

Successful design of Bioprocesses: an integrated approach

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MOTIVATION

Today, it is generally recognised that THE challenge for biobased processes is upscaling from pilot or demo scale to commercial scale. Despite massive investments in research and development, many companies often fail to commercialize their innovative bioprocess.

In particular this goes for bioprocesses that often consider new and unproven technologies. The impact on process feasibility, energy consumption and economics is often not well understood or properly evaluated leading often to commercialization failure.

An important aspect in this matter is that mostly technology, energy, economics, etc. are evaluated separately whilst an **integrated** approach will reveal changes in economics directly related to changes in the process.

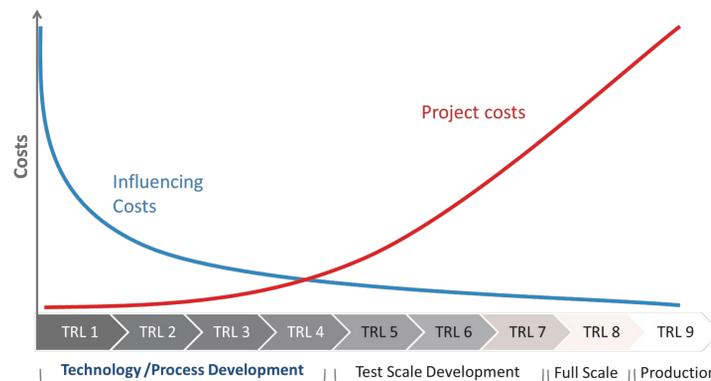
INTEGRATED APPROACH

Integrated process design philosophy provides cost effective development of industrial bioprocesses by combining sophisticated tools, methodologies and expert know-how to evaluate bioprocesses in the early research phases. Main characteristics of an integrated approach are:

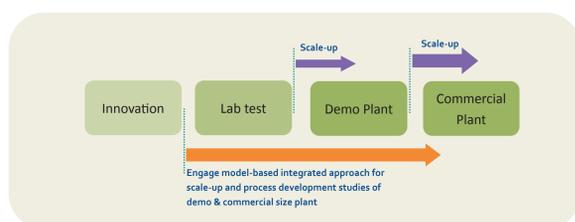
1. Early phase process evaluation (starting at technology readiness level TRL 1)
2. Technology, energy efficiency and economics are key **interconnected** process evaluation factors
3. Impact beyond process boundaries is evaluated

SOLUTION

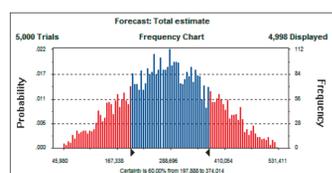
The key to successful (bio) process development with respect to technology, sustainability, cost and time to market lies in identifying opportunities, risks and limitations related to technology selection, design and upscaling from day 1 of the process development.



The core of our approach is a sophisticated detailed model with the capacity to simulate (bio)processes at different technological and capacity levels. This allows R&D to evaluate their **selected technology** for feasibility at each moment in development AND understand the impact of different process parameters on energy efficiency, emissions and the overall economics of the design.



Challenges when upscaling to demo or commercial scale are very often not visible at lab scale. Applying integrated model-based evaluation in early development stages as we propose will reveal these challenges and provide guidance to solve them. Part of this visualization lies the application of Monte Carlo based risk assessment tools.



Risk evaluation provides fact based information about the nature and magnitude of identified challenges during process development. Our experience and expertise to combine all key parameters in terms of process, economics, energy and logistics provides the basic needs for successful risk assessment and provide solutions when they most matter: **before making the wrong decisions!**

Selected Technology

Energy Demand

Economics

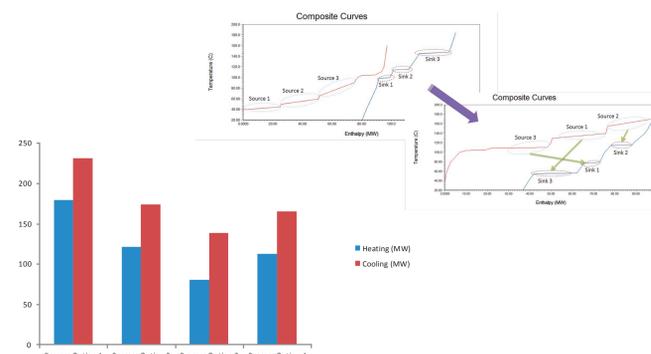
Risk evaluation

Impact of the technology selection

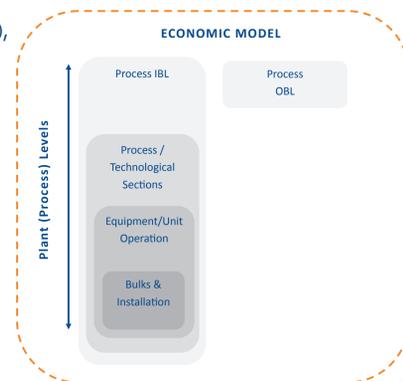
Technology and process improvement

Direct calculation and breakdown of **energy demands and carbon emissions** (of the ongoing design) is key for comparing different technologies. The integrated approach applies energy analysis tool to locate specific process parameters. Adjustment mostly lead to major energy efficiency improvement.

This is of great importance for the design of bioprocess since their energy demand often leads to economical infeasibility.



The forthcoming economic evaluation allows for a detailed analysis of capital and operational costs. But it is not limited to these: also challenges that may not seem so obvious at first glance, such as logistics or choosing the best location (worldwide), become visible and can easily be analyzed.



BENEFITS

- Fast and cost effective process development
- Fast and reliable evaluation of many different process option and alternatives
- Guiding R&D activities and setting targets for techno-economically optimal design (yields, temperatures, pressure, etc.)
- Supporting and guiding process scale-up activities
- Less redesign and reengineering in later development stages (TRL 5 - 8)
- Minimizing waste and valorisation of waste streams
- Mitigating risks related to process scale-up (technology, energy & economics)

TOOLS AND METHODOLOGIES

Tools: Advanced process simulation and Economic modelling tools, Energy and Risk Analysis
 Knowledge: Science, engineering, heat & process integration, cost estimating, finance & statistics

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