



COLLEGE OF ENGINEERING

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Novel Natural Gas Monetization Method for Simultaneous Production of Electricity, Fertilizer, and Salicylic Acid with Inherent CO₂ Sequestration and Utilization

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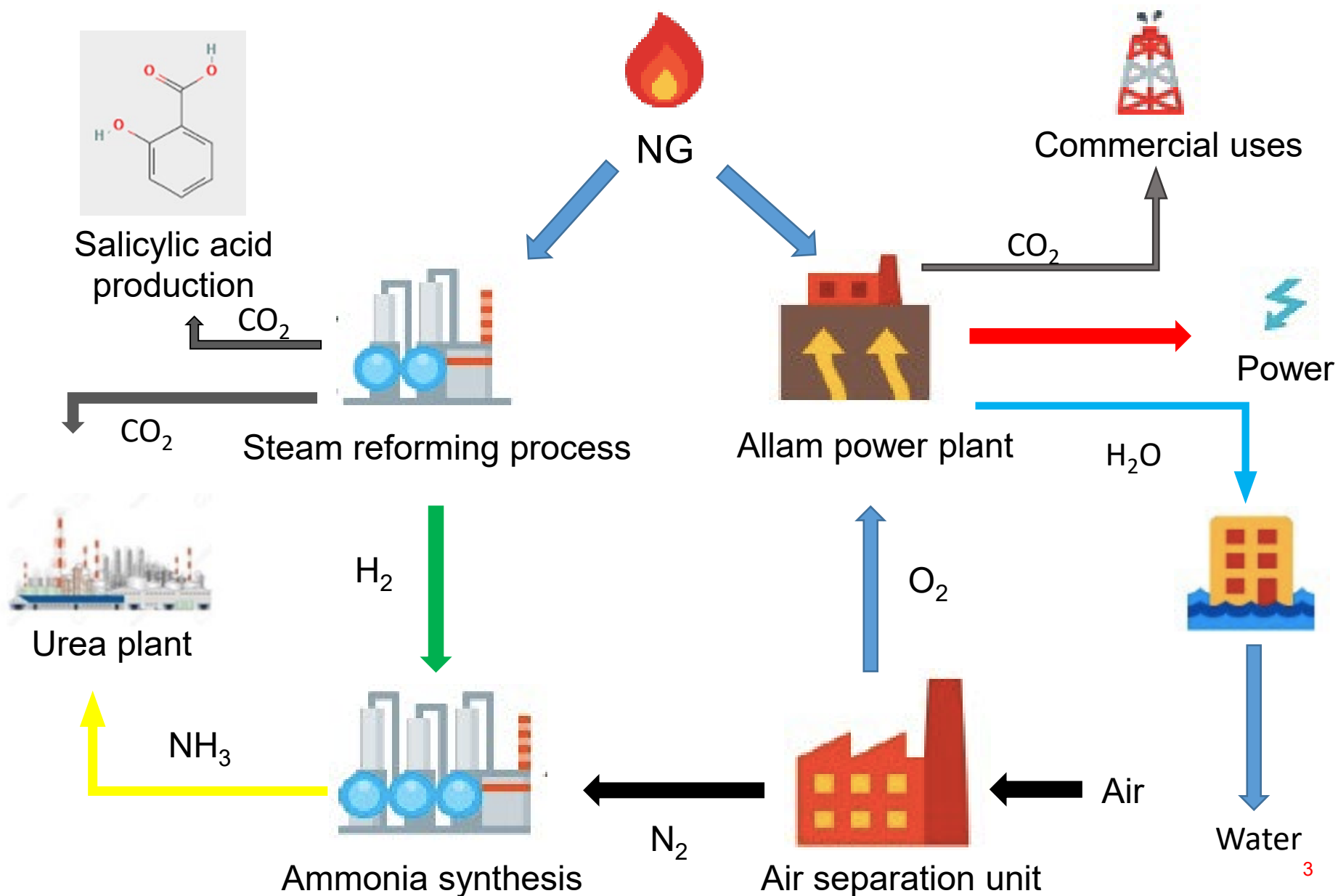
Global Challenges

- **Challenges of global warming**
 - emission reduction → industrial emission reduction
- **Challenges of world population growth**
 - food supply increase → fertilizer production increase
 - electricity supply increase
- **How to face the above challenges from chemical industry perspective?**

System integration + Using technologies effectively



A3US Complex Motivation



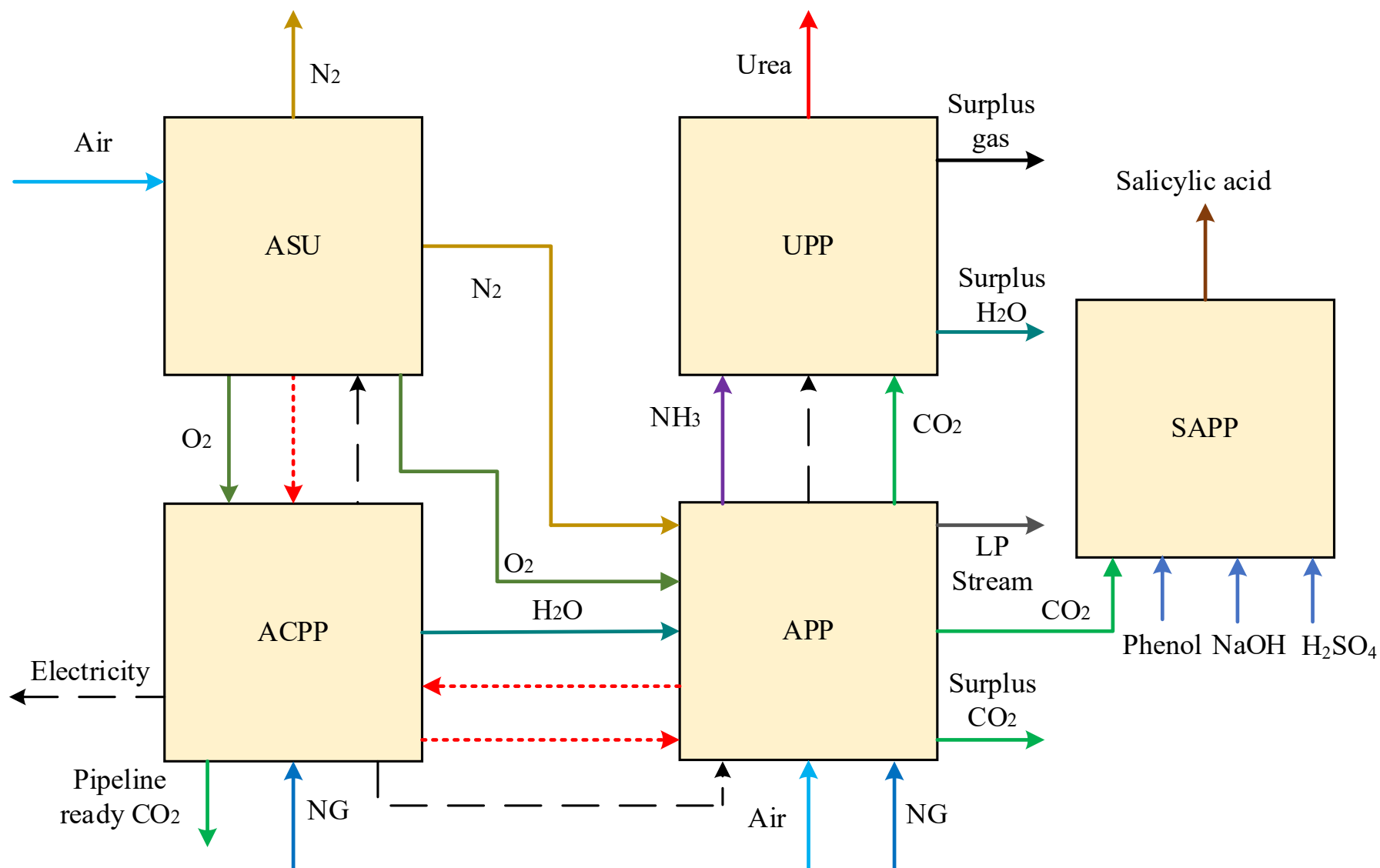


Research Accomplishments

- A **conceptual design** of an **industrial complex** integrating **Allam** power cycle, **air**-separation unit, **ammonia**, **urea**, and **salicylic acid** productions (**A3US**)
- **Zero NO_x emission** and **less CO₂ emission**;
- **Feedstock**: Natural gas, air + phenol, NaOH, H₂SO₄
- **Multiple products** with the **high profitability potential**
- Great potential for **extensive integration** with other plants (e.g., LNG)
- Comprehensive analysis to demonstrates its **economic** and **environmental benefits**



A3US Complex Overview





Production Analysis and Comparison

Productions per NG Consumption	Stand-alone Plant	Integrated A3US Complex
Net Electricity (kWh/Mcf)	130	120.87
Urea (kg/Mcf)	30.30	18.00
Pipeline-ready CO ₂ (kg/Mcf)	--	39.66
LP Steam (kg/Mcf)	--	32.45
N ₂ Product (kg/Mcf)	--	284.46
Salicylic Acid (kg/Mcf)	--	1.05
Product Revenue (\$/Mcf)	\$16.76 for gas power plant \$20.91 for urea plant	\$66.24



Emission Analysis and Comparison

Emissions per Urea Product	Standalone Ammonia Plant	Integrated A3US Complex
CO ₂ (kg/kg)	0.92	0.146
NO _x (kg/kg)	2.43E-05	0
Emissions per Net Electricity	Typical Gas Power Plant without Carbon Capture	Integrated A3S Complex
CO ₂ (kg/kwh)	0.41	0.0217
NO _x (kg/kwh)	7.98E-06	0



Conclusions

- Developed a conceptual industrial complex integrating **Allam power cycle, ASU, ammonia, urea, and salicylic acid plants (A3US)**
- Performed **modeling** and **simulation** to demonstrate the efficacy of the development
- Conducted comprehensive analysis to demonstrates its **economic** and **emission reduction benefits**
- Proposed a promising way for **natural gas monetization**, which simultaneously produce **power, urea, and salicylic acid** with high efficiency, **free NOx emission**, as well as inherently capture and produce **pipeline-ready CO₂** for commercial utilization