# sCO2 Turbomachinery for Nuclear Applications

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EXPERTS IN TURBOMACHINERY

# Pros and Cons of $sCO_2$ for Nuclear

Upside

- Inherent thermodynamic advantage for the cycle
- Very high-power density
  - Allows about 1/10 the scale of a steam cycle
- Very low viscosity
  - High Reynolds number -> lower losses
- Fits neatly into the power and temperature range of the latest proposed nuclear applications

Downside

- High pressures required
- Nonlinear properties can limit the range of the system
- Adds an additional element of risk to what is already an inherently risky endeavor





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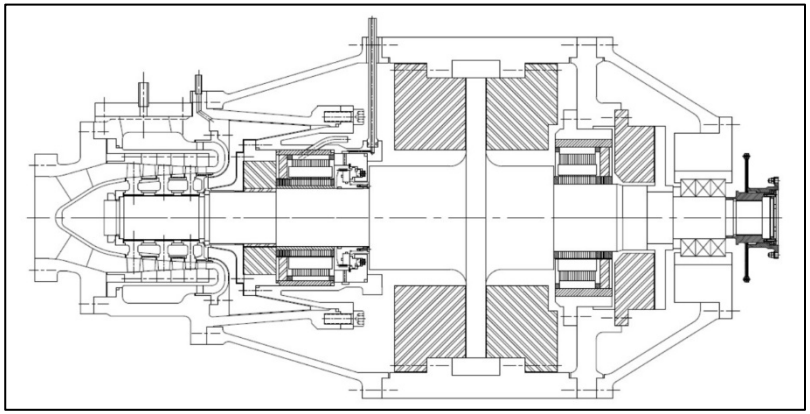
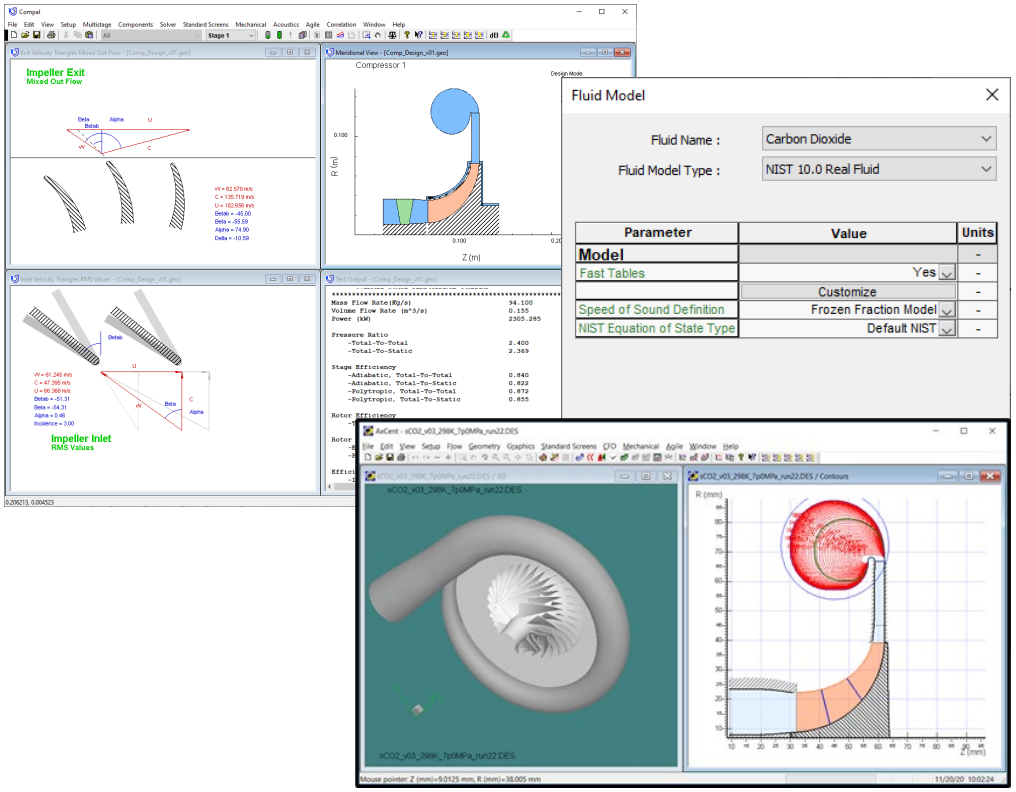
# DOE Funded Work at Concepts NREC






Turbine Magnetic Bearing Development

Software Enhancements for sCO2





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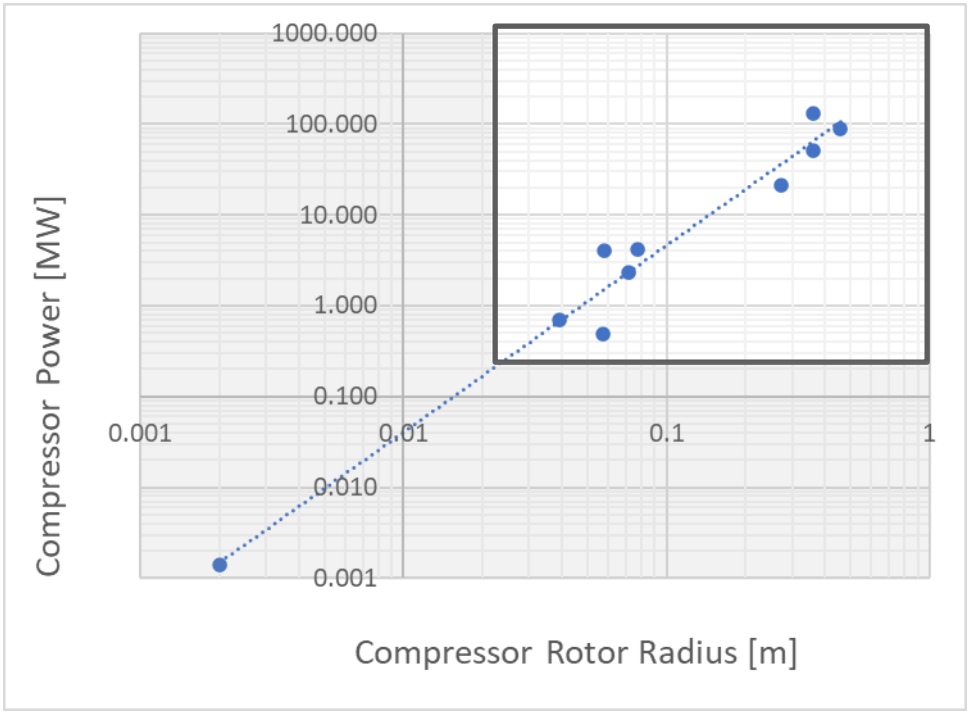
# Low Power Scale




- Applications on the order of cycle 1 MW (~.3 MW compressor power) and lower are typically quite small in physical scale
- Leakage and sealing become major challenges
- Other parasitic losses become more significant





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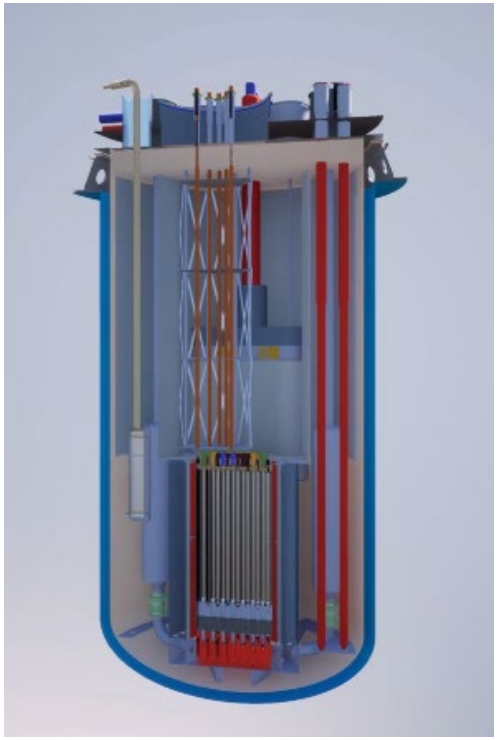
# Moderate Power Scale: ARC-100 Advanced Small Modular Reactor

- ARC Clean Technology
- In collaboration with:
  - Sandia National Labs
  - Argonne National Labs
  - United Engineers & Construction
  - Concepts NREC
- 100 MW net power
- Sodium cooled
- 20+ years between refueling



https://www.arc-cleantech.com/technology





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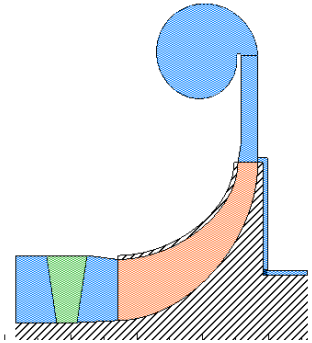
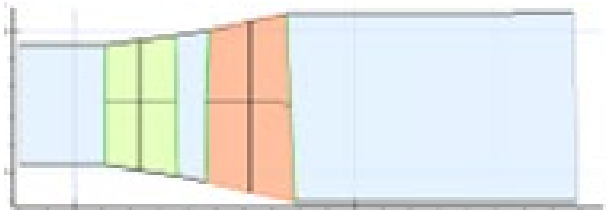
# Moderate Power Scale: ARC-100 Turbomachinery



~35MW Compressor



~150 WM turbine





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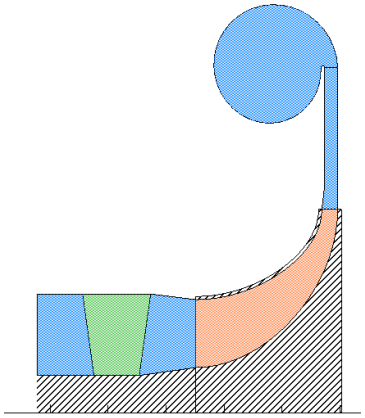
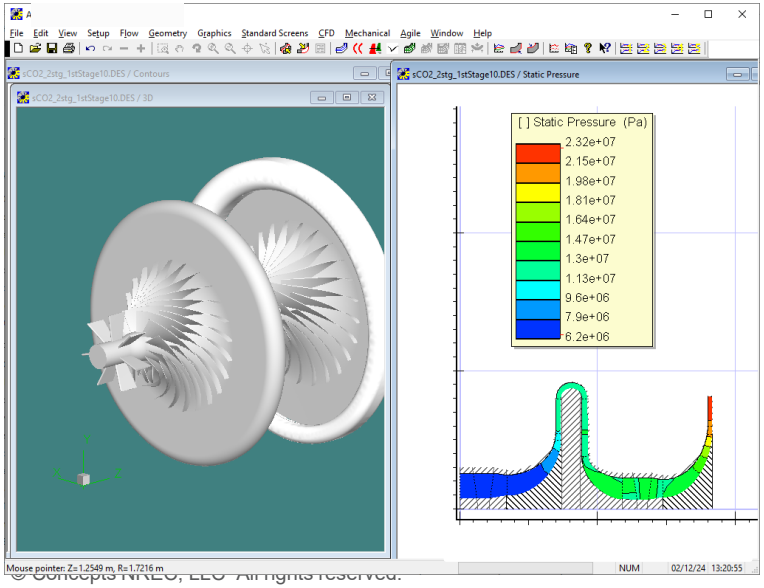
# Larger Scale Nuclear






- Compressor designs over a >100 MW compressor power are being considered
- Designs like this, if they are ever produced, would be some of the most powerful radial compressors ever built





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# General Comments

- Growing consensus that sCO2 machines can achieve expected performance in practice
  - Most models used for conventional turbomachinery design seem to apply adequately to sCO2
    - Meanline models
    - Turbulence models
    - Equilibrium phase assumption
  - Others…. maybe not so much
    - Specific speed guidelines
- Actual product design tends to be dominated by sealing, thrust and leakage control concerns
- sCO2 technology is maturing but some risk factors remain and need to be considered in the context of other risks in nuclear power

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