



Are We Missing Something?

Yes, and Altos has a solution.

by

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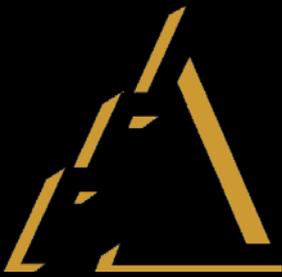
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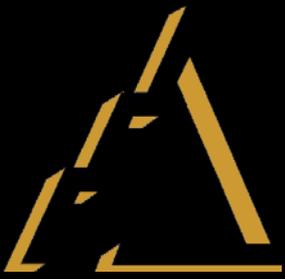


There Just Aren't Any Simple Problems Any More

- **Single fuels (e.g., power only)**
- **Single regions (e.g., North America only, NWPP only, Oregon only)**
- **Single nodes**
- **Single market segments (e.g., pipelines only, upstream only)**
- **Single technical issues (e.g., power flow models, hydraulic models)**
- **Single issues (e.g., margin compression from LNG entry, transmission operation)**
- **Single scenarios (e.g., deterministic models)**
- **Statistical correlations among prices that are not completely misleading.**
- **Retainer studies contribute little**
- **Real world problems are horizontally and vertically interconnected and strongly multidisciplinary**
- **Real world problems require that we represent a market with a multiplicity of independent, goal seeking agents and that we integrate that with a definitive representation of the “chemistry and physics”**



Prerequisites for Success in Power/Energy Modeling



Prerequisite No. 1

PROBLEM

- 1. Geographic diversity**

SOLUTION

- 1. GIS coupled with graphical “Tinkertoy Set” for building models**
 - ✓ You must be able to “drag and drop” regions hierarchically into your model.
 - ✓ You must be able to use a GIS to characterize each region at whatever level of the hierarchy.
 - ✓ **Altos has that in our modeling system today.**
 - ✓ Spatial economic/physical approach
 - ✓ Different fuels have different regional characteristics

Altos Offers Hierarchical Regionality

- Root
 - WGTM
 - Africa
 - Demand: North Africa
 - Demand: Algeria
 - Demand: Libya
 - Demand: Tunisia
 - Demand: Other Africa
 - Supply: Nigera Supply
 - Supply: North Africa
 - Supply: Northwest Africa
 - Supply: Oil in Africa
 - Supply: Southwest Africa
 - Australia
 - Europe
 - Latin America
 - Demand: Brazil
 - Demand: Mexico
 - Demand: Northern South America
 - Demand: Southern S. America
 - Supply: Bolivia-Chile-Argentina
 - Supply: Brazil
 - Supply: Columbia-Ecuador-Peru
 - Supply: Mexico
 - Supply: Oil in Latin America
 - Supply: Trinidad-Tobago
 - Supply: Venezuela
 - Mainland Asia
 - Middle East
 - Pacific Rim
 - Russia
 - World LNG Liq/Regas
 - World Oil

Hierarchical regional representation

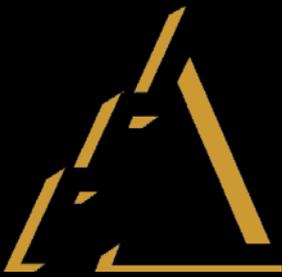
Today

Diagram and map of selected region

Actions Logic Views

Market Model

Palette of actions



Prerequisite No. 2

PROBLEM

2. **Facility/asset enumeration**

SOLUTION

2. **Graphical process “Tinkertoy Set” with unlimited expansion capability**

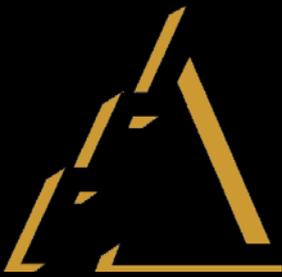
- ✓ You must be able to drag and drop facility nodes into your model.
- ✓ You must be able to drag facility nodes on top of a GIS
- ✓ You must be able to aggregate or disaggregate
- ✓ **Altos has node based drag and drop in our modeling system today**
- ✓ Different fuels use different facilities



Altos Has Process Networks Overlaying Maps at Whatever Level You Want



Source: MarketBuilder screen
from Altos NARG



Prerequisite No. 3

PROBLEM

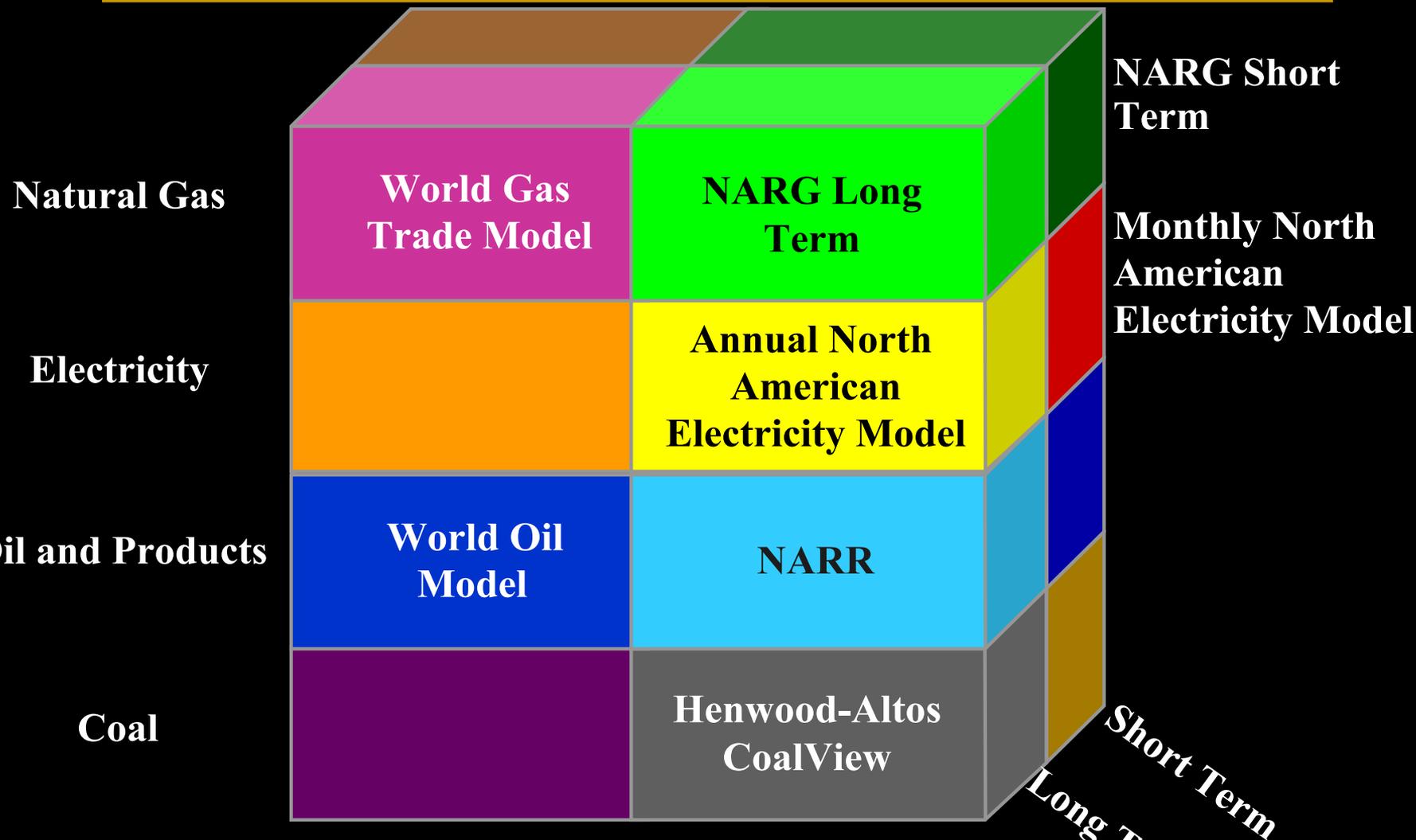
3. **Everything is connected to everything else (which means you cannot ignore fuels, demand elasticities, etc.)**

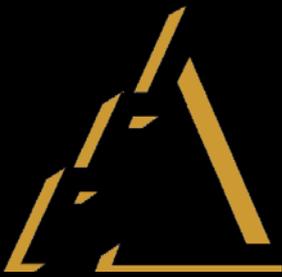
SOLUTION

3. **All your models need to be housed within a common software platform so they can be interconnected**
- ✓ **Altos has comprehensive power, gas, oil, products, and coal interconnected today**
 - ✓ **Standalone models are naïve models**
 - ✓ **Single fuel models are naïve models**
 - ✓ **Single issue models are naïve models**



Altos Today Offers a Complete, Maintained, Fully Interconnected Suite within MarketBuilder





The Altos Gas and Power Models Were Selected and Coupled by the National Petroleum Council (2003)

■ Andrew Slaughter, Shell (Lead)

✓ 281-544-4992, andrew.slaughter@shell.com

■ Ken Medlock, formerly El Paso, now Rice University

✓ 713-348-3757, medlock@rice.edu

■ Mike Hupp, Dominion

✓ 804-819-2388, Michael_Hupp@dom.com

■ Meg Gentle, Anadarko/Cheniere

✓ meg.gentle@cheniere.com

■ Gary Tsang, ExxonMobil

✓ 281-654-4203,
gary.h.tsang@exxonmobil.com

■ Rusty Riese, BPAmoco

✓ 281-366-0775, rriese1@bp.com

■ Red White, ExxonMobil, retired 2004

✓ 713-864-7213, redwhite@houston.rr.com

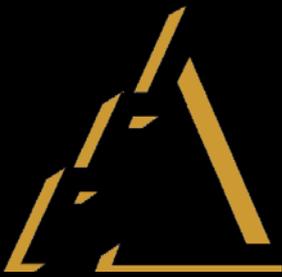
■ Contributors: Keith Barnett, AEP; Ken Logan, TransCanada

■ They used NARG for gas integrated with NARE for power.

■ They reported the forward market situation in North America to Secretary of Energy Spencer Abraham

■ Their workproduct, a major step forward, is completely available under license through Altos and the NPC.

■ Contact John H. Guy, NPC, (202) 393-6100 to request the Supplementary Modeling Team (Altos model) workproduct.



Prerequisite No. 4

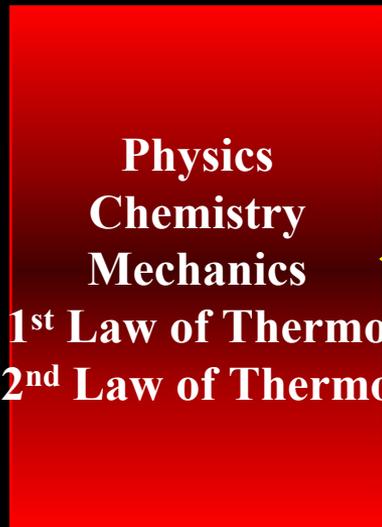
PROBLEM

4. **Single purpose models are largely useless**

SOLUTION

4. **You have to have “physics and chemistry” integrated into economic models.**

✓ **“Dispatch” is NOT economics**



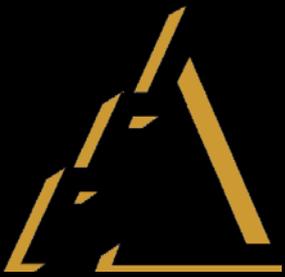
**Hydraulic models (Stoner)
Power flow models (PTI, Power World)**



Market model



**Real options models
(FEA, Amram)**



Prerequisite No. 5

PROBLEM

- 5. The world is nonlinear, and very highly so.**

SOLUTION

- 5. Inherently nonlinear equations and solution technique ONLY.**
 - ✓ Linear programming is called “linear” for a reason.
 - ✓ Linear differential equations are called “linear” for a reason.
 - ✓ Discrete linear approximations to nonlinear models are computationally wasteful (and usually intractable)
 - ✓ **Altos is intrinsically nonlinear.**



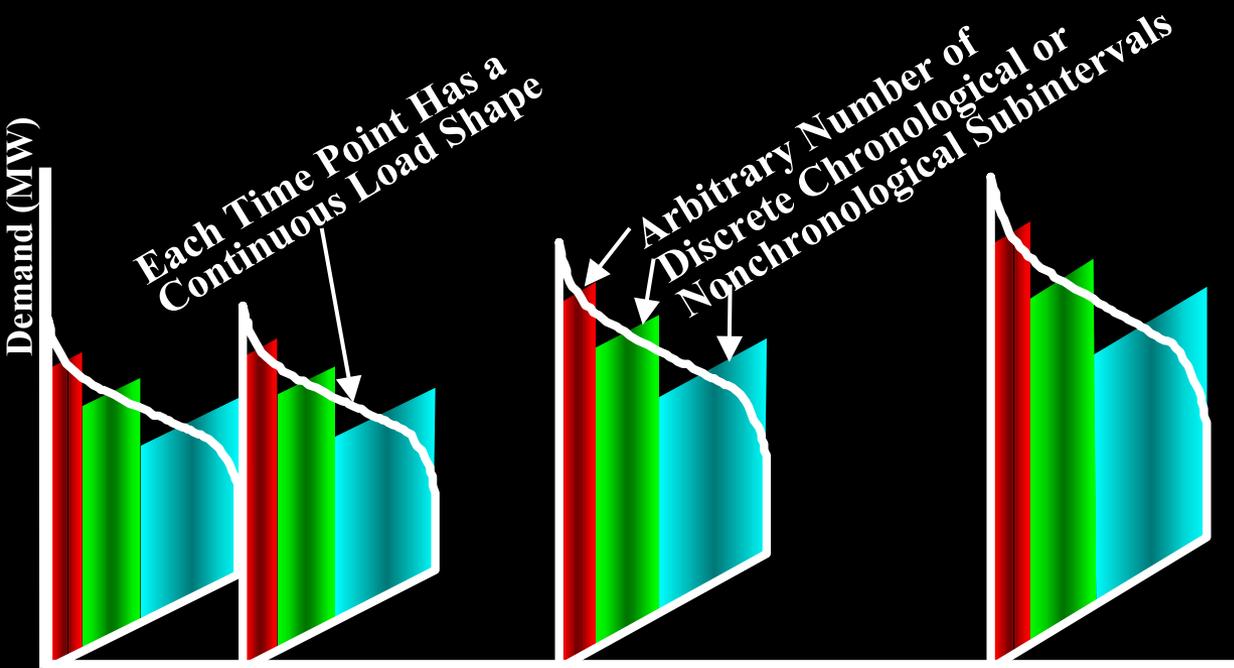
Prerequisite No. 6

PROBLEM

6. **Completely general temporal structure**

SOLUTION

6. **Continuous forward timeline with arbitrary and different time increments**



- ✓ You must be able to skip intervals
- ✓ Integrals and derivatives across time intervals must be pre-programmed
- ✓ **Altos has this**



Prerequisite No. 7

PROBLEM

7. **The agent decision space is huge**

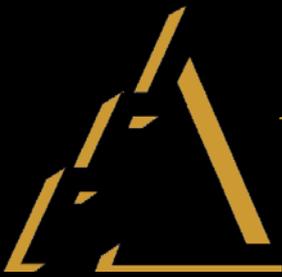
SOLUTION

7. **Price iteration**
- ✓ You just cannot get there with mathematical programming, simulation, systems dynamics, or “genetic algorithms”
 - Compute time
 - Roundoff/truncation
 - Algorithmic “drift”
 - Conceptual and empirical deficiencies
 - ✓ **Altos does price iteration across fuels, geographies, and times now**



Altos Has This in Place Today

- **Altos has tried to build the “ideal economic modeling system.”**
 - ✓ **It links together disparate models, whether built by Altos or by others.**
 - ✓ **It can benefit from better embedded**
 - **Physics and chemistry**
 - **Uncertainty (my next talk)**
- **Altos is licensed and operational at a number of sites throughout the world.**
- **I will demo it for anyone who wants after the session or any time of your choosing.**



Altos Is Not the New Kid on the Block, We Are the Old Kid (30 Years)

- 1965: Mexico CFE Model
- 1973: SRI-Gulf Model
- 1977: EIA LEAP Model
- 1979: TVA SAM Model
- 1981: EPRI IFM and LMSTM
- 1982: DOE World Oil Model
- 1983: North American Regional Gas (NARG) Model
- 1988: California Refining/Transportation Model
- 1989: World Gas Trade Model (WGTM)
- 1991: Crude Quality Model
- 1991: Western European Gas Model
- 1992: Southern Cone (South America) Model
- 1993: OG&E, Duke, Minnesota Power, SCE, CIPSCO, PP&L competitive electric models
- 1995: Southeastern Australia Model
- 1995: PanEnergy North American Regional Electricity Model
- 1995: Altos North American Electricity Model
- 1998: Altos Short Term NARG Model
- 2002: Completely Modernized Technology
- 2003: Modernized World Oil and Gas Models
- 2003: USGS and NPC partnerships
- 2004: Henwood partnership

We took the most established model in the business out of the market for almost six years to modernize it.

