Integrating Energy Modeling with the Environment, Economy, & Society

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The Millennium Institute

- MI is a not for profit established in 1983 to promote integrated, long-term, global thinking.
- MI has assisted over 45 countries in preparing strategic studies of sustainable development.
- Our tool, Threshold 21, based on System Dynamics, integrates a wide range of sector models to reflect observed real world relationships and to analyze cross sector links and feedbacks.
- T21 is composed of three main pillars rising from a foundation of energy: the economy, society, and the environment; it is adapted to country-specific issues.
How T21 Functions

- GDP
- Employment
- Capital
- Investment

Economy

R
How T21 Functions 3
The Key Connections in T21
T21 Integrates Effects of Policies

- Shows how the three pillars and various sectors interact, including positive and negative feedback
- Generates continuous long-term scenarios that provide a better framework for strategic planning
- Compares policy options in terms of economic, social, and environmental results, rather than an “optimal” solution, so it promotes dialogue
- Helps identify risks and ways to mitigate possible negative side-effects
- Is transparent and readily modified or adapted to add more detail or different views of the underlying structure
Examples of Energy Issues

• Oil demand continues to grow, production cannot continue to grow indefinitely, so prices will rise
• North America and the world are facing a transition from cheap and plentiful energy to scarce and pricey energy
• The challenge is how to manage that transition while protecting good living standards and growth
• With the right policies, we can manage the global energy transition
• With ineffective policies or external shocks, we face high risks of a serious setback and stagnation
Application Example of T21

• Compare the implications of EIA and ASPO assumptions about oil production
• Examine how to deal with direct and indirect effects and manage a transformation
• Investigation could include:
  – Can we increase use of alternative sources of energy?
  – What about increasing the efficiency of energy use?
  – Can we increase energy conservation?
  – What are the impacts of valid regional, national and state energy policies?
  – What are the costs and benefits of different policies, in dollars and impacts of living standards?
Oil Production: EIA and ASPO MB

The graph shows the comparison of world oil production estimates from EIA and ASPO from 1980 to 2050. The EIA data is represented by the green line, the ASPO data by the red line, and the blue line indicates the data. The graph illustrates a gradual increase in oil production from 1980 to a peak around 2020, followed by a steady decrease towards 2050.
...and Oil Price: EIA vs ASPO (UD$/B)
The Impacts Look Like ... US GDP (Real USD 2000/year)
Addressing The Challenges ... 
US GDP (Real USD 2000/year)

![Graph showing US GDP growth over time with different scenarios: Market Low URR, Emissions Low URR, Renewable Low URR, Data, T21-USA (CBO, EIA).]
What Do We Learn?

- T21 shows how various options affect major indicators over time
- It demonstrates both positive and negative impacts throughout the whole system
- For example, raising CAFE reduces fuel consumption in the medium term, and leads to higher GDP, which over the longer term, raises energy consumption and CO2 emissions. It helps, but more actions are needed.
- Graphical display of results facilitates stakeholder discussion and exploration
Center for Resilience

An interdisciplinary center dedicated to improving the resilience of industrial systems – the capacity to survive, adapt and flourish in the face of turbulent change.

External Advisory Board:
AEP, Chevron, City of Columbus, Duke, Dow Chemical, EPA, General Motors, JCPenney, Limited Brands, Scotts, SWACO
Industrial Ecology Project

Industrial ecology is a process systems approach that mimics natural cycles, converting waste into “food”
Project Background

- **Eco-Flow™** is a modeling tool that helps optimize the financial and societal benefits of industrial ecology – developed at OSU.

- EPA ORD awarded OSU a STAR grant to create an Industrial Ecosystem Toolkit including **T21-Ohio**.

- OSU is working with the U.S. Business Council for Sustainable Development (USBCSD) to encourage a systems approach to sustainable business practices.

- **Eco-Flow™** is currently being applied to the **Kansas City Byproduct Synergy Network**.
Kansas City
Byproduct Synergy Network

Estimated Savings
$15 million per year
Multi-Scale Modeling

- **T21-USA**
  - National Scale Policy Implications

- **Eco-Flow™**
  - Regional Aggregation

- **T21-Ohio**
  - Policy Implications

- **Eco-Flow™**
  - Industrial Network Configuration and Optimization

- Economic Benefits (e.g., Employment)
- Life Cycle Analysis (e.g., Eco-LCA)
- Sustainability Indicators (e.g., TRACI)

Secondary analysis modules
Pathways for Biomass to Energy

- **Municipal Solid Waste**
  - Landfill
    - Landfill Gas
      - Lignin
      - Energy Feedstocks
        - Internal Combustion
        - Micro turbine
        - Fuel Cell
        - Direct Fire
        - Co-Fire
      - Electric Power
      - Electric Power

- **Material Recovery Facility**
  - Recyclables (glass, metal, plastic, rubber, etc.)
  - Anaerobic Digestion
    - CH4 & CO2
  - Gasification
    - SynGas
    - H2 & CO
  - Pyrolysis
    - Oil
  - Energy Feedstocks
    - Internal Combustion
    - Micro turbine
    - Fuel Cell
    - Direct Fire
    - Co-Fire
    - Heat or Steam

- **Recovered Biomass** (paper, cardboard, yard waste, food scraps, etc.)
- **Biomass from Waste**
  - Source Separated Biomass
    - (wood, food crops, grassy & woody plants, ag & forest residue)
  - Biofuels
    - (ethanol, biodiesel, mixtures, etc.)
  - Bioproducts
    - (chemicals, plastics, adhesives, etc.)

Source: Mike Long Resource100
Thank You for Your Attention

Questions and comments are welcome

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