

Your Techno-Economic Assessment Is Only as Credible as Your Assumptions

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Deep technology and science-based ventures are usually very good at explaining what their technology can do.

A new process may achieve higher recovery. A new material may perform better than the incumbent. A technology may reduce energy consumption, improve efficiency, use a lower-cost feedstock, or solve an environmental problem that existing solutions cannot address.

These are all important achievements. But as a technology moves closer to commercialization, another question becomes increasingly important: Does the technology actually make sense economically and operationally at commercial scale?

Technical performance, economic viability, and commercial viability are closely connected, but they are not the same thing. A technology can perform very well technically and still face major challenges when translated into a real operating environment.

This is where techno-economics becomes important, and why a first-level Techno-Economic Assessment (TEA) can be a valuable exercise for early-stage deep-tech ventures. This is also why TEAs are an important part of what we do in the Earth Tech program. Earth Tech ventures work through a first-level TEA to begin testing the economic assumptions behind their technology.

But there is an important point to remember: a TEA is only as credible as the assumptions underneath it.

What is a first-level TEA actually trying to answer?

At an early stage, a TEA should not try to predict exactly what a company will look like five or ten years from now. There are simply too many unknowns.

Instead, I think of a first-level TEA as a way of asking a simpler and more useful question: Based on what we know today, what needs to be true for this technology to make economic sense?

Rather than starting with a five-year revenue projection, the analysis starts with the technology itself, and asks:

- How does the process work?

- What goes into it?
- What comes out?
- What equipment is required?
- How much energy is consumed?
- What throughput can realistically be achieved?
- What are the major capital and operating costs?
- What does it cost to produce the product or deliver the service?

In simple terms, the thinking may follow a path like this: Technology → Process → Inputs and Outputs → CAPEX/OPEX → Unit Economics → Commercial Implications.

For an early-stage, science-based venture, understanding this can sometimes be more informative than immediately building a detailed financial forecast. A five-year financial projection may show where the company hopes to go. A techno-economic model asks whether the underlying technology and operating model can economically support getting there.

The objective is not to build the most complicated spreadsheet possible. Particularly at an early stage, simpler can often be better.

The objective is to understand what actually drives economics.

The model is only as good as what goes into it.

It is easy to become impressed by a detailed spreadsheet.

A model may have twenty tabs, hundreds of calculations, detailed cash flows and financial projections extending years into the future. But none of that makes the model reliable if the information entering it is unreliable.

In techno-economics, the quality of the assumptions often matters more than the complexity of the spreadsheet.

Consider a technology that has demonstrated a 95% recovery rate in a laboratory experiment. Can that same recovery reasonably be assumed in a continuous commercial operation?

Or perhaps a piece of equipment costs \$50,000 at the current scale. Can its commercial-scale cost simply be estimated by multiplying that number by the increase in capacity?

The opposite assumption can be equally problematic.

In one commercial model I reviewed, the venture expected operating capacity to increase approximately tenfold, while operating costs were assumed to remain essentially unchanged.

The expectation was that efficiencies gained through scale would offset the additional operating requirements.

Economies of scale are real, and unit operating costs can absolutely decrease as a technology scales. But that does not mean a tenfold increase in capacity automatically comes with no meaningful increase in total operating cost. Feedstock, utilities, labour, maintenance, consumables, logistics and other operating requirements still need to be considered.

The spreadsheet itself may calculate everything correctly.

The math can be right, but if the assumptions don't reflect commercial reality, the conclusion won't either.

A good assumption does not have to be a perfect assumption.

One challenge with early-stage technologies is that founders simply do not have all the information yet.

That is normal.

If a technology is at an early Technology Readiness Level (TRL), nobody should reasonably expect its commercial economics to have the same level of accuracy as a technology operating at demonstration or commercial scale.

However, the answer is not to hide that uncertainty behind precise-looking numbers. A better approach is to make the uncertainty visible and understand where the assumptions are coming from:

- Was the number measured experimentally?
- Was it provided by an equipment supplier?
- Was it taken from literature?
- Was it benchmarked against an existing industrial process?
- Is it an engineering estimate?
- Or is it a future target that the technology still needs to achieve?

Cost assumptions deserve the same attention.

Whenever possible, costs should be supported by reliable sources such as supplier quotations, published cost curves, engineering studies, literature or relevant industry benchmarks. But having a source alone is not enough. You also need to understand what that number represents and whether it is actually applicable to your process, scale, geography and operating conditions.

A good TEA treats assumptions with nuance, recognizing that not all data points carry equal weight or certainty. It makes the level of confidence behind each assumption clear.

This becomes particularly important when communicating with investors, funding organizations and strategic partners. Experienced reviewers generally understand that early-stage economics contain uncertainty. What creates concern is when an aggressive assumption is presented as a known fact without a clear basis.

Uncertainty itself is not a weakness in an early-stage TEA; failing to identify, test, and communicate that uncertainty is.

Techno-economics should evolve with technology maturity.

The purpose and expected accuracy of a TEA should change as the technology progresses.

At an early TRL, the objective may simply be to understand the major economic drivers:

- Which technical parameters have the greatest influence on cost?
- Which assumptions matter most?
- What performance level would make the technology competitive?
- What needs to be demonstrated experimentally?

This is also where sensitivity analysis becomes useful.

If feedstock cost, recovery, energy consumption, throughput or equipment cost are major economic drivers, what happens when that assumption changes? How much do the economics improve if one of those parameters improves? How much do they deteriorate if the assumption turns out to be too optimistic?

A first-level TEA should not only provide one economic outcome; it should help the venture understand which variables the economics are most sensitive to. Those may be the assumptions that deserve the most attention.

As the technology progresses, better information should gradually replace early assumptions.

Pilot data can replace laboratory estimates. Supplier quotations can replace generalized equipment costs. Actual energy consumption can replace theoretical calculations. Customer discussions can provide better information about pricing, specifications and willingness to pay.

The economic model should mature alongside the technology.

Where techno-economic credibility starts to break down.

There are a few patterns that can quickly make an otherwise promising analysis difficult to trust:

1. Blurring demonstrated performance with future targeted performance
2. Assuming laboratory conditions translate directly to commercial-scale operation

3. Using cost and financial assumptions that are not technically or economically defensible
4. Building financial projections before understanding the underlying technical economics

The first is distinguishing demonstrated performance from future targeted performance. If a process currently achieves 70% yield but the commercial model requires 95%, there is nothing wrong with modelling the 95% scenario. In fact, that can be extremely useful. But the model should clearly identify 95% as a target rather than demonstrated performance.

The second is assuming that laboratory conditions translate directly to commercial operation. Scale-up introduces equipment limitations, process variability, downtime, maintenance, logistics and many other factors that may not appear in a controlled laboratory environment.

The third is using optimistic cost assumptions without a defensible source. A feedstock may appear inexpensive in a market report, for example, but that does not necessarily mean the required quality and volume will be available at that price in the location where the technology will operate.

And finally, there is the temptation to build detailed financial projections before understanding the underlying technical economics. Revenue growth, EBITDA, cash flow and return metrics can all be useful. But for a science-based venture, they sit downstream of another set of questions:

- What does the process actually cost?
- What does scale look like?
- What technical performance is required?
- What capital needs to be deployed to achieve that scale?

If those assumptions are weak, adding another five years to the financial forecast does not make the analysis stronger.

A TEA should help founders make decisions, not just raise money.

Techno-economic assessment is often discussed in the context of fundraising and investor readiness. It absolutely has value there.

But limiting TEA to fundraising misses much of its value.

A good TEA should first help the venture itself make better decisions.

If improving recovery from 80% to 85% barely changes the economics, but reducing energy consumption by 20% dramatically improves unit cost, that tells the technical team something important about where development effort may have the greatest commercial value.

If the economics only work when a particular feedstock is available below a certain price, that is something the company should investigate early.

If equipment cost dominates the economics, it may be worth speaking with suppliers before spending another six months refining a revenue forecast.

There are three valuable outcomes a TEA can reveal:

1. It can validate the direction a venture is already taking.
2. It can identify an economic risk that needs to be addressed.
3. It can show that technical development priorities should change.

The objective should not be to make the economics look as attractive as possible—it should be to understand the economics as clearly as possible.

Techno-economics should not end with the TEA.

Techno-economics should not live only inside a standalone TEA report.

Once a venture understands its economic drivers, that understanding should start showing up in investor presentations, funding proposals, commercialization plans, technical development priorities and conversations with strategic partners.

And just as the technology evolves, the techno-economics should evolve with it.

Assumptions become measurements. Estimates become quotations. Laboratory performance becomes pilot data.

The uncertainty may not disappear completely, but the economic picture should become progressively more defensible as the technology matures.

Ultimately, the goal is not to build the most impressive economic model. It is to build one that you, your team, and eventually others can trust.

About the Author

Arian Shahnazari is a techno-economic consultant and founder of **Oimiz Innovations**, working at the intersection of deep technology, commercialization and investment readiness. With a background in chemical engineering and more than 11 years of experience working with science-based technologies, he works with deep-tech ventures to translate technical performance into economic and commercial understanding.

His work focuses on techno-economic assessment, commercialization strategy and technical due diligence across climate tech, energy, advanced materials, resource technologies and other hard-science sectors. Arian is also a Lead Entrepreneur-in-Residence with Foresight Canada's Earth Tech 2050 program, where he works with emerging climate-tech ventures as they move from technical development toward commercialization.