

Burk TechnoEconomics Techno-economic analysis for hard-tech innovation

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Hard-tech development presents unique challenges



If a technology is to be useful for solving real-world problems, it needs to be economically viable. Its benefits must outweigh its costs. Since the economic viability of hard-tech innovations is largely beholden to the laws of physics, many ideas are not worth pursuing simply because scientific or engineering constraints make them uneconomical—their benefits would not outweigh the cost of developing or manufacturing them. When evaluating a technology for commercialization, developers and investors consider its anticipated benefits and costs along with the associated uncertainty. The earlier and more accurately they can estimate these variables, the better they can direct their efforts and resources away from dead ends and toward potentially successful, highimpact objectives. This is where techno-economic analysis is useful.

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.

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 technoeconomic analysis

Techno-economic modeling links economic value to process and market parameters. By combining it with sensitivity analysis like Tornado and Monte Carlo analysis, you can objectively identify the parameters that are most critical to success and the risks that threaten it.

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

What is a technoeconomic model?

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



Financial & process metrics



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

The techno-economic model, a new approach

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

Burk TechnoEconomics models are modular, flexible, and internally 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 timeconsuming to build, so they are underutilized despite being an excellent tool for prioritizing development. This is why *Burk TechnoEconomics techno-economic models include proprietary software that lets you build them automatically with the touch of a button.*



Improving single-pass conversion will

Feedstock 1 price has potential

yield the greatest increase in IRR

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

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.



Why work with Burk TechnoEconomics



Engineering services

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



Quality and speed

Burk TechnoEconomics 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 both investor and investee. It also leaves other personnel free to focus on development work.

Notes from recent clients

"Chris came highly recommended from our network and delivered what we needed right off the bat. He understood what we were trying to do, and produced high-quality, professional models that are constantly being requested by the entrepreneurs we help here at Cyclotron Road. For anyone needing help building a cost model for a new technology, I couldn't recommend anyone better than Chris."

> Beth Zotter Technology Economics Cyclotron Road

"Chris has proven to be a solid reliable partner in developing innovation models that capture the complexity of numerous variables into an understandable simplicity. He is quick to understand the big picture and elegant in how to visualize and tell the story financially and technically. "

> *Kimberly Samaha Chief Executive Officer Synthesis Venture Fund Partners & Born Global LLC*

Some recent clients include DMC Biotechnologies, Mosaic Materials, Cyclotron Road, GlycoSurf, HiFunda, Sythesis Venture Fund Partners, and Adama Materials.

Chris Burk, PE Professional bio

Chris is a Licensed Professional Engineer and holds Bachelors and Masters Degrees in Chemical Engineering from Cornell University. Chris learned the value of early techno-economic modeling early in his career. He then developed his skills and the experience to apply them through 12+ years working with new process technologies, ranging from labscale R&D to pilot plant operation. His clients include private and academic startups, investors, and start-up fellowships, in industries including energy storage, biofuels, bio-engineering, energy production, nano-materials, oil & gas, and others.

Industry experience

Techno-economics Consulting with Burk TechnoEconomics	2016– present
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







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Chris vacationing on the Eiger, 2015.