Building Predictability into Nanoparticle Therapeutics Scale-Up

An economic framework for reducing manufacturing risk and predicting development timelines

Prepared independently by BioEdge Insights LLC | July 2026

Nanoparticle therapeutics scale-up is a technical translation challenge, not simply a volume increase. When mixing conditions change across equipment and scale, critical quality attributes can drift, creating rework, delay, and additional CMC burden.

Why scale-up risk matters

Recent years have seen rapid clinical expansion of nanoparticle therapeutics, from mRNA vaccines to individualized gene editing therapies. As these assets move from laboratory development to GMP manufacturing, changes in mixer geometry, flow regime, throughput, residence time, and downstream processing can affect particle size, encapsulation efficiency, potency, and stability.

When CQAs move outside the intended operating range, sponsors may need additional development runs, engineering batches, analytical / stability work, and comparability assessment. The resulting burden can extend well beyond the cost of an extra batch.

What independent research found

BioEdge Insights combined structured interviews with CDMO, biotechnology, formulation, and CMC experts with secondary research and a probability-weighted economic model. Three themes were consistent:

Re-optimization is common - Most mixer geometry transfers require process adjustment. True formulation change is less frequent, but highly disruptive when it occurs.

Downstream burden compounds risk - Upstream variability can increase troubleshooting requirements in processes such as TFF, buffer-exchange, filtration, concentration, and analytical work.

Delays dominate cost - The largest economic impact is often not the additional batch, but lost time to process lock, GMP readiness, regulatory milestones, or clinical progression, ultimately resulting in later time to market and reduced project NPV.

The risk is technical in origin - but economic in consequence

Direct costs include development material, engineering runs, testing, and internal technical resources. The larger exposure can arise when rework delays process lock, GMP readiness, regulatory submissions, or clinical milestones. This effect increases as programs mature and monthly operating burn rises.

Risk is highest when scale-up involves a transition from research-scale chips to different GMP hardware, a change in mixer class, a novel payload or lipid system, a narrow process window, or a later-stage program with greater comparability consequences.

Where process-robust platforms may create value

LEON's platform is designed to maintain consistent mixing behavior across development and manufacturing scales. The intended value is broader than avoiding a single reformulation event: it has the potential to eliminate such scale-up rework.

Consistent mixing across scales	**Greater CQA consistency**	**Eliminated rework iterations**	**Eliminated delay and CMC burden**

The strongest value arises from elimination of higher-risk transfers, where inconsistency could otherwise create additional GMP activity, development delay, or regulatory burden.

Implications for platform selection

As nanoparticle therapeutics programs become more complex and advance into later-stage development, manufacturing platforms will be judged on predictable process translation — not throughput at single scale alone.

A process-robust platform may help protect development timelines, reduce avoidable capital consumption, and lower the risk that technical scale-up challenges escalate into broader CMC disruption.

To capture its full value, LEON's platform is ideally introduced early in the development journey, although later-stage transfers are also possible. Early adoption should avoid high-risk transfer scenarios by eliminating the need to move a program between different mixer architectures or manufacturing platforms. Its potential value should be assessed in the context of the program's technical complexity, development stage, transfer pathway, and underlying risk profile.

Method notes: *Findings are directional and based on expert interviews, secondary research, and documented model assumptions. They are not statistically validated industry benchmarks.*