Burk Engineering

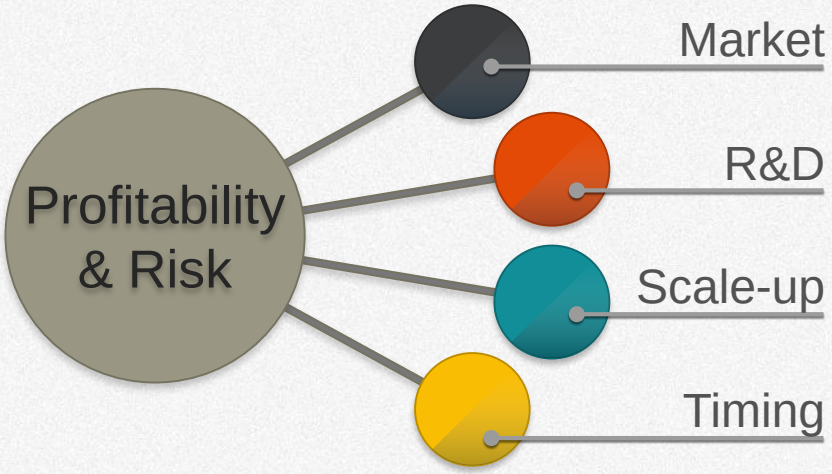
Techno-economic analysis

for new chemical technology investing

Chris Burk, PE
cburk@BurkEngineeringLLC.com

TABLE OF CONTENTS

Chemical technology investments present unique challenges



Investing in a new chemical technology is different than, for example, investing in a new mobile app. It's not like you can lock a bunch of twenty-three year old chemical engineers in a closet for the weekend and expect them to emerge with a minimum viable product.

Capital and operating costs are high and depend strongly on the results of R&D and scale-up. Further, lengthy timelines increase chances that market conditions will change.

The impact of these factors can be difficult and time-consuming to estimate. So, they are often visited once at the beginning of a project and then largely ignored in favor of the tasks at hand.

This doesn't have to be the case. *Techno-economic analysis offers a way to rapidly assess and reassess profitability and risk in terms of process and market parameters* – a tool to select winning investments and to maximize their chances of success.

Aiming for success quantitatively

When evaluating a technology, you are concerned with its probable profitability. After you have invested, you are concerned with ensuring that development stays on track and is successful.

Evaluation stage

To identify winning technologies, you need to *accurately estimate economic value* for baseline and projected cases, using metrics like NPV and IRR.

You also need to assess potential *technology and market risks*. Technology risk is unavoidable when doing something for the first time. Market risks include fluctuations in raw material and product prices.

Execution stage

After an investment has been made, your focus shifts to facilitating development and tracking progress. You goal is to maximize chances of success and minimize time to market.

By *identifying and focusing on critical process parameters*, you maximize R&D efficiency. Through *regular reevaluation,* you quantitatively track progress and adapt quickly to changing priorities.

Tools for techno-economic analysis

We use techno-economic modeling to estimate economic value based on process and market parameters. By combining it with deterministic and stochastic sensitivity analysis (like Tornado and Monte Carlo analysis), we can quantitatively assess risk and identify the parameters that are critical to success.

	Techno-Economic Modeling	Tornado Analysis	Monte Carlo Analysis
Evaluation stage			
Economic value assessment			
Technology risks assessment			
Market risks assessment			
Execution stage			
Identify key opportunities			
Track progress			
Adapt to changing priorities			

What is a techno-economic model?

In a techno-economic model, profitability metrics are linked to process and market parameters through a network of correlations.

Process parameters

conversion
selectivity
pressure
efficiency

raw material prices
product prices
auxiliary services
financing options

Economic parameters

Techno-economic model

Economic & process metrics

CapEx, OpEx, Revenue

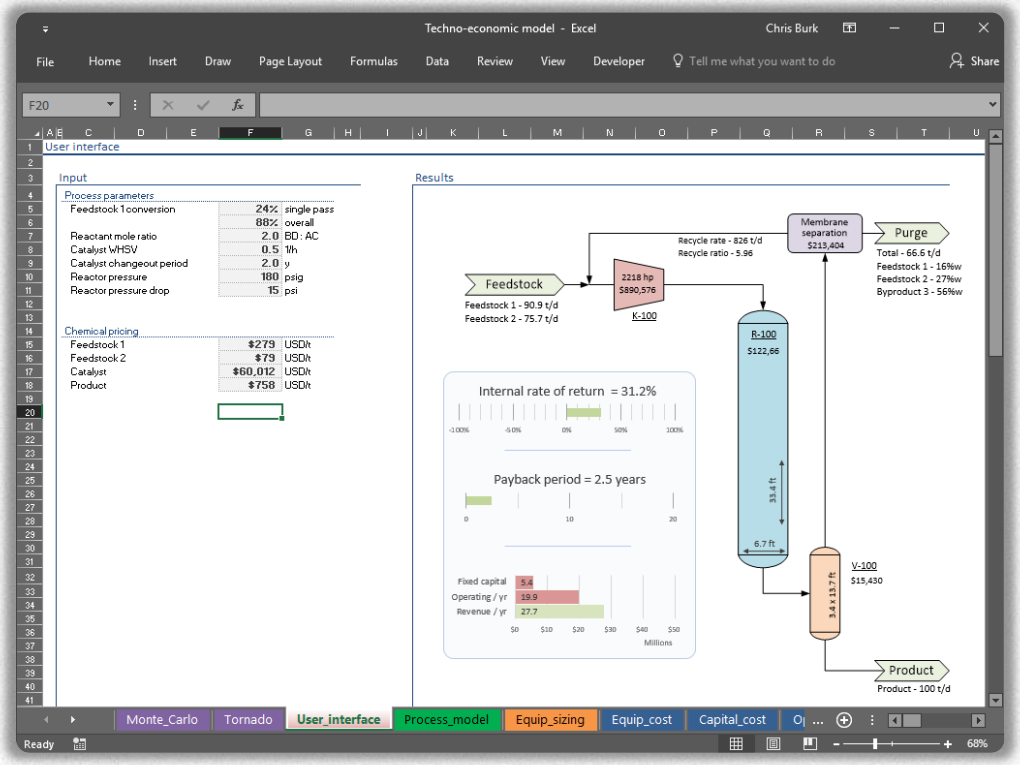
NPV, IRR, ROI, PBP

Process results

The techno-economic model, a new approach

Usability is central to the Burk Engineering approach to techno-economic modeling.

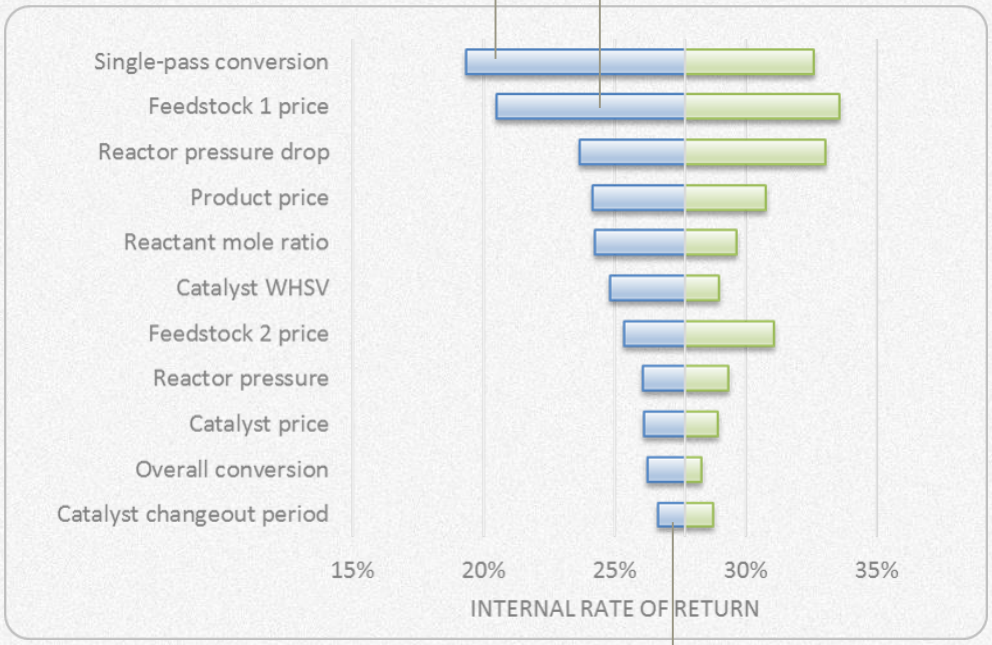
Burk Engineering models are modular, flexible, and fully documented, making them easier to understand, update, and test. Each model also comes with a custom intuitive user interface, allowing it to be used by engineering, science, and business personnel alike.



Identifying key variables with Tornado Diagrams

Improving single-pass conversion will yield the greatest increase in IRR

Feedstock 1 price has potential to strongly affect profitability



Further effort to improve catalyst changeout period will have minimal impact on IRR

Tornado diagrams help direct R&D efforts to the highest impact parameters.

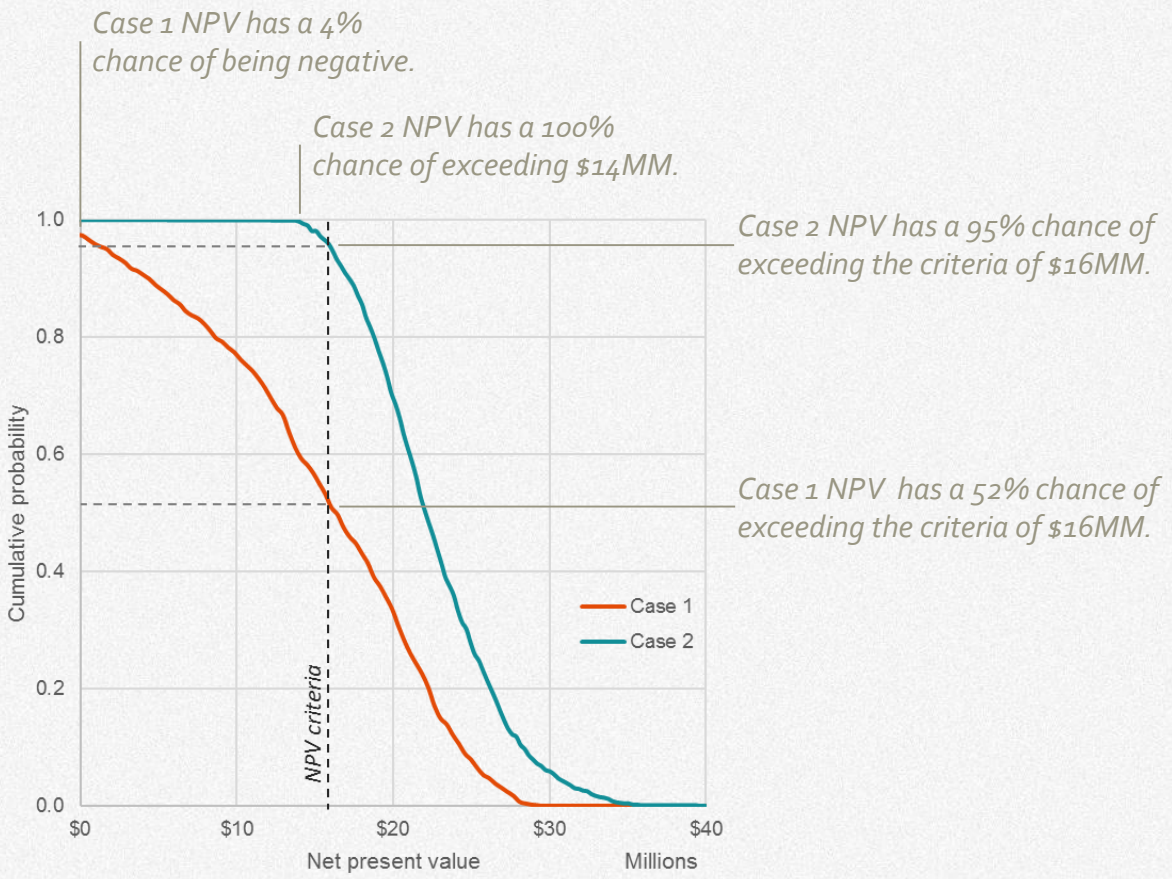
Tornado diagrams compare the impact of process and economic parameters on profitability. They let us identify the key variables that are critical to profitability.

Tornado diagrams are typically time-consuming to build, so they are underutilized despite being an excellent tool for prioritizing development. This is why *Burk Engineering techno-economic models include proprietary software that lets you build them automatically with the touch of a button.*

Quantifying risk with Monte Carlo Analysis

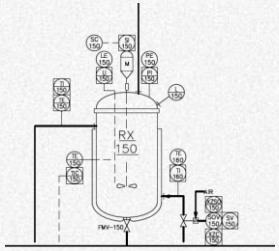
By compiling the results of thousands of simulations, Monte Carlo analysis brackets the range of possible outcomes and predicts the probability that any given case will occur.

Monte Carlo analysis is especially useful for quantifying the risk associated with fluctuations in raw material and product prices and for understanding the implications of uncertainty in CapEx, OpEx, and revenue.



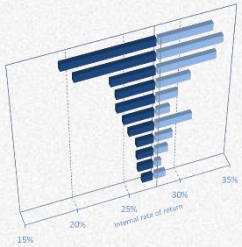
Monte Carlo analysis lets us quantify the risk associated with market fluctuations and uncertainty.

Why work with Burk Engineering



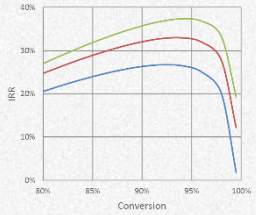
Engineering services

Process design goes hand-in-hand with techno-economic analysis. Burk Engineering can help design the process surrounding your chemical technology and then optimize it based on the techno-economic analysis results.



Quality and speed

Burk Engineering specializes in techno-economic modeling, and leverages years of experience, proprietary templates, custom software, and access to key resources, to give you the answers you need as efficiently as possible.



Credibility

The results of economic analysis are guaranteed to spark debate. Bringing in a credible third party reduces perceived bias and increases buy-in from all parties. It also leaves other personnel free to focus on development work.

Notes from recent clients

"Chris' work provided immediate value by giving us *insights into the economic impact* of each process operation. My team now has a list of priorities and a *clear roadmap for process optimization*."

Robert Ferris, PhD
Chief Executive Officer
Adama Materials Ltd

"Chris provided *high-quality, cost-effective design services* and was able to quickly come up to speed on new aspects of the project. We'll definitely be working with him again."

Philip Michael
VP Eng. & Prod. Dev.
New Sky Energy LLC

Photo: Chris (left) managing commissioning of a sour gas treatment pilot in Wyoming.

Chris Burk, PE
Professional bio

Chris is a Licensed Professional Engineer and holds Bachelors and Masters Degrees in Chemical Engineering from Cornell University.

Chris is a chemical process engineer with a knack for solving problems and building software tools, models in particular. He developed his skills and the experience to apply them through 12+ years working with new chemical technologies, ranging from lab-scale R&D to pilot plant operation.

He has worked with technologies from numerous industries, including oil & gas, specialty chemicals, sour gas, biogas, water treatment, nano-materials, electrochemical processes, membranes, and catalysis.

Industry experience

Independent consulting with Burk Engineering LLC	2015–2016
Start-up engineering, scale-up with New Sky Energy LLC	2013–2015
Pilot plant EPC with Continental Technologies LLC	2011–2013
Private & gov't funded R&D with Eltron R&D Inc.	2007–2012
Corporate R&D with AkzoNobel N.V.	2004–2006

Chris, left, managing commissioning of a first-of-its-kind sour gas treatment pilot plant.

Photo: Chris (left) managing commissioning of a sour gas treatment pilot in Wyoming.

Burk Engineering LLC

Salt Lake City

www.BurkEngineeringLLC.com

Chris Burk, PE
914.434.1529
cburk@BurkEngineeringLLC.com

Chris vacationing on the Eiger, 2015.