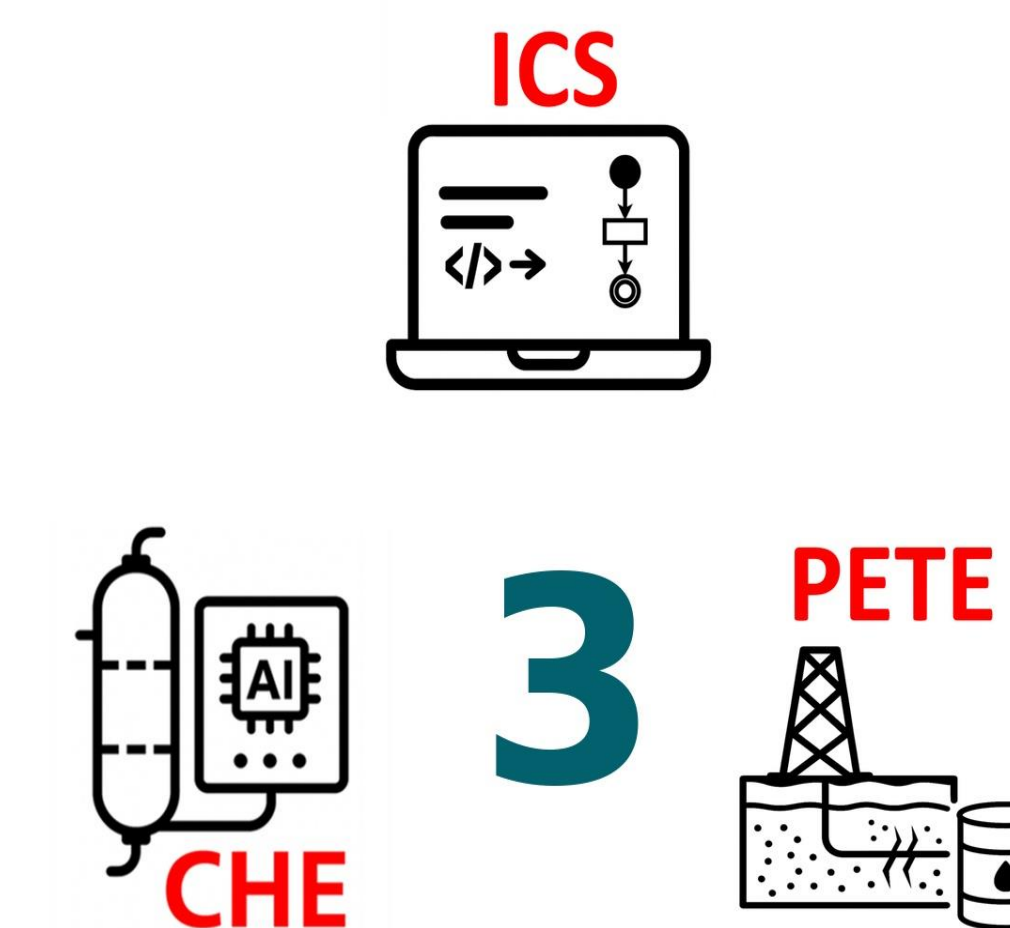


Digital Twin and AI-Assisted Optimization of Refinery Hydrogen Network for Cost and Emission Reduction

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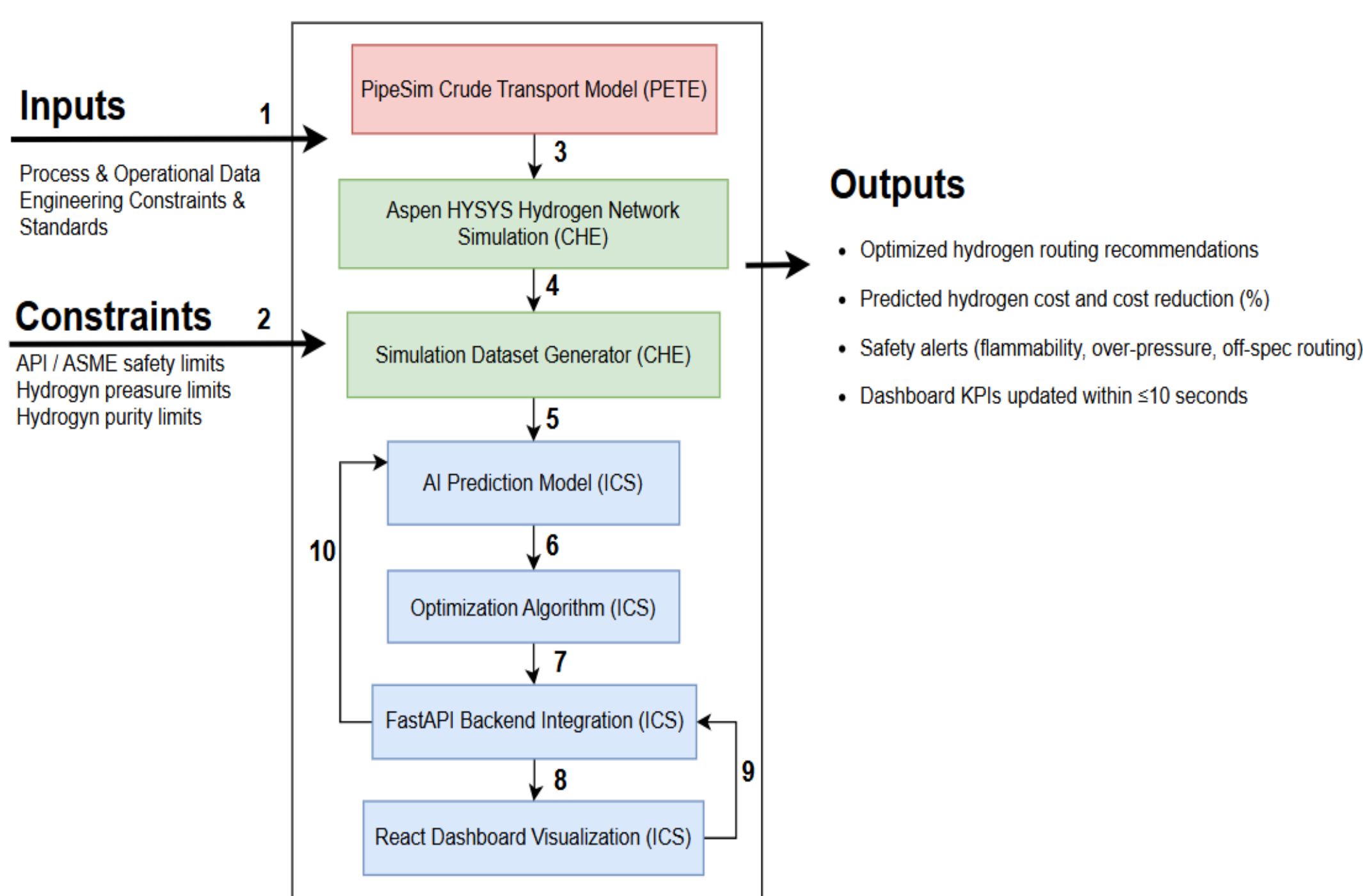


Background

Hydrogen networks are essential to refinery operations but are complex to manage. They require balancing cost, safety, and environmental impact under changing conditions. Traditional optimization relies on slow, manual analysis. AI and digital twins offer faster and more efficient solutions.

Problem Statement

Refinery hydrogen networks are highly constrained and difficult to optimize in real time. Conventional steady-state methods cannot adapt to changing conditions. This results in inefficient hydrogen utilization and higher operating costs. Therefore, a faster and more reliable optimization approach is required.



Key Constraints

- Operate within API/ASME safety limits
 - Meet SMR pressure requirements (stay below MAOP)
 - Manage hydrogen safety risks (flammability, overpressure)
 - Ensure product purity and pressure limits
 - Detect and flag off-spec conditions
- Validate pressures using Aspen HYSYS

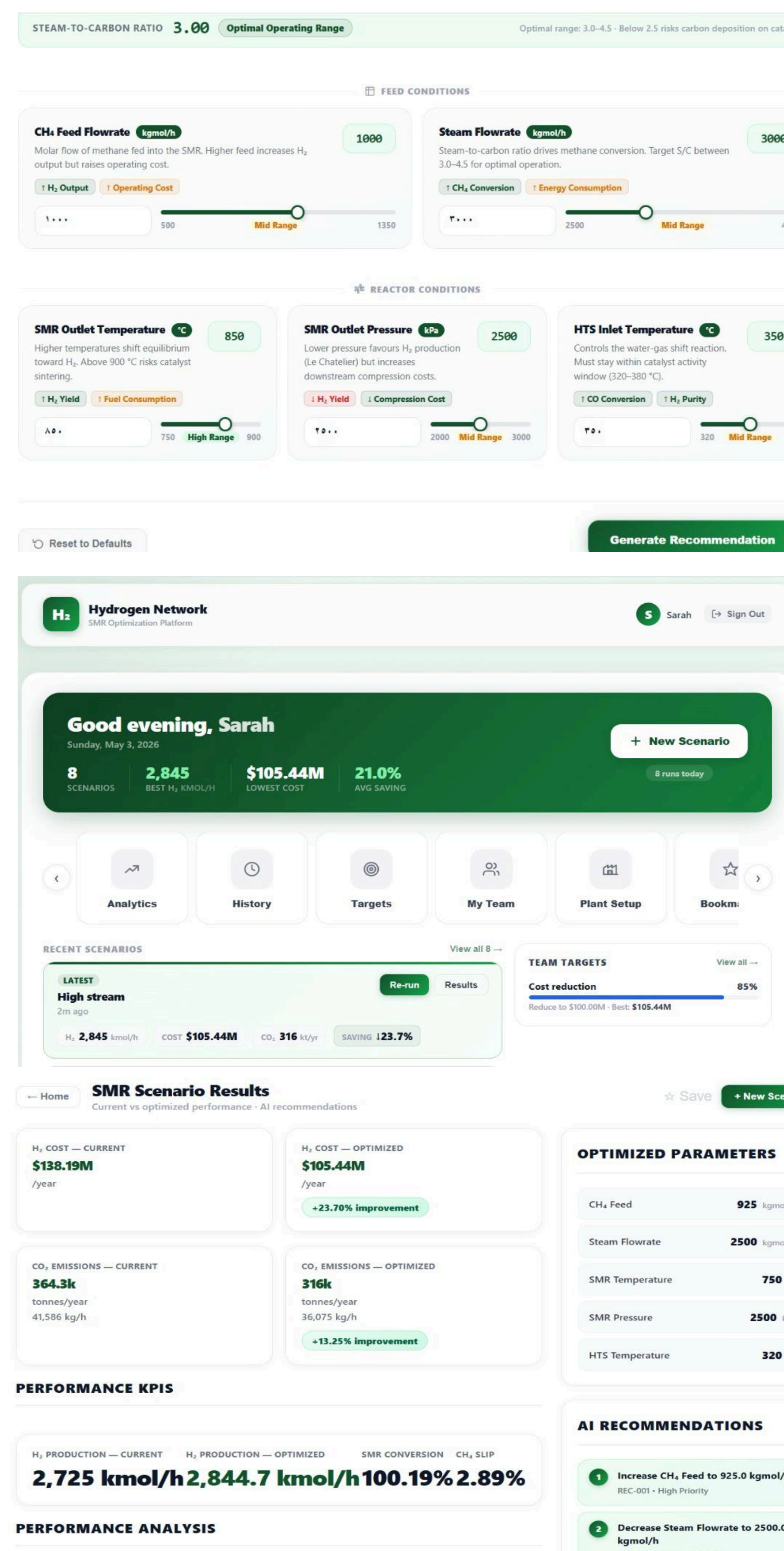
Specifications

- Achieve $\geq 2\%$ reduction in hydrogen cost
- Provide results in seconds (fast AI predictions)
- Maintain $\geq 95\%$ system reliability
- Keep AI error within $\pm 5\%$ vs HYSYS
- Limit pipeline pressure drop to $\leq 10\%$
- Ensure stable flow ($\geq 95\%$)

Conclusion

An integrated digital twin and AI-based framework enhances hydrogen network optimization by improving utilization, reducing costs and CO₂ emissions, and enabling fast, reliable decision-making while maintaining safety and compliance with industry standards.

Prototype Design



Testing / Validation

