



Burk Engineering  
**Techno-economic analysis**  
for new chemical technology investing

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# 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.



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# Aiming for success quantitatively



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*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.*

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## 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. Your 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
<b>Evaluation stage</b>			
Economic value assessment			
Technology risks assessment			
Market risks assessment			
<b>Execution stage</b>			
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

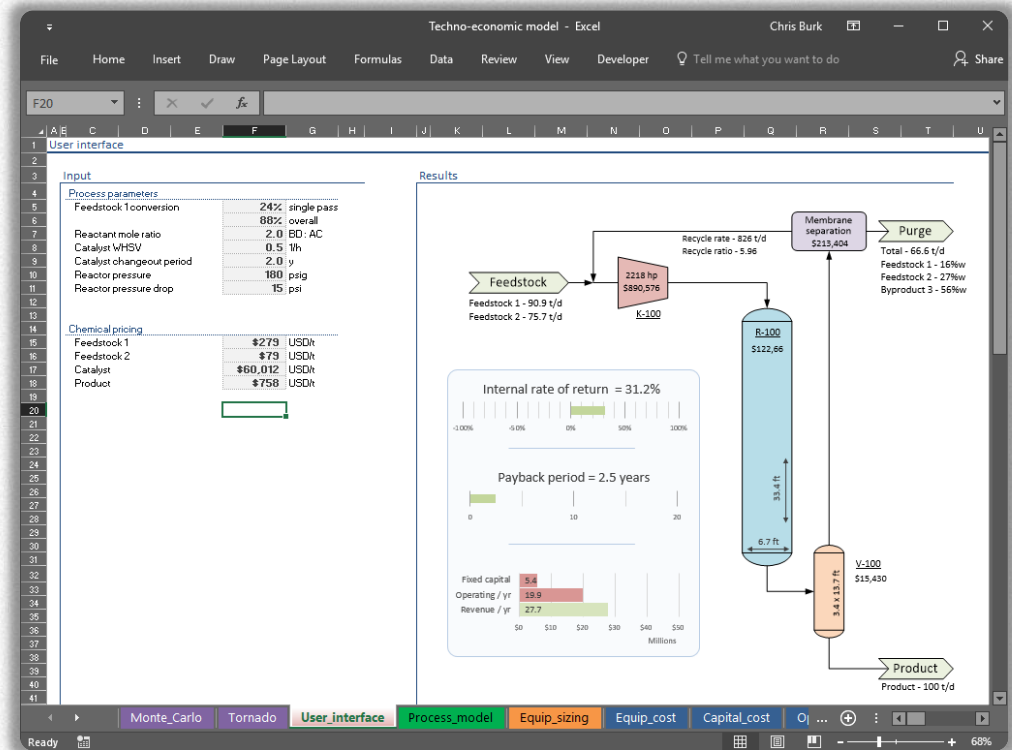


CapEx, OpEx, Revenue  
NPV, IRR, ROI, PBP  
Process results

# 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.



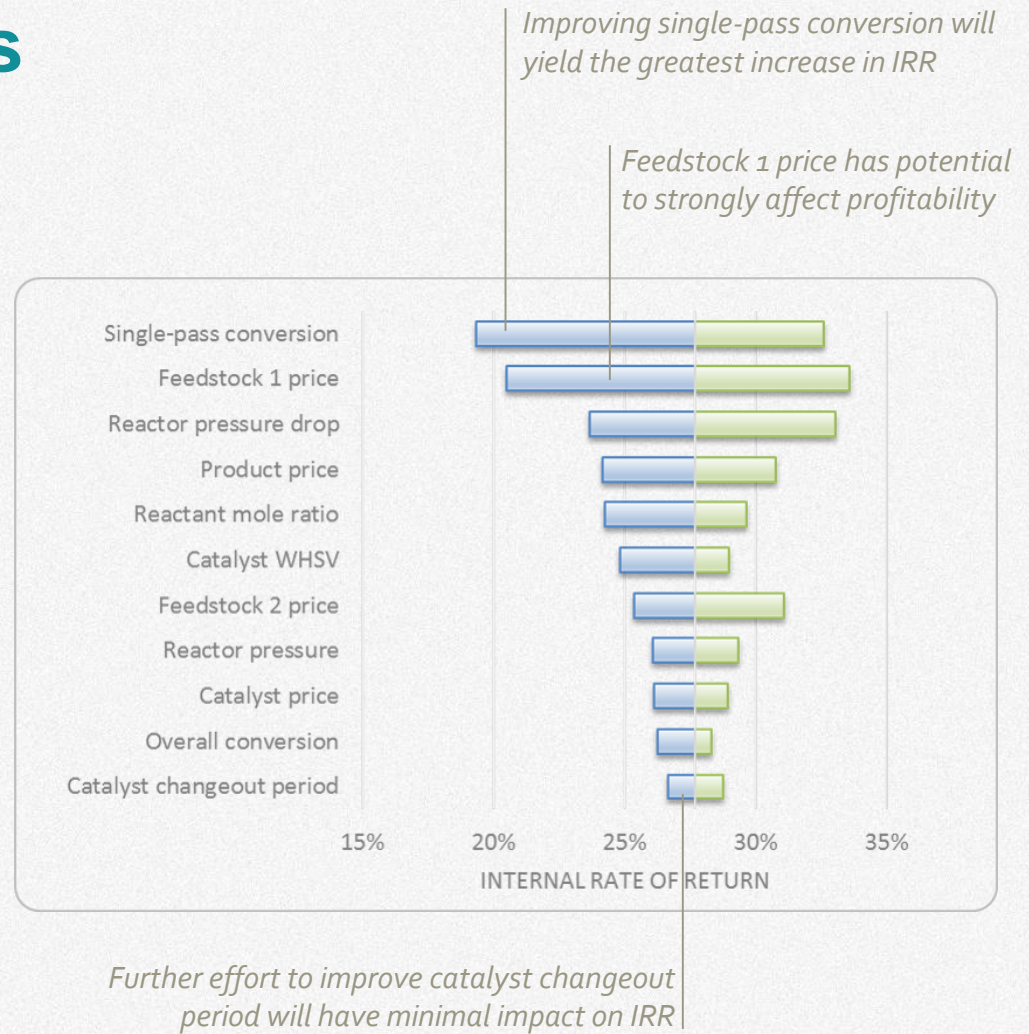


# Identifying key variables with Tornado Diagrams

*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.*

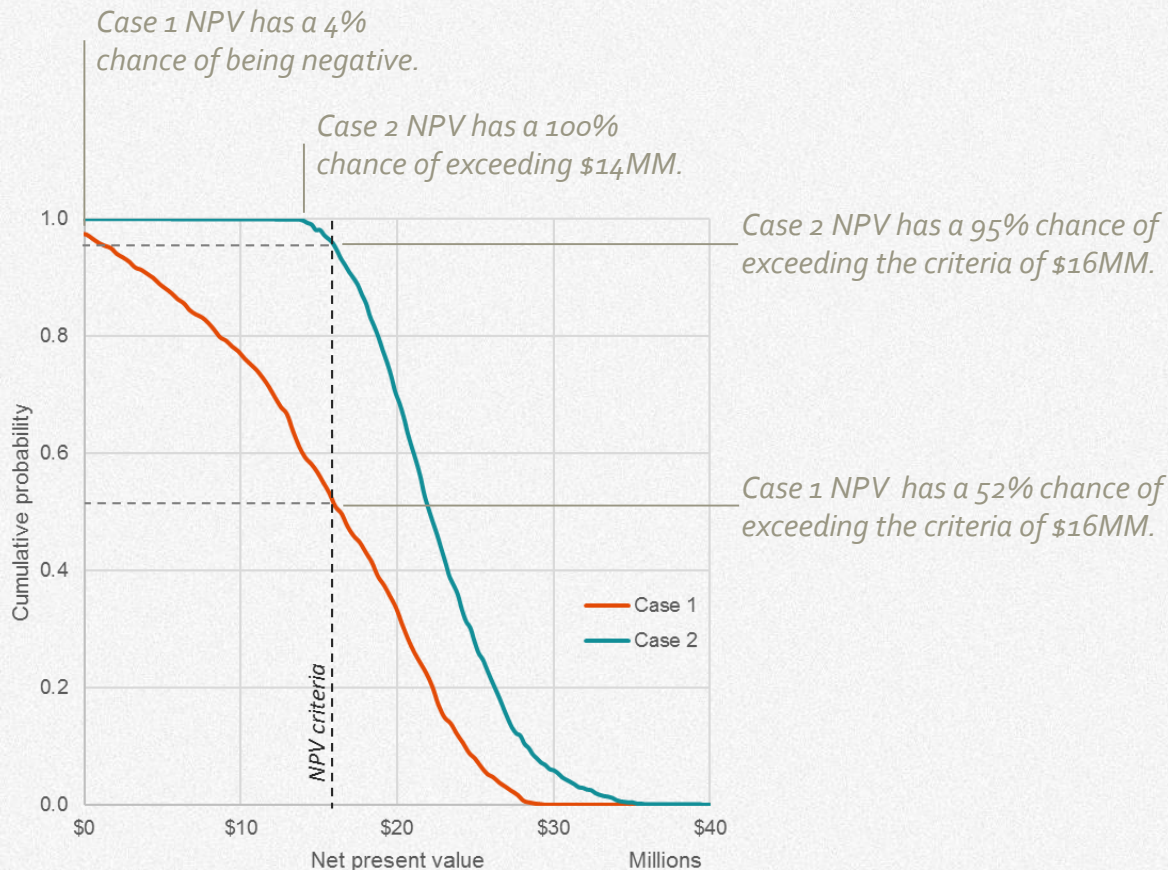




# Quantifying risk with Monte Carlo Analysis

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.

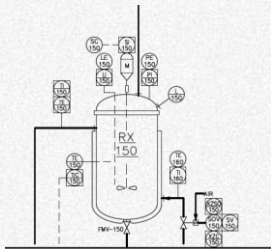
Monte Carlo analysis is especially useful for quantifying the risk associated with fluctuations in raw material and product prices and for understanding the implications of uncertainty in CapEx, OpEx, and revenue.



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

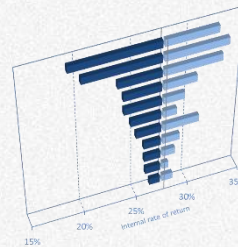


# Why work with Burk Engineering



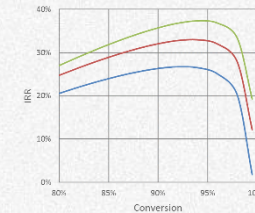
## Engineering services

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.



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## 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*



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# Chris Burk, PE

## Professional bio

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

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### *Industry experience*

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**Independent consulting** 2015–2016  
with Burk Engineering LLC

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**Start-up engineering, scale-up** 2013–2015  
with New Sky Energy LLC

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**Pilot plant EPC** 2011–2013  
with Continental Technologies LLC

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**Private & gov't funded R&D** 2007–2012  
with Eltron R&D Inc.

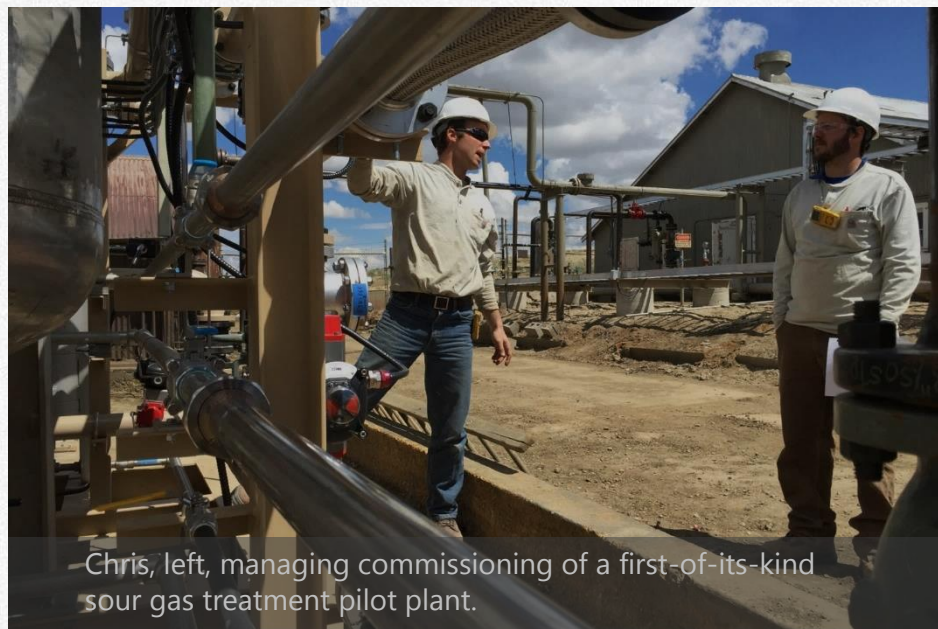
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**Corporate R&D** 2004–2006  
with AkzoNobel N.V.

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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.



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





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Chris vacationing on the Eiger, 2015.