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#### **Pathways for Methanol Process Decarbonization**

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hanging the World's Energy Future

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# Introduction

The Integrated Energy System (IES) Program at Idaho National Laboratory (INL) is investigating the use of advanced nuclear reactors to displace fossil fuels in methanol production.

Methanol is considered to be an essential basic building block of chemical products. In addition, methanol is also a core component in the production of synthetic gasoline. Traditionally, natural gas (NG) serves as a critical feedstock and fuel for methanol production, resulting in CO<sub>2</sub> emissions. Replacing NG with clean nuclear energy and exploring alternative pathways for methanol production are critical steps toward decarbonizing methanol production facilities.

### **1. Syngas Preparation**

Energy intensive reaction: steam methane reformer (SMR)

- NG used as carbonaceous feedstock
- NG used as heat source

### 2. Syngas Conditioning

Energy-intensive highpressure syngas compression

### 3. Methanol Synthesis

- Exothermic reaction
- Lurgi's two-stage reactor

### 4. Downstream Distillation

Waste heat recovered from methanol synthesis used for methanol purification

# Methodology

Pathway-1 reduces NG use by replacing the heat source in the SMR with nuclear-generated  $H_2$  for heating purposes.

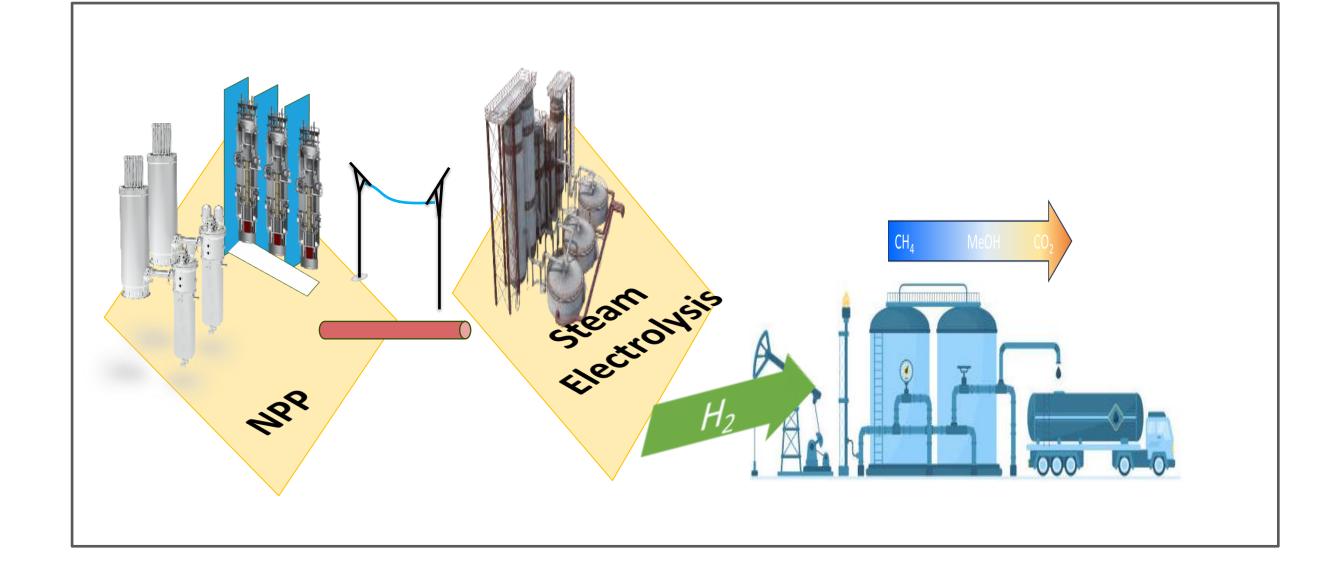
- Minimal disruption to existing methanol plant
- $H_2$  is produced via high-temperature steam electrolysis • (HTSE)
- ,300 tpd NG used as fuel is replaced with 500 tpd  $H_2$

## **Results & Conclusions**

- Pathway-1 provides carbon emissions benefits and can be adapted for existing sites.
- **Pathway-2** is a more radical approach, offering huge carbon emissions benefits by consuming CO<sub>2</sub> from an external source, but it will have to be a new methanol production facility.

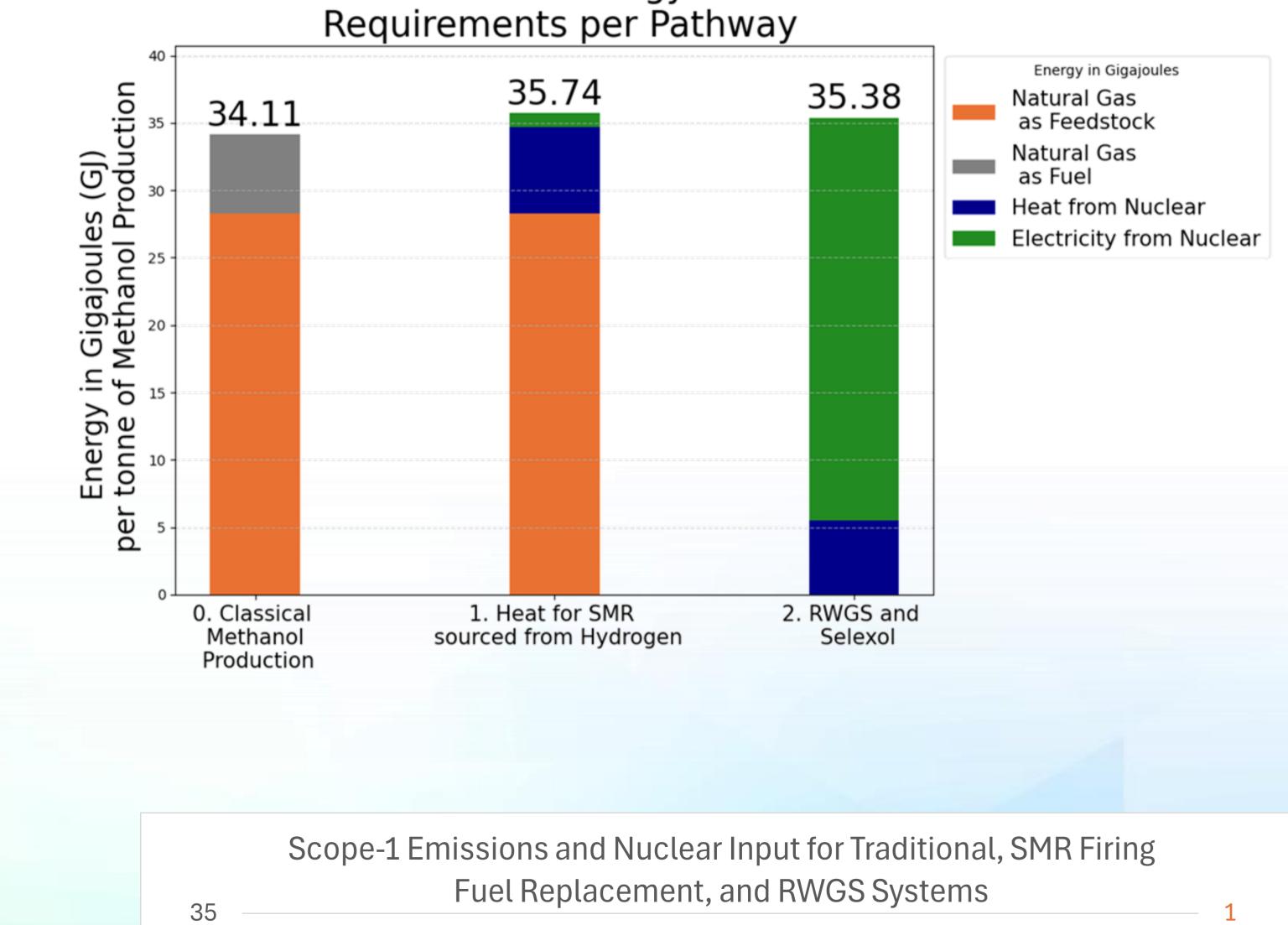
Stacked Energy

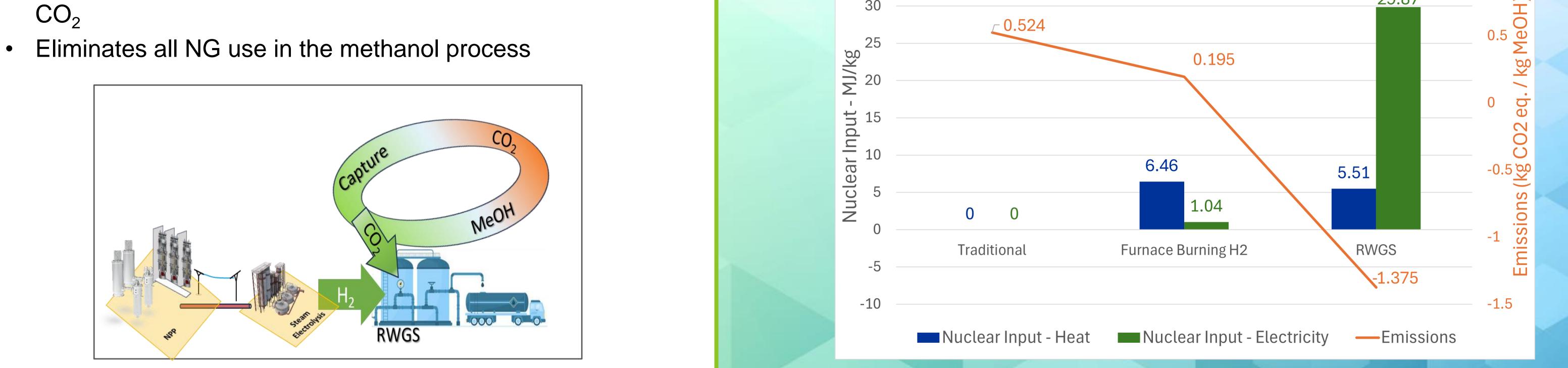
Eliminates all CO<sub>2</sub> emitted from the furnace



**Pathway-2** CO<sub>2</sub> and H<sub>2</sub> with a reverse water gas shift (RWGS) reactor and a Selexol carbon capture process entirely replace traditional syngas preparation via the SMR process.

- Uses hydrogen as the heat AND feedstock  $\bullet$
- HTSE process to produces H<sub>2</sub> lacksquare
- RWGS process produces CO from an external source of  $CO_2$





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B. Choi, N. Popli, S. Creasman, R. Yoshiura, J. Yoo, and D. Mikkelson, "Reference Piping and Instrumentation" Diagrams for Heat Transport Systems for Methanol Plants," INL/RPT-24-77932, Idaho National Laboratory, Idaho Falls, ID, USA May 2024. Battelle Energy Alliance manages INL for the www.inl.gov

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