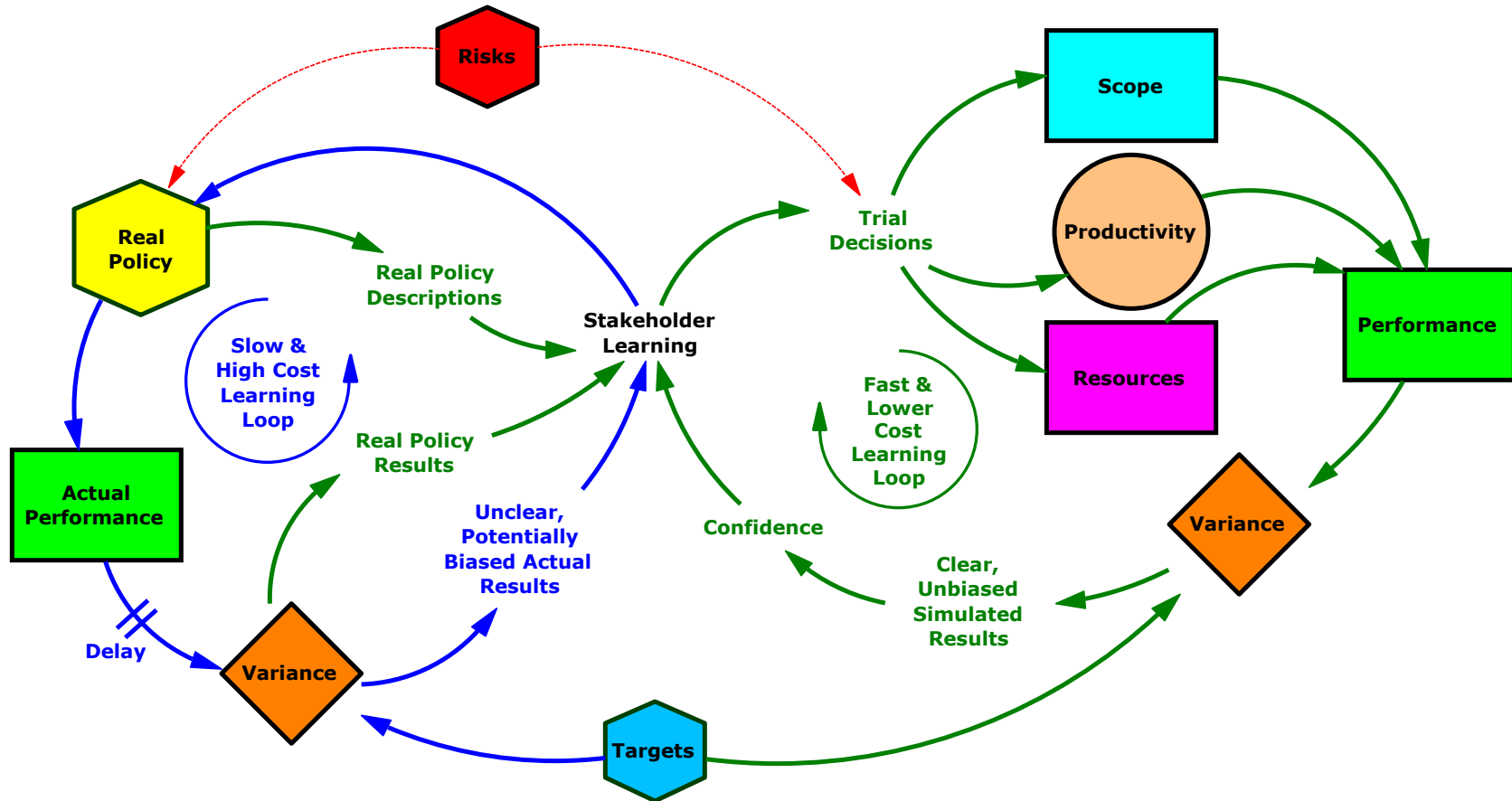
Step 2. – Modeling and simulation.

- Benefits:
 - ✓ Transparent
 - ✓ Safe
 - ✓ Challenge
 - ✓ Inclusive
 - ✓ Formulate policies
 - ✓ Monitor policies
 - ✓ Etc.



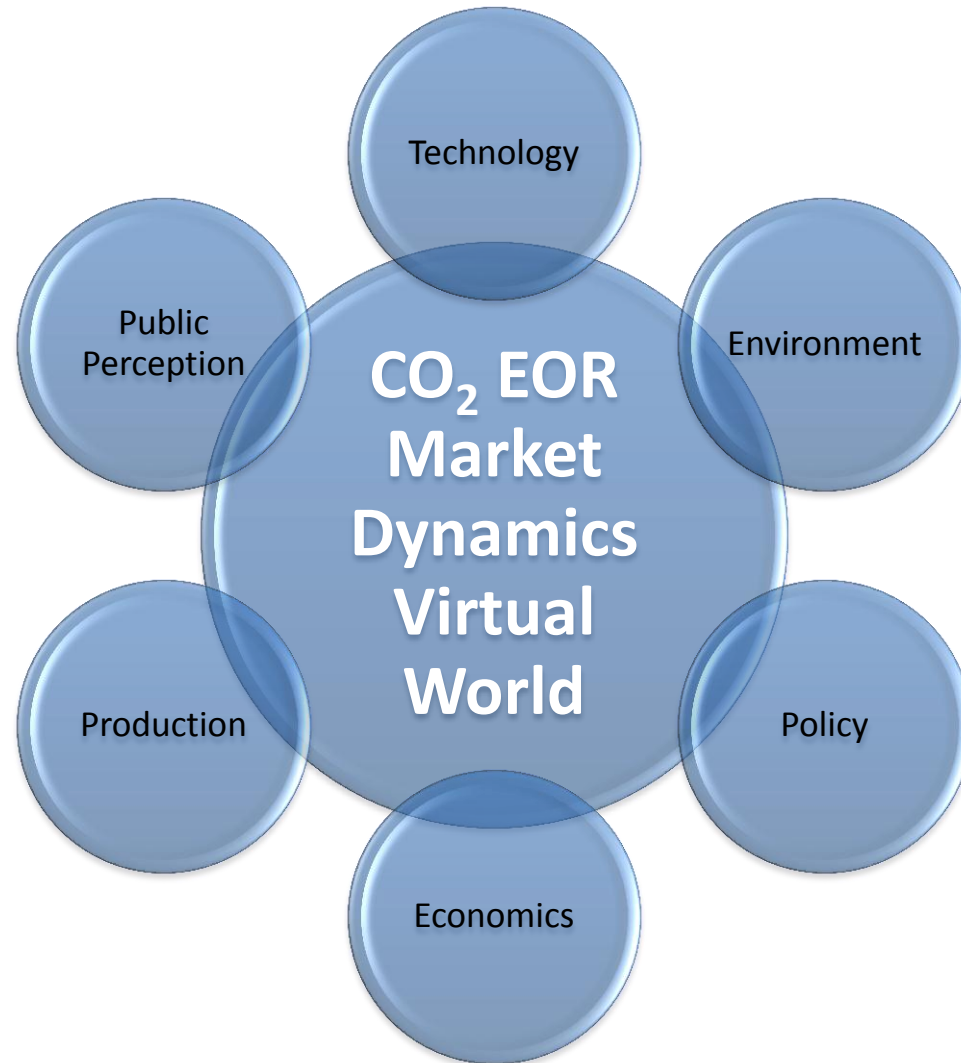
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Why use 'Virtual Worlds' ?



TEST plans & key decisions **BEFORE** you have to **ACT!!**

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Institute for Energy Studies (IES) Virtual World: Interface

KPI Management Flight Simulator

Instructions

Goal: Manage Process Performance for Business Impact

How? Understand Leading Indicators & Decision Levers

Step 1: Context Step 2: Simulate Step 3: Introduce KPIs Step 4: Simulate Step 5: Leverage KPIs Step 6: Simulate

Step 1 Step 2 Step 3 Step 4 Step 5 Step 6

Core Business Process Cycle Time Reduction View Model Diagram

Week: 156

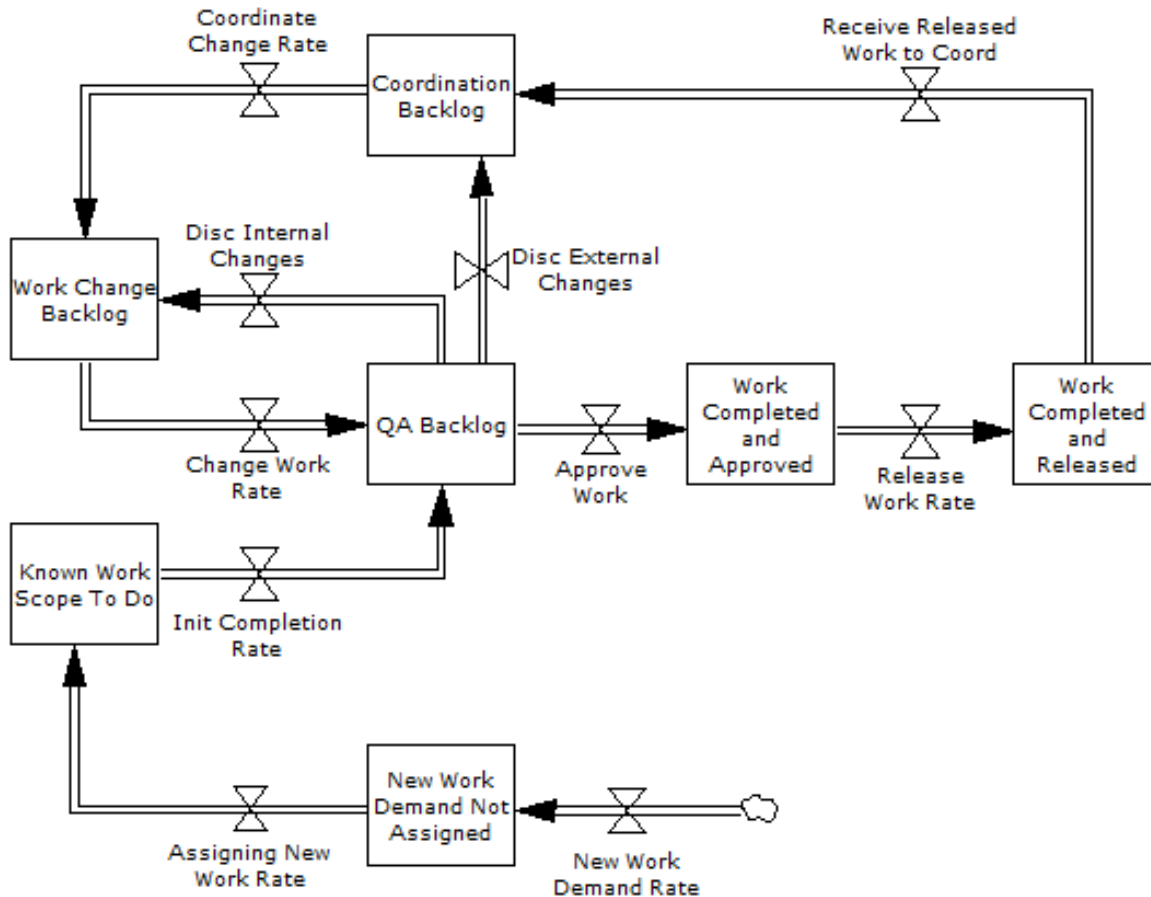
Set Staff Target - People

Schedule Overtime

Assign Labor - People

Assign Work - Task/Wk

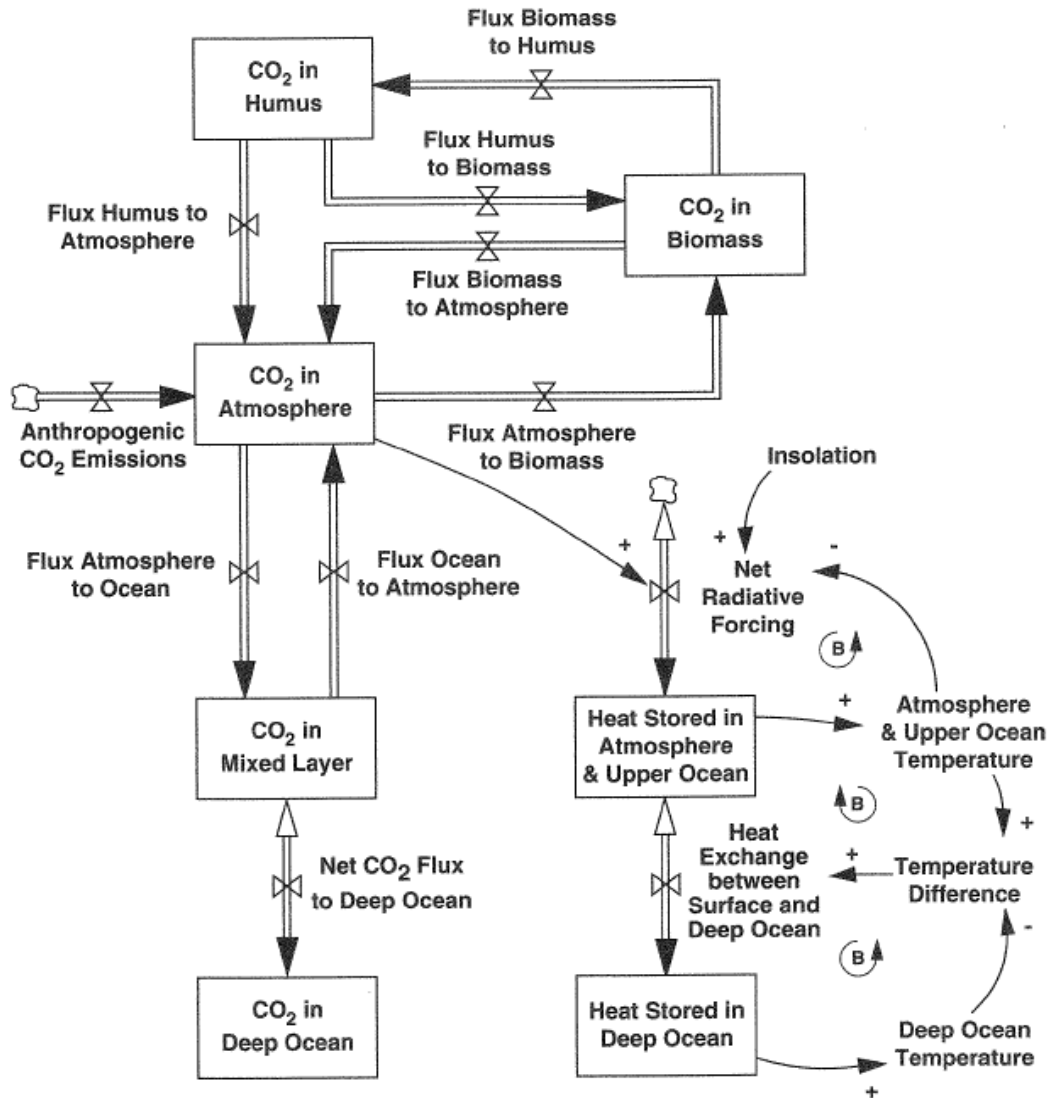
Institute for Energy Studies (IES) Virtual World: Model



Six Phases Modeled

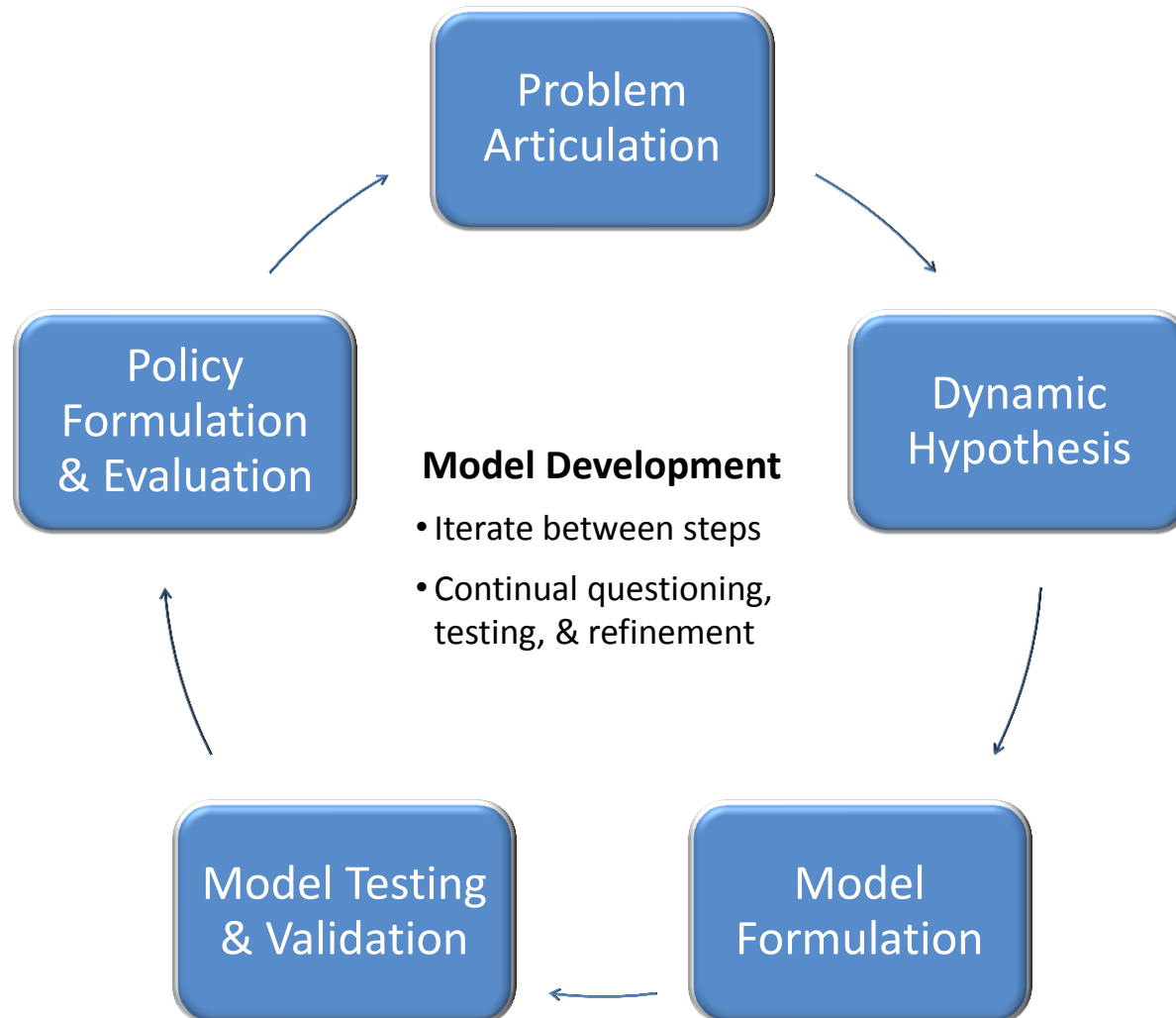
- Opportunity ID
- Planning
- Material
- Scheduling
- Logistics
- Labor

Institute for Energy Studies (IES) Virtual World: Model



Source: Adapted from Fiddaman (1997).

Institute for Energy Studies (IES) Simplified Model Building Process



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Virtual World Development Principles

- Interface:
 - Shield user from unnecessary model complexity
 - Focus user on key decisions and behaviors
 - Provide user tools to understand ‘why’
- System Dynamics Model:
 - Team: modeler plus domain experts
 - Maintain focus on the ‘problem’
 - Start top-down . . . add detail ‘only’ if necessary

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Virtual Worlds In Action



Institute for Energy Studies Virtual Worlds In Action



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Virtual World: Who uses them?

- The Dynamics of Climate Change: Understanding and influencing the planet's future
 - <https://www.youtube.com/watch?v=EDI7bZbGxNI>
- ReThink Health: Simulation models supporting local solutions to a national problem
 - <http://www.youtube.com/watch?v=1PmpVTJpLLM>

Institute for Energy Studies (IES) Virtual World: Who uses them?



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News

23 Jul 2013: C-ROADS receives System Dynamics Society award

26 Jun 2013: The Climate Leader systems thinking trainings announced

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News

- 23 Jul 2013: C-ROADS receives System Dynamics Society award
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Virtual World Uses

- Research:
 - Describe and explain CO₂ EOR market dynamics
 - Scenario planning
- Education:
 - Equip students with wider perspective
 - Technical, environmental, social, and policy
 - Support entrepreneurial thinking
- Outreach:
 - Facilitate constructive dialogue
 - Influence public policy