Predicting the Future: Evaluating Technology through Dynamic Stochastic Economic Modeling

(or: why engineers and economists need to talk)

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This should never be applied to fundamental research, unless "cheaper" "more efficient" etc. is claimed.

Dynamic Predictive Technology Modeling: Approach

Preferably prior to or at most in parallel to any laboratory/bench/pilot research

Process Engineering

Material- and Energy Balances

Spreadsheet based
Steady State process modeling,
Aspen Plus

as needed: Aspen Dynamics

Math: systems of algebraic (steady state) or differential (dynamic) equations

It is not acceptable to avoid this by saying that research/development must be done first, then the promising impact will be shown later. Overall economics (including feedstocks, non-ideal conditions, waste treatment, public opinion, politics, policies...) are to be shown first IF the "cheaper/more efficient" argument is used. Capex/Opex is never sufficient.

Team:
Engineers and economists are required, scientists as needed.

Audience: Industry, venture capital, government agencies, your research group

Economics

Dynamic economic simulation
define sources, sinks, processes, markets, tax/government support, relationships, set up Stella model

Math: systems of differential equations

Dashboard type live dynamic what-if, scenarios:
Policy changes, market changes, technology improvement, impact of discoveries

Decisions

no go

go

fund research, invest, plan work ...

Dynamic Predictive Technology Modeling
Success Stories

Bio-Butanol, 2010:
predicted that no fuel bio butanol will be produced, also predicted fuel bio ethanol return to positive territory in 2014
Proof: no fuel butanol industry emerged. Fuel bioethanol returned to profitability as predicted.

Fuel from algae, 2011:
predicted that no success is possible without very substantial government support.
Proof: no algae fuel is being produced.

Renewable Solar Thermochemical Ammonia, 2012:
Work was started with dynamic predictive modeling, not lab work. The technology approach appeared reasonably competitive with state of the art natural gas based ammonia even with no benefit from avoiding fossil CO2.
Proof: substantial industry- and government funded work towards renewable ammonia is in progress globally (electrolytic hydrogen production is currently favored). Renewable ammonia will first be used to decarbonize shipping, with outlook to use it as a hydrogen vector.

Ongoing:

Small Scale Renewable Ammonia from Wind:
Under way, via NSF INFEWS project. Viability of small scale renewable ammonia synthesis in the Midwest U.S. is the focus. Engineering is ready to be integrated into dynamic economic modeling. Engineering economics (capital & operating cost) look promising, dynamic economic modeling will show overall viability.