GEOTHERMAL ENERGY SIG

A Pore-to-Process Digital Design Methodology to Evaluate Efficiency of Geothermal Power Plants

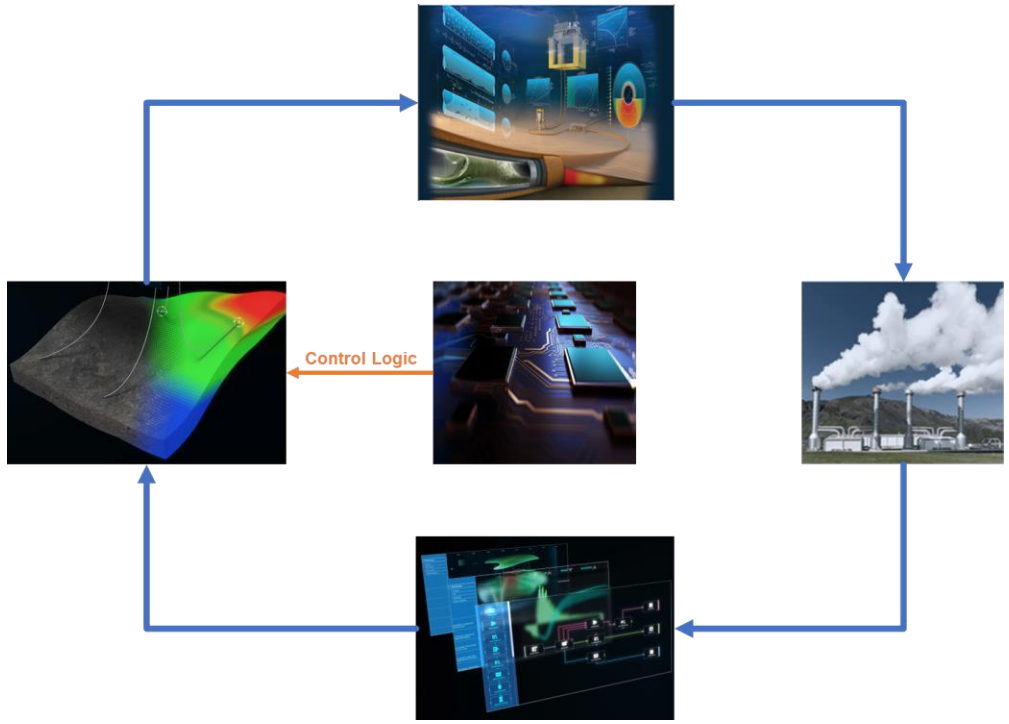
Lorenzo Angelini – November 19, 2024

Presentation Overview

Digital pore-to-process solution for geothermal system design and evaluation

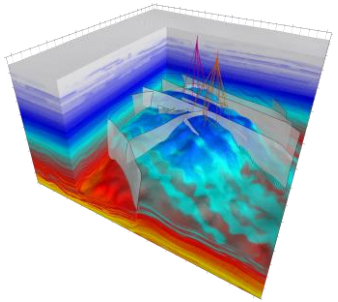
Control logic to integrate a high-resolution reservoir simulator into a rigorous process simulator

Facilitate the exploration of different operational and optimization scenarios for the entire geothermal system

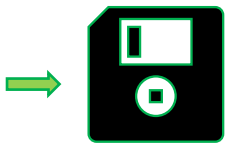


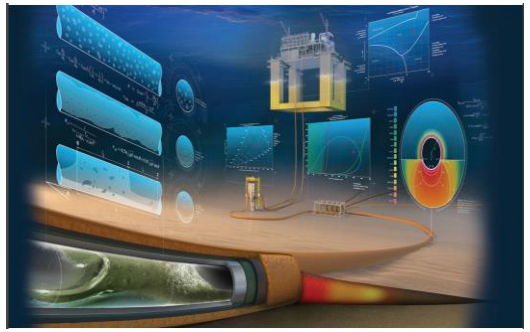
Based on the publication: SPE217007 “A Pore-to-Process Digital Design Methodology for Life-Cycle Assessment of a Geothermal Power Plant” **A. Behrang, H. Abbas, C. Istchenko, A. Solano, and S. Kisra**

Conventional Workflows

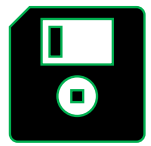


Reservoir





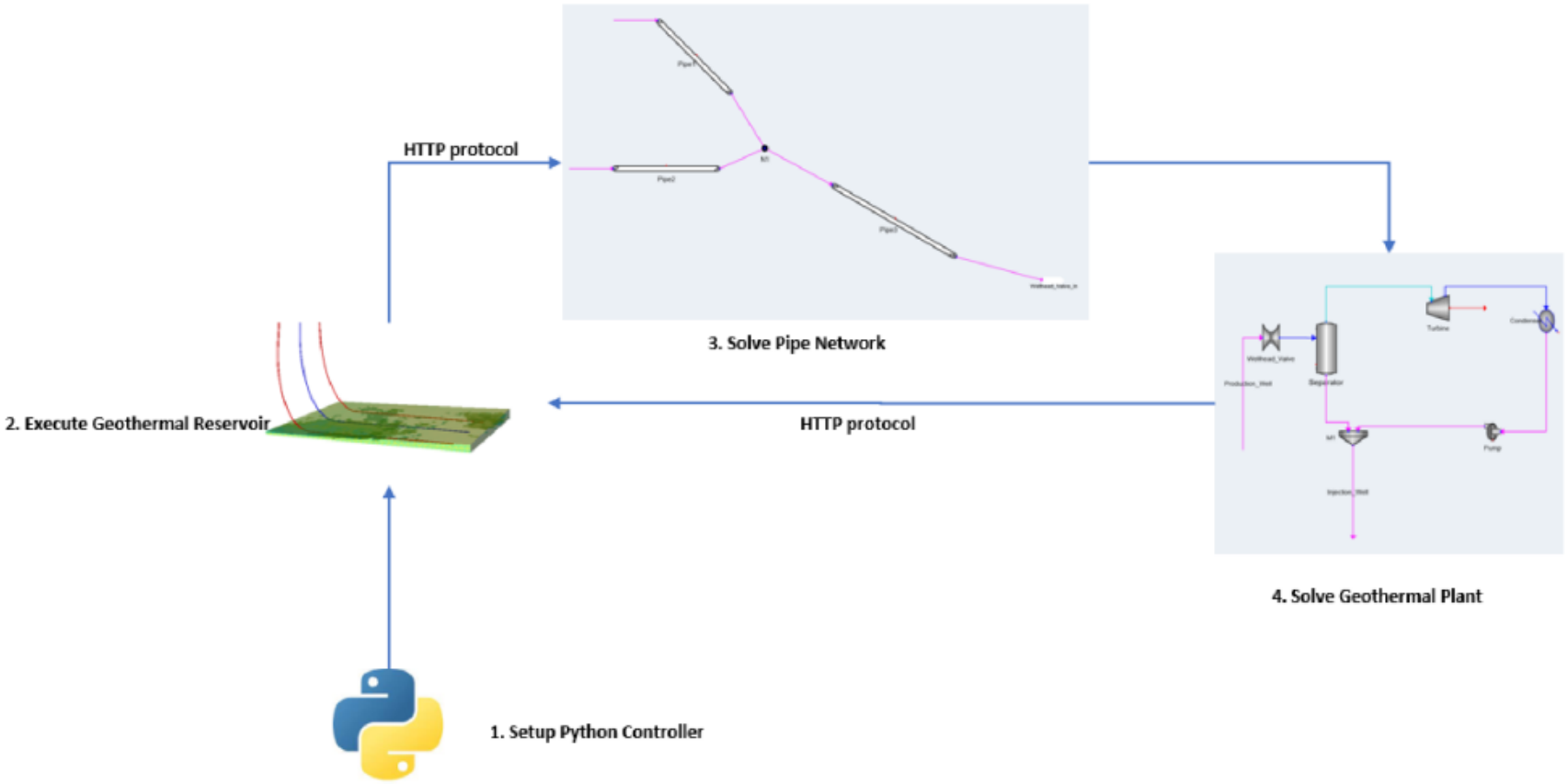
Pipe



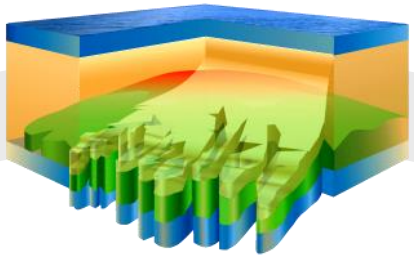
Facility

Pore to process integration methodology

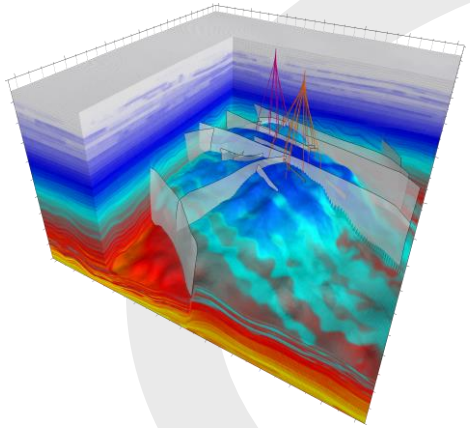
- Integrated Field Management Framework



Integrated Geothermal Field Development in a Digital World

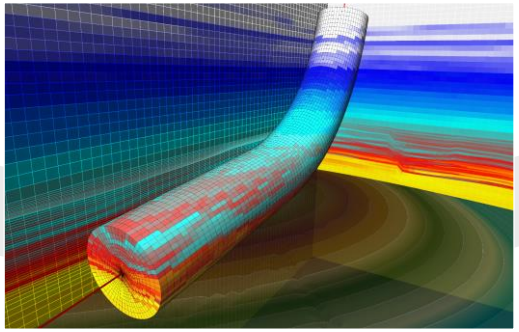


Optimization



Reservoir Modeling

Power Plant Modeling

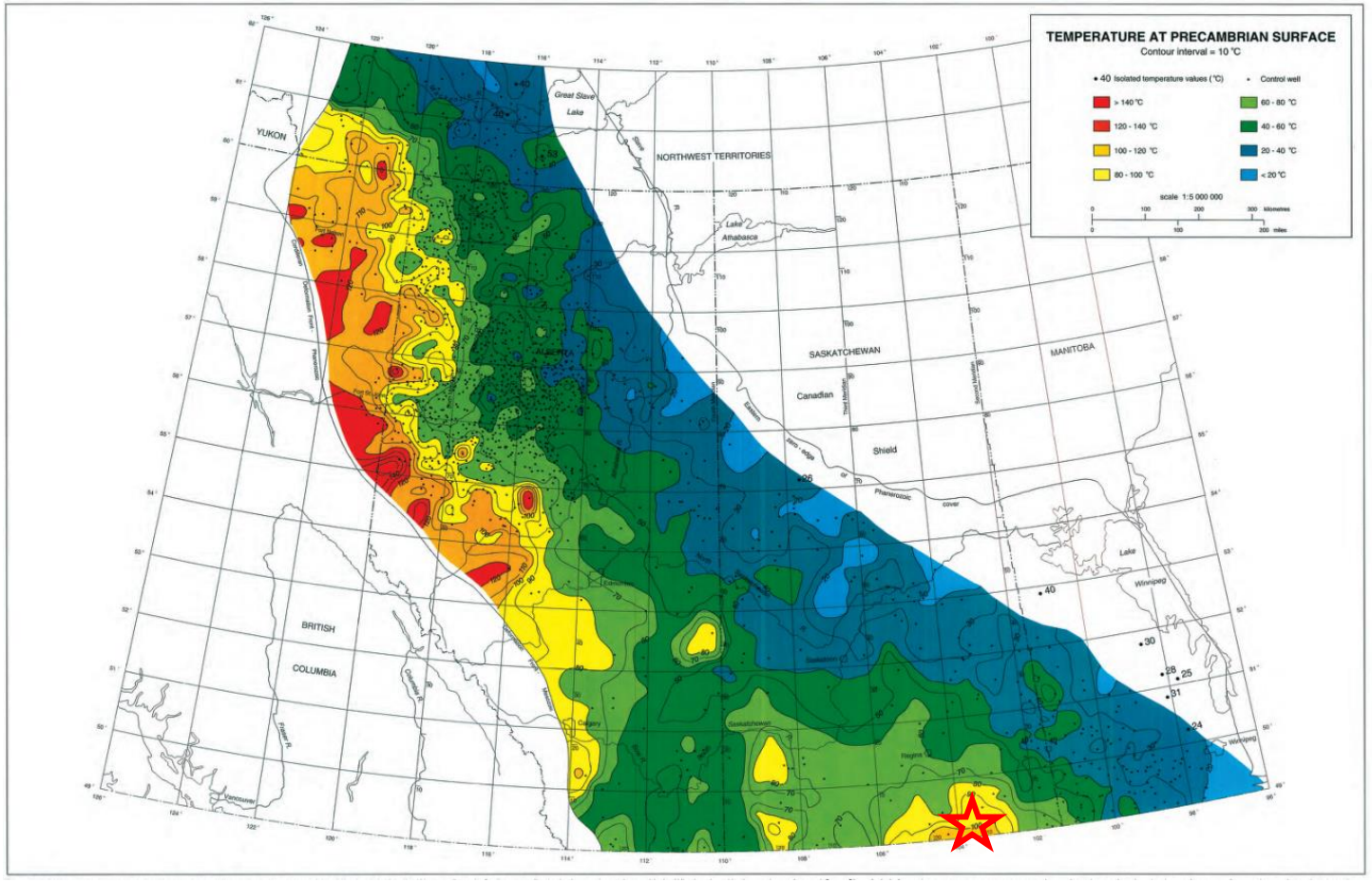


Well Analysis

Case Study

Saskatchewan, Canada

Temperature at Precambrian Surface



Project location

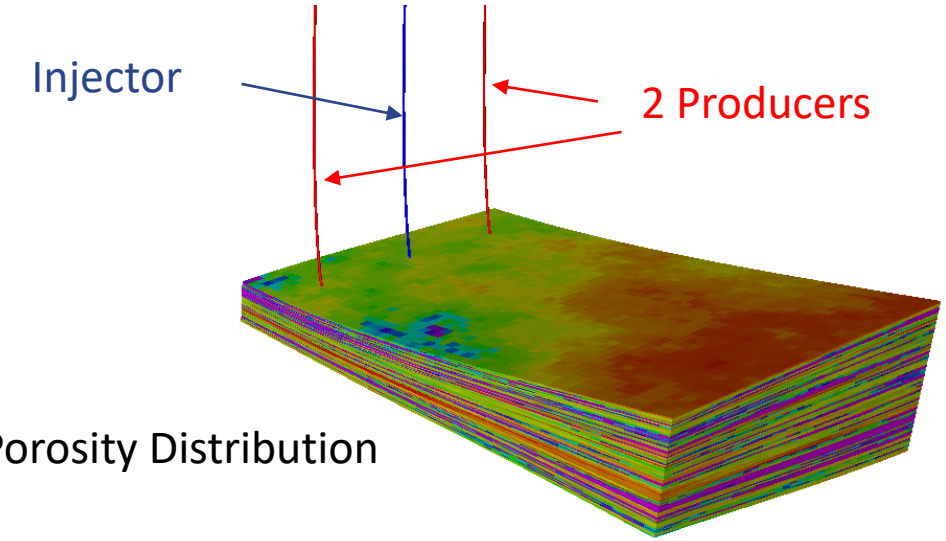
Source: Atlas of the Western Canada Sedimentary Basin

Reservoir Model

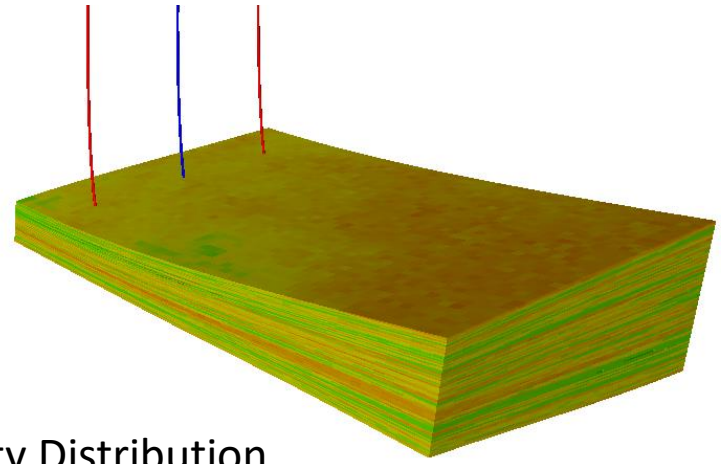
A representative model of a proposed Geothermal Project is Saskatchewan, Canada built from public data. Modelling Deadwood and Winnipeg formation with <u>average</u> reservoir properties:

- Porosity: 6%
- Permeability: 120 mD
- Reservoir Temperature: 120 °C
- Thickness: 46 m

One Injector and Two Producers with spacing of 600 m

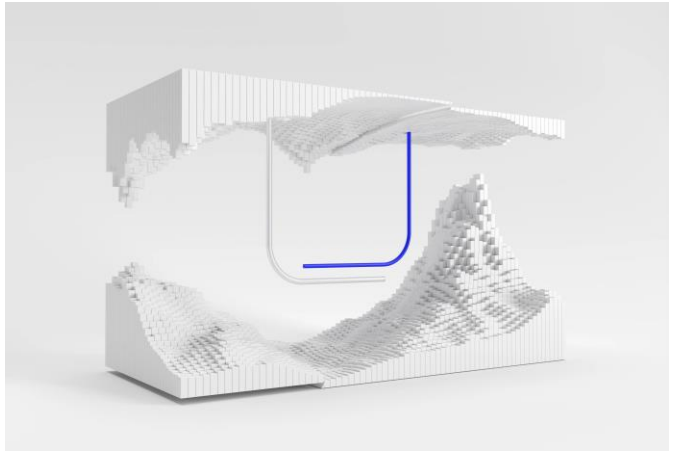


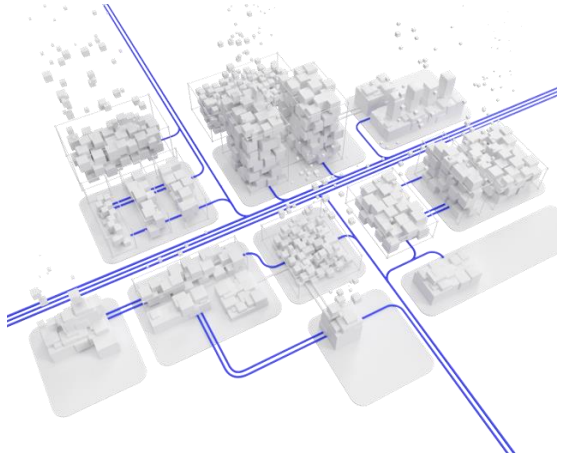
Porosity Distribution

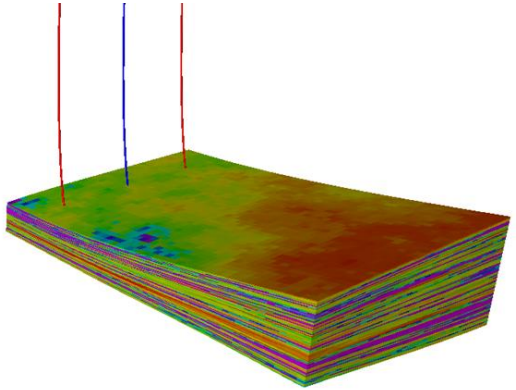


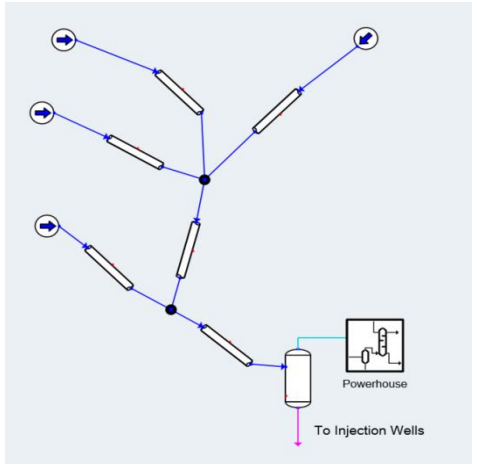
Permeability Distribution

Integrated System Model





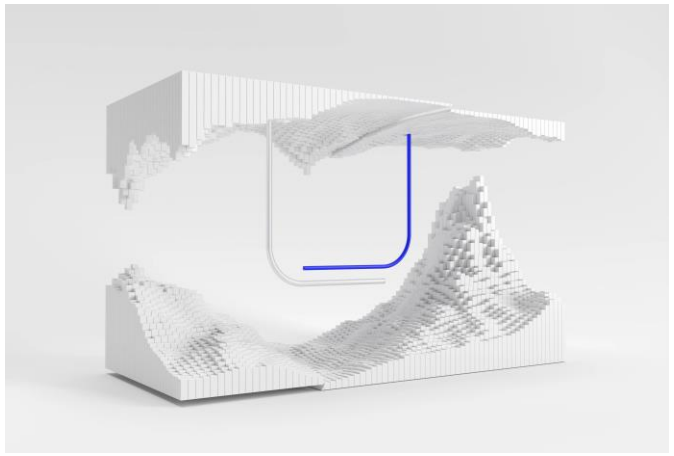




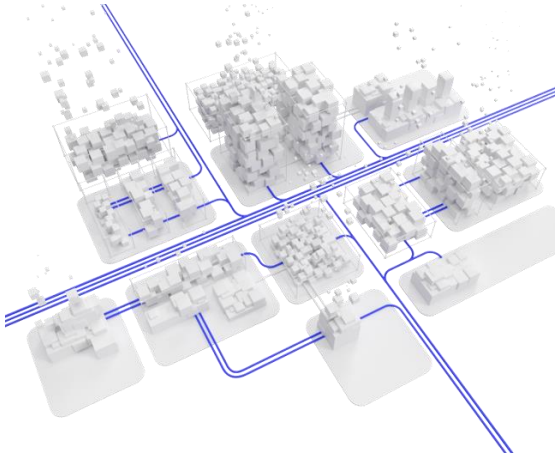
Geothermal Reservoir

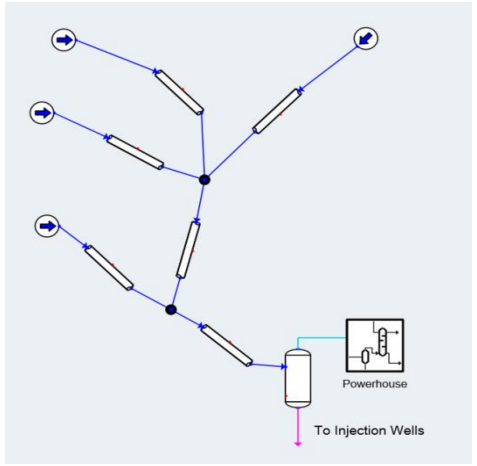
Gathering Network

Integrated System Model

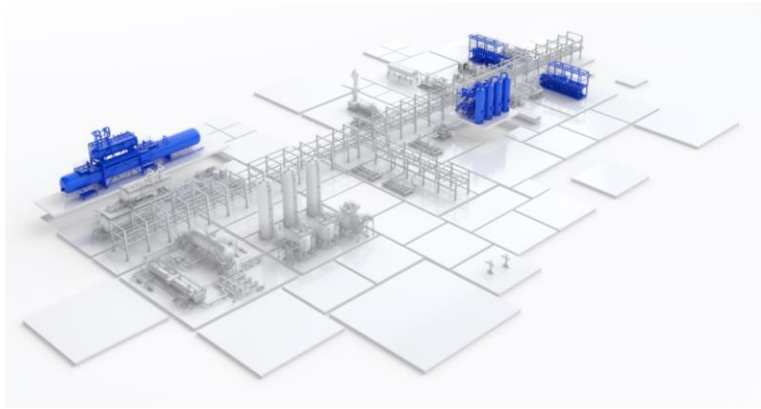


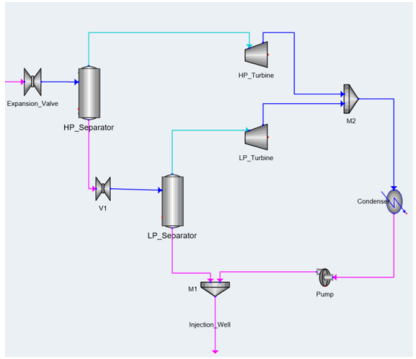
Geothermal Reservoir



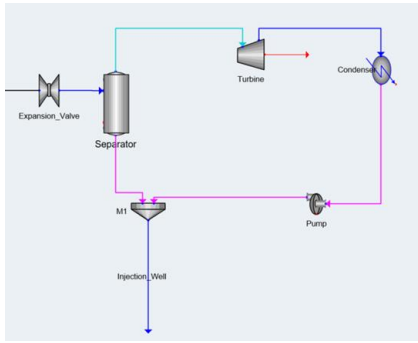


Gathering Network





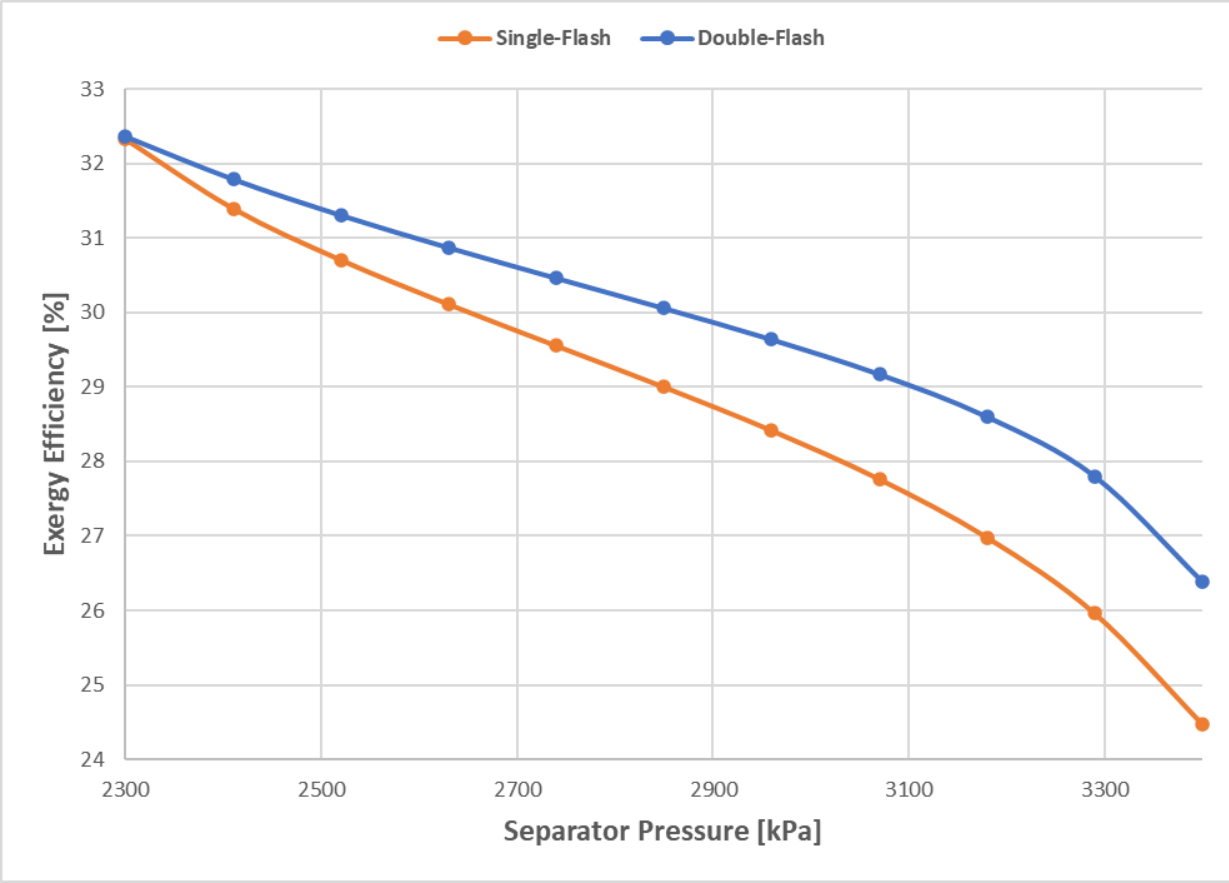
Single-Flash

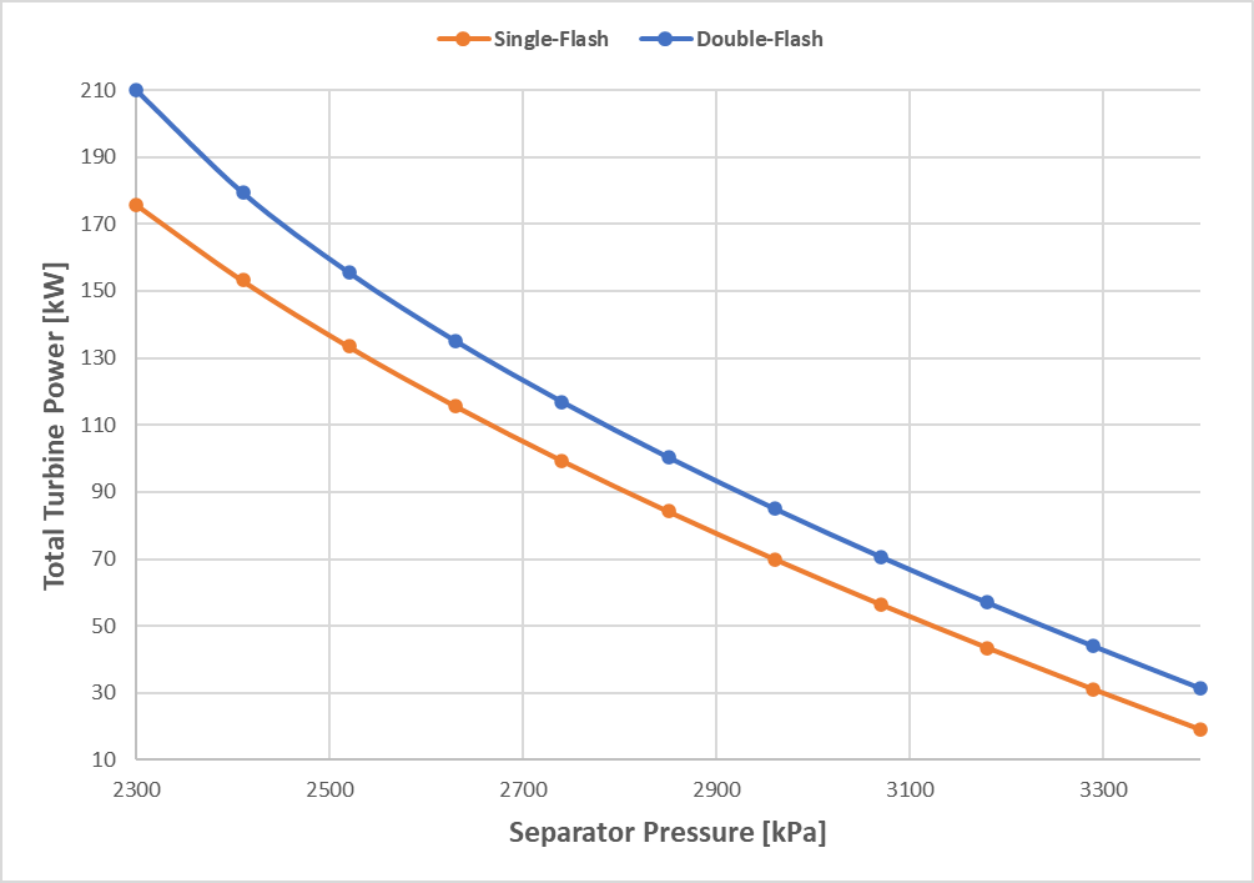


Double-Flash

Parametric Study

Impact of Inlet Separator Pressure on Plant Efficiency and Turbine Power

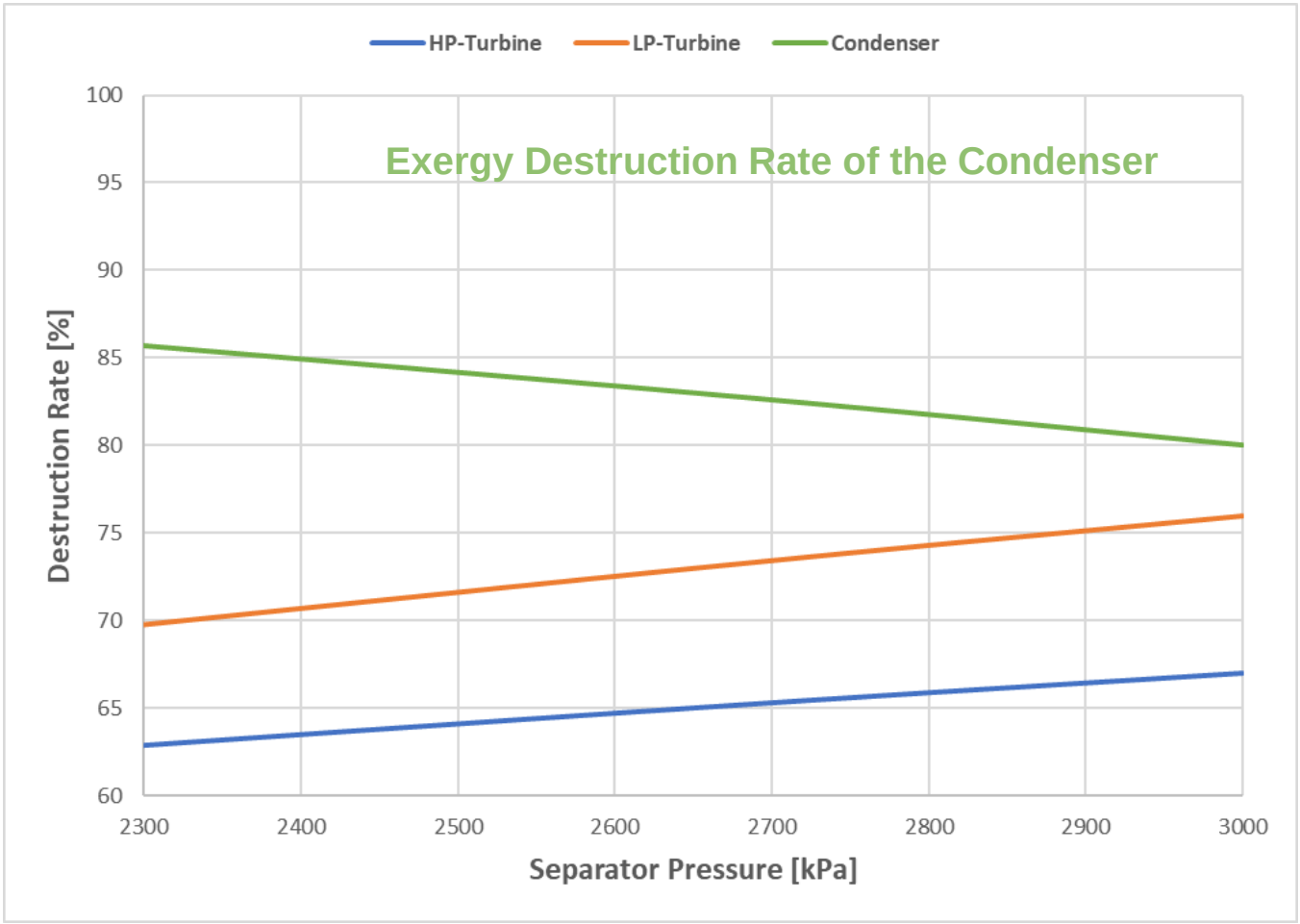




Exergy: Useful energy

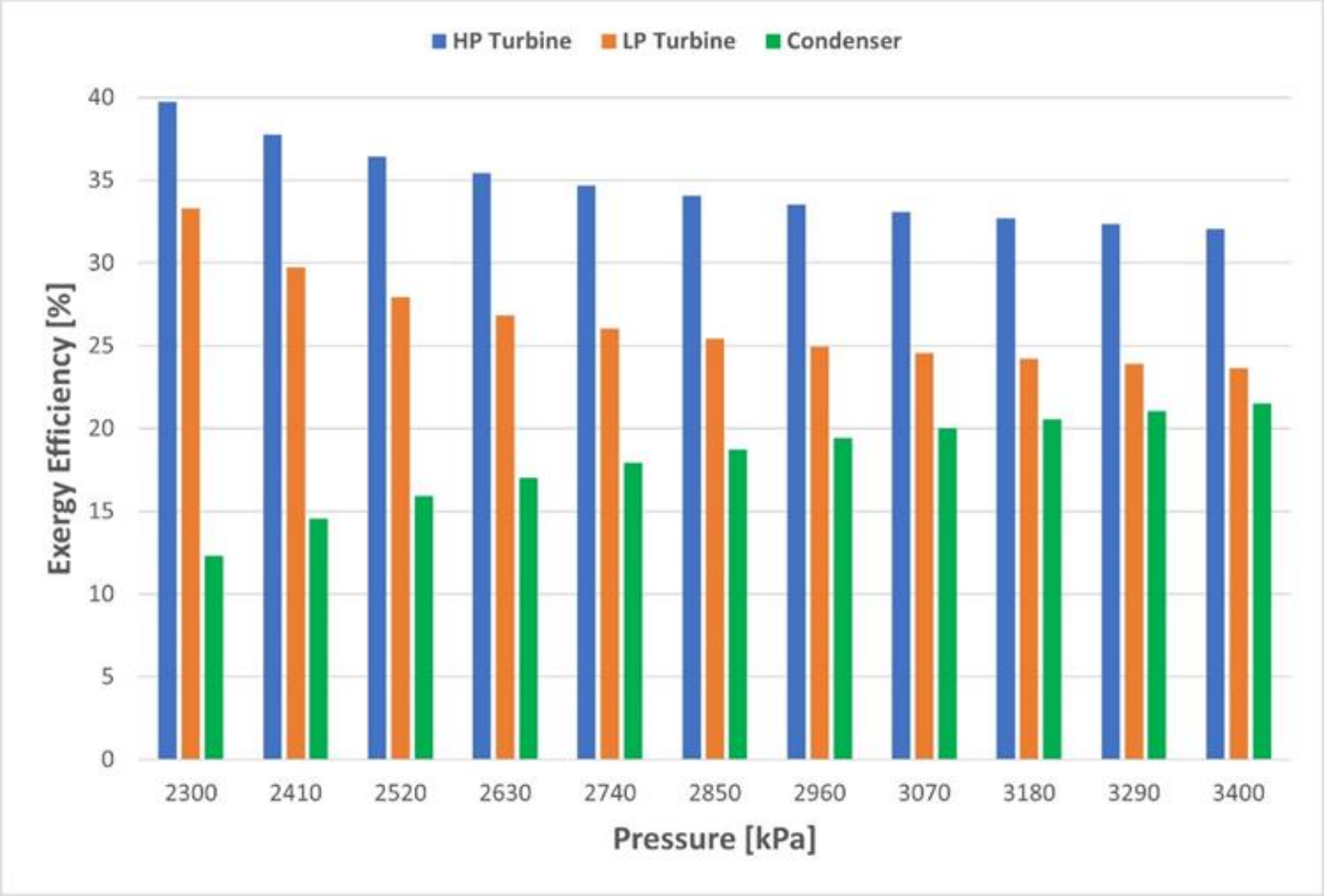
Parametric Study

Impact of Inlet Separator Pressure on Plant Efficiency and Turbine Power



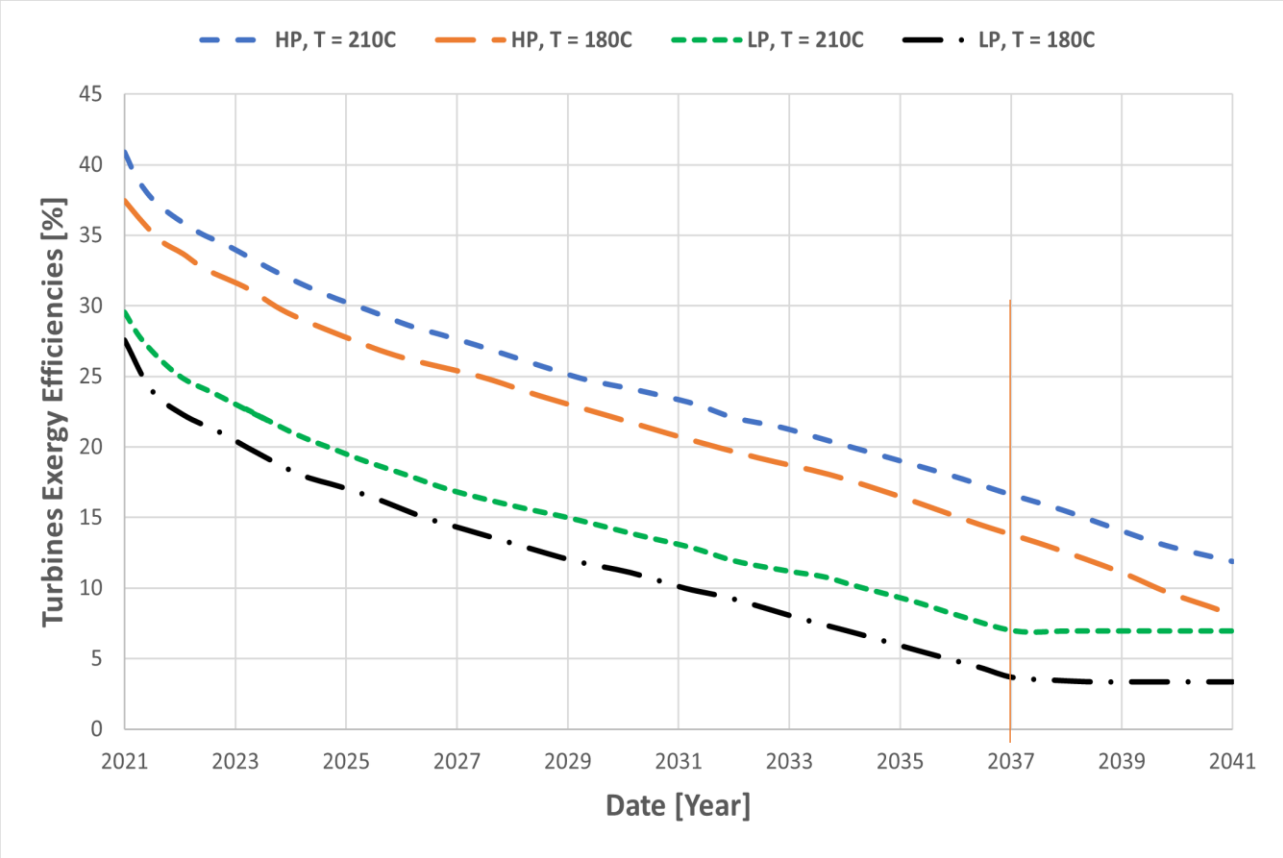
Parametric Study

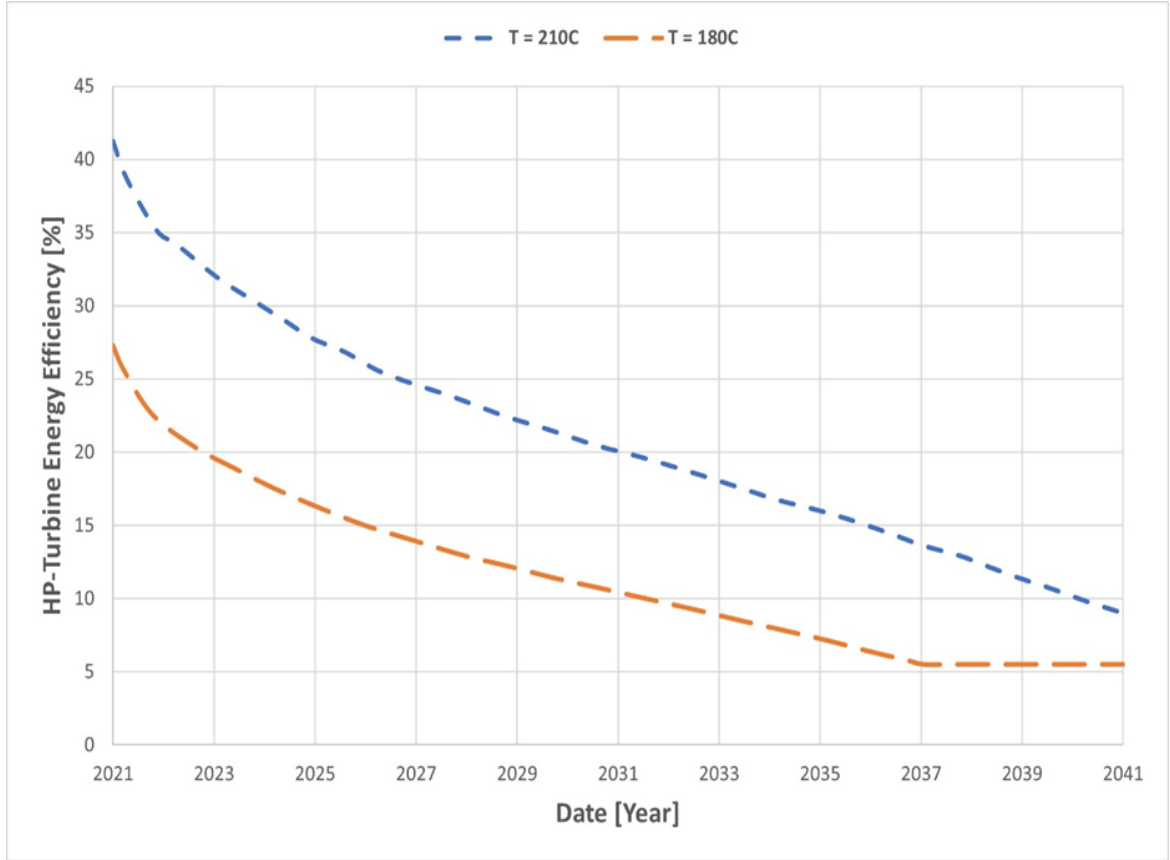
Inlet Separator Pressure & Turbine Efficiency of Double-Flash Plant



Pore to process integration

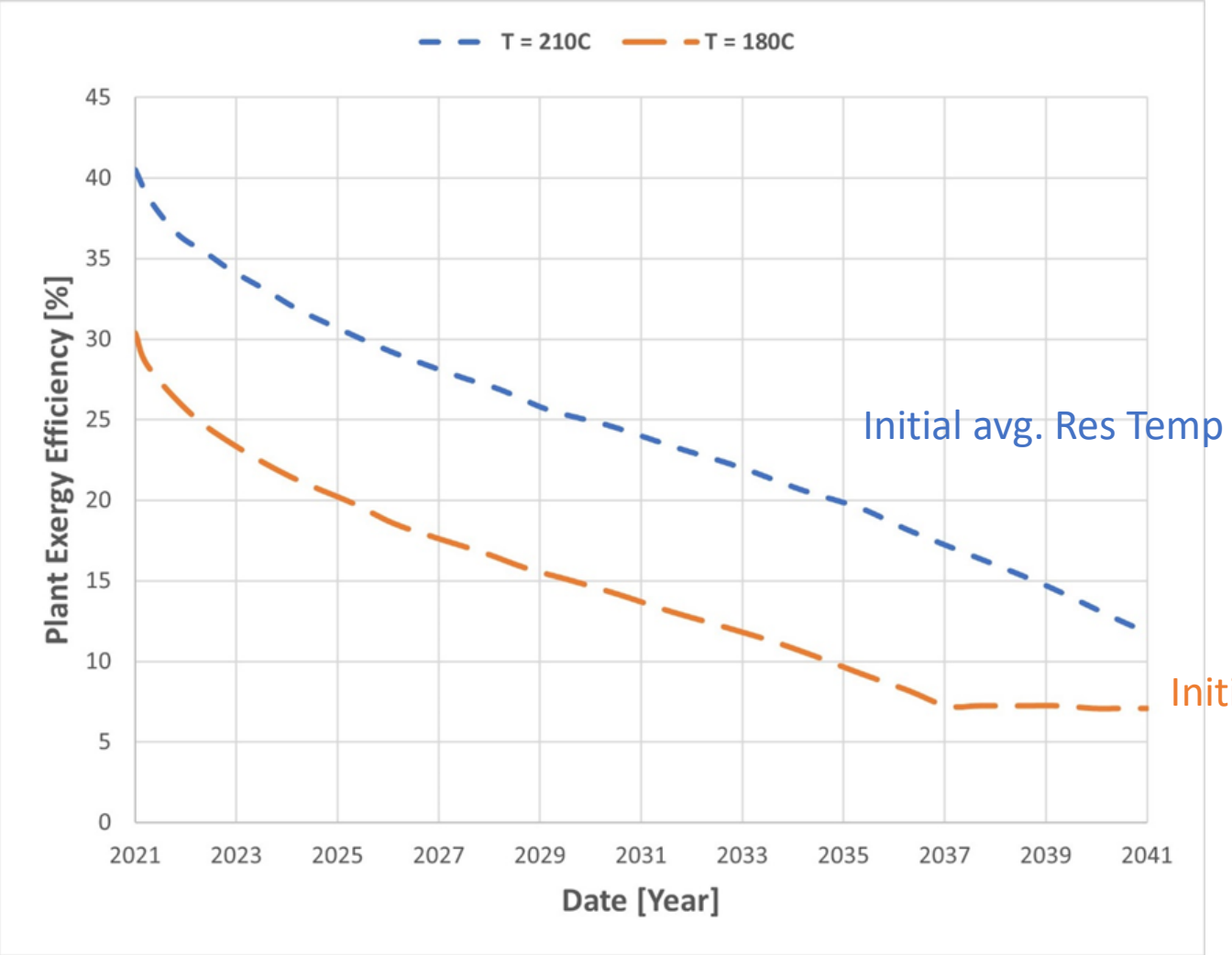
Turbine Efficiency Evaluation over the lifetime of the field using Double-flash plant





Pore to process integration

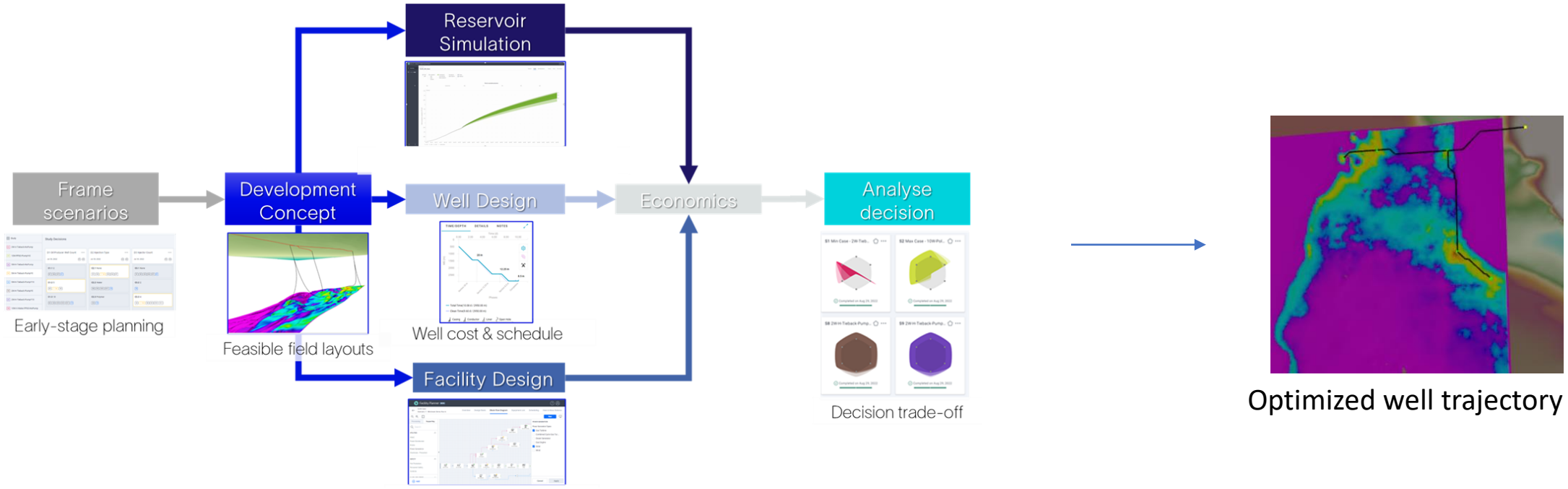
Plant/System Efficiency Evaluation



Initial avg. Res Temp = 210 C

Initial avg. Res Temp = 180 C

Digital planning for geothermal development



Ref: Amoudruz and Harb, Automated Development Concept Generation - SPE-216332

Conclusions and Future Work

We presented an integrated field management method to analyze and optimize the entire geothermal system combining the reservoir, pipes and the power plant.

This unlocks the potential for detailed design, optimization, and evaluation of different strategies in geothermal power plants

Highlights the impact of operating parameters such as geothermal fluid properties, efficiencies of turbines and condensers on the overall efficiency of the geothermal system

Identified the primary contributors to overall exergy destruction of the geothermal plant (condenser in our case study). Providing insights to fine-tune the operation of geothermal plants and maximize total energy conversion efficiency.

In the future, we need to combine rigorous science with exergo-economic analysis and exergo-environmental analysis to assess the viability and overall life cycle of geothermal plants