INTRODUCTION TO LIFE CYCLE ASSESSMENT

FNCI INFORMATION SHARING

December 2019

PAUL BLOMERUS

UBC TEAM

DR. VICTORIA
LEMIEUX

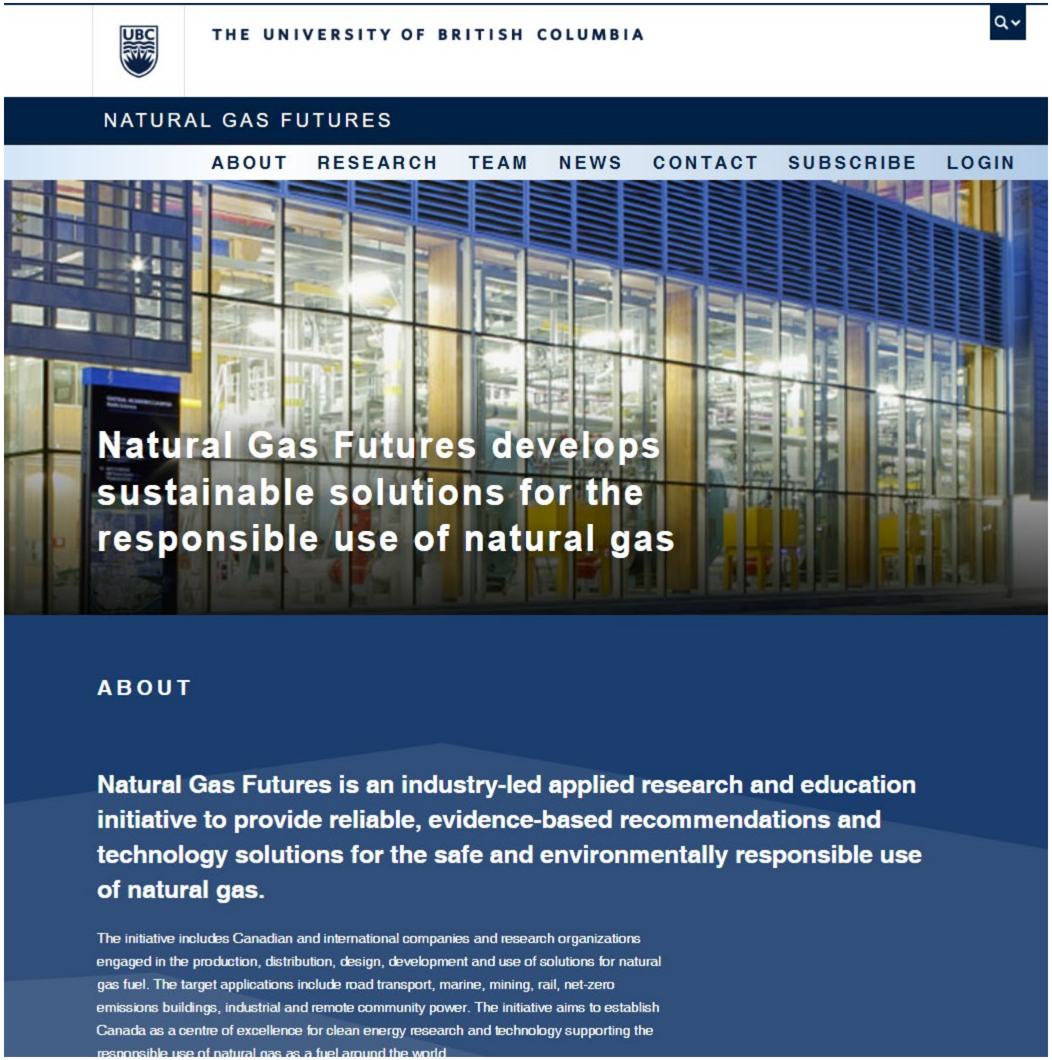
DR. HARISH
KRISHNAN

DR. NADJA
KUNZ

DR. JOHN
STEEN

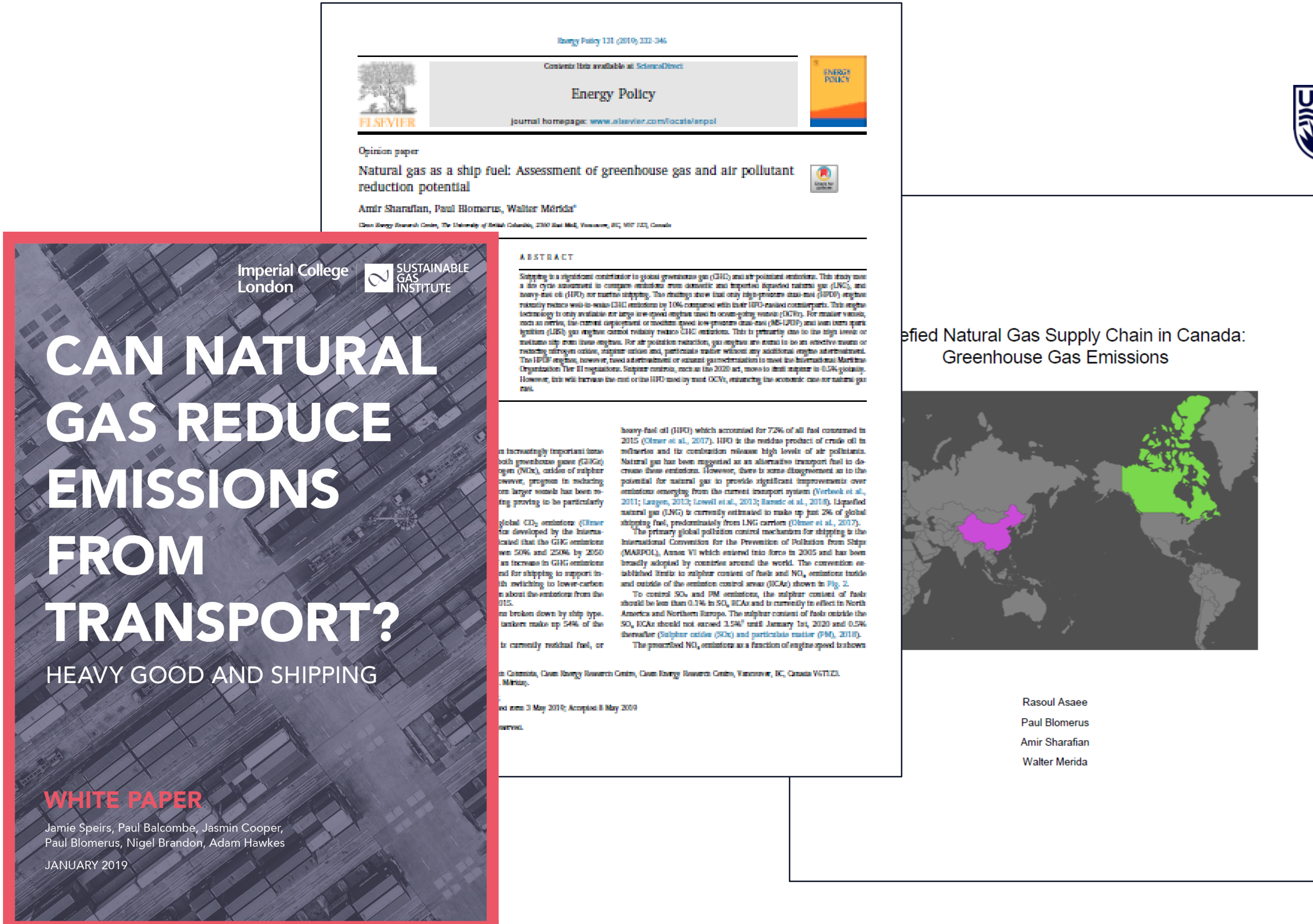
DR. PAUL
BLOMERUS

NATURAL GAS FUTURES



http://naturalgas.apsc.ubc.ca/

LIFE CYCLE ASSESSMENT PROJECTS



DISCUSSION OUTLINE

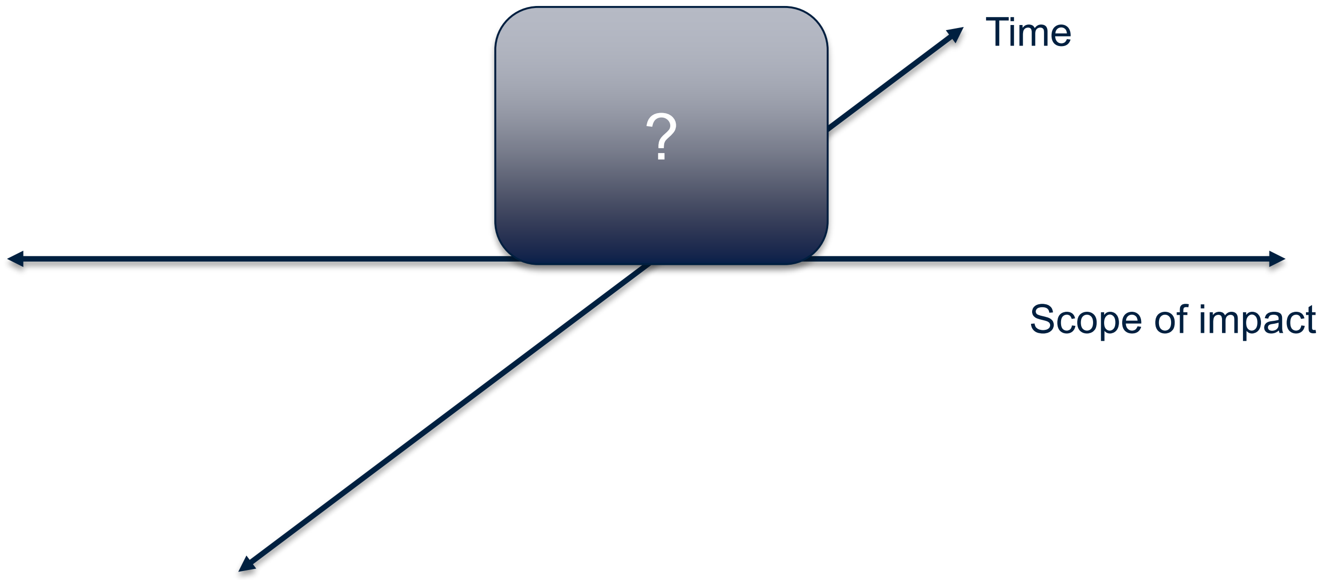
Life Cycle Assessments

1. Why do we need them?
2. What are they?
3. How do we use them?

MAKING BETTER DECISIONS

Which car is most economical to drive?

What should I build my house out of?

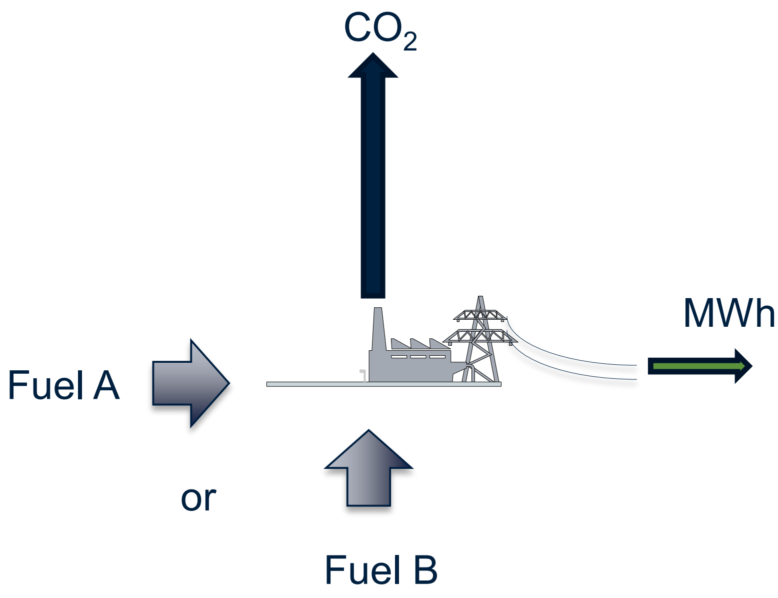


Life Cycle Assessment (LCA)

ISO 14040

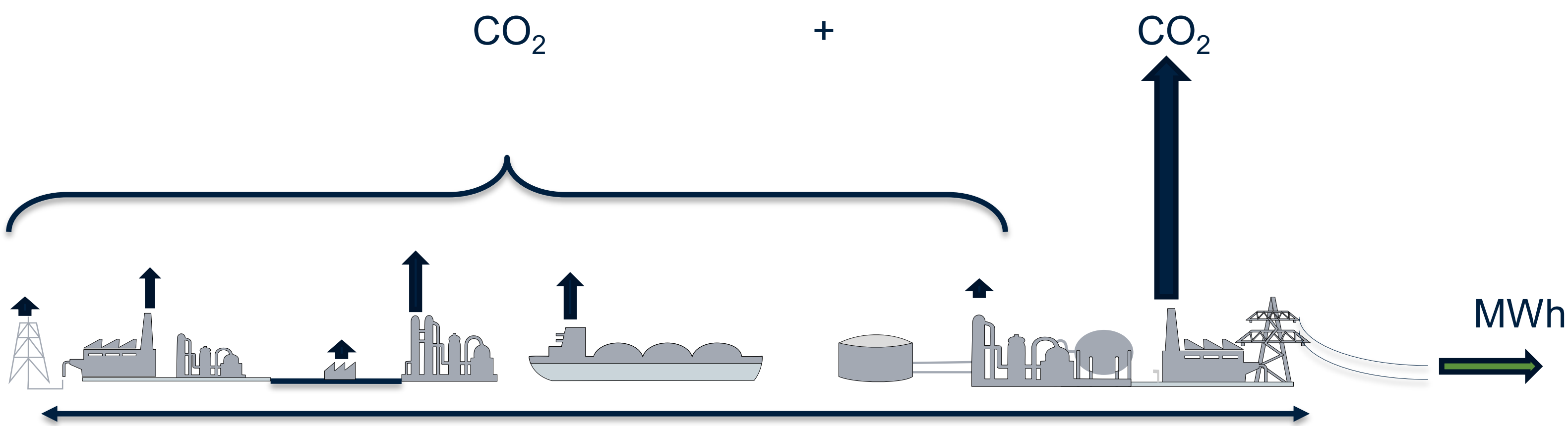
LIFE CYCLE ASSESSMENT (LCA) APPLIED TO ENERGY AND FUEL

Which energy source has the lowest CO_2 emissions?



LIFE CYCLE ASSESSMENT (LCA) APPLIED TO ENERGY AND FUEL

Which energy source has the lowest CO_2 emissions?

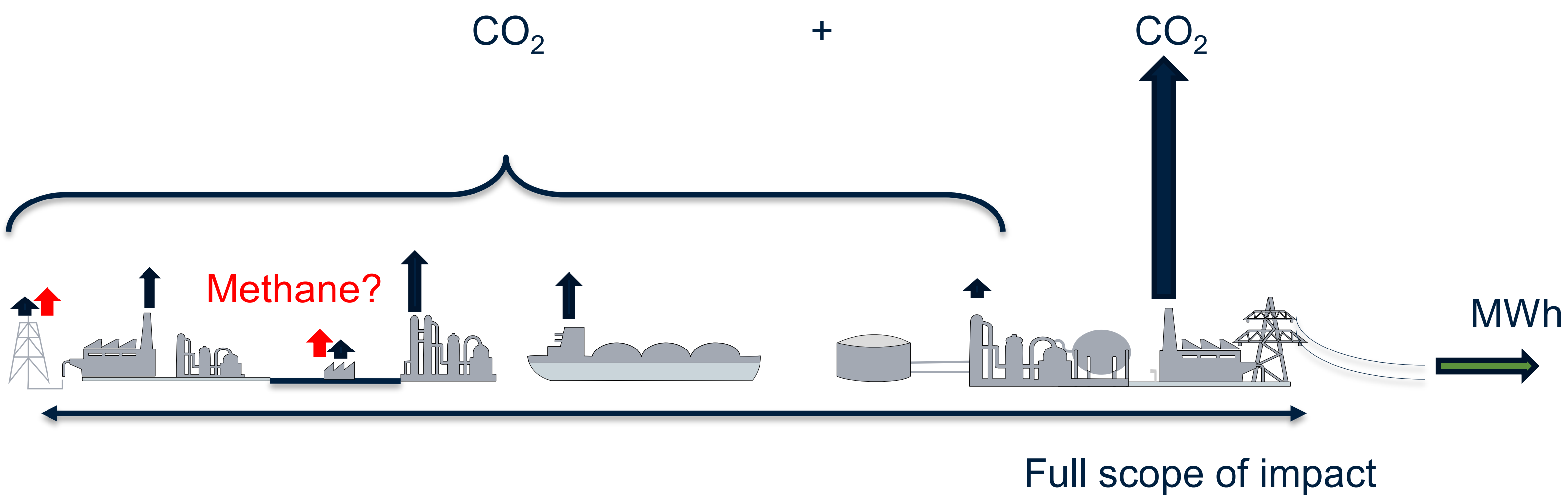


Full scope of impact

Well to wires

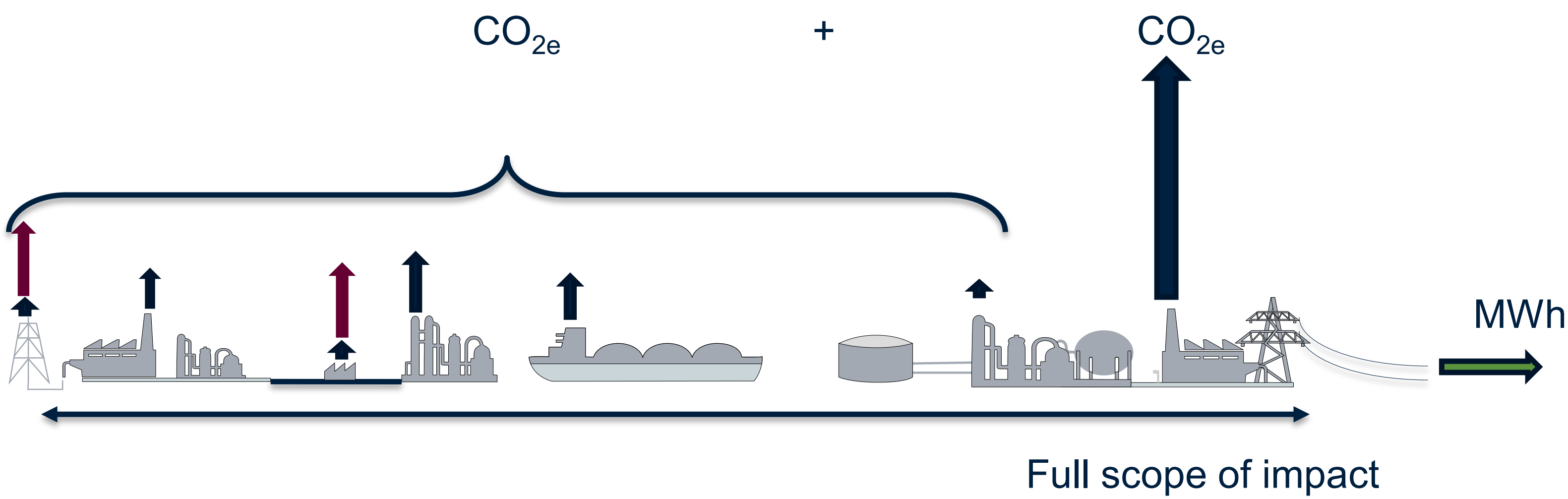
LIFE CYCLE ASSESSMENT (LCA) APPLIED TO ENERGY AND FUEL

Which energy source has the lowest CO_2 emissions?

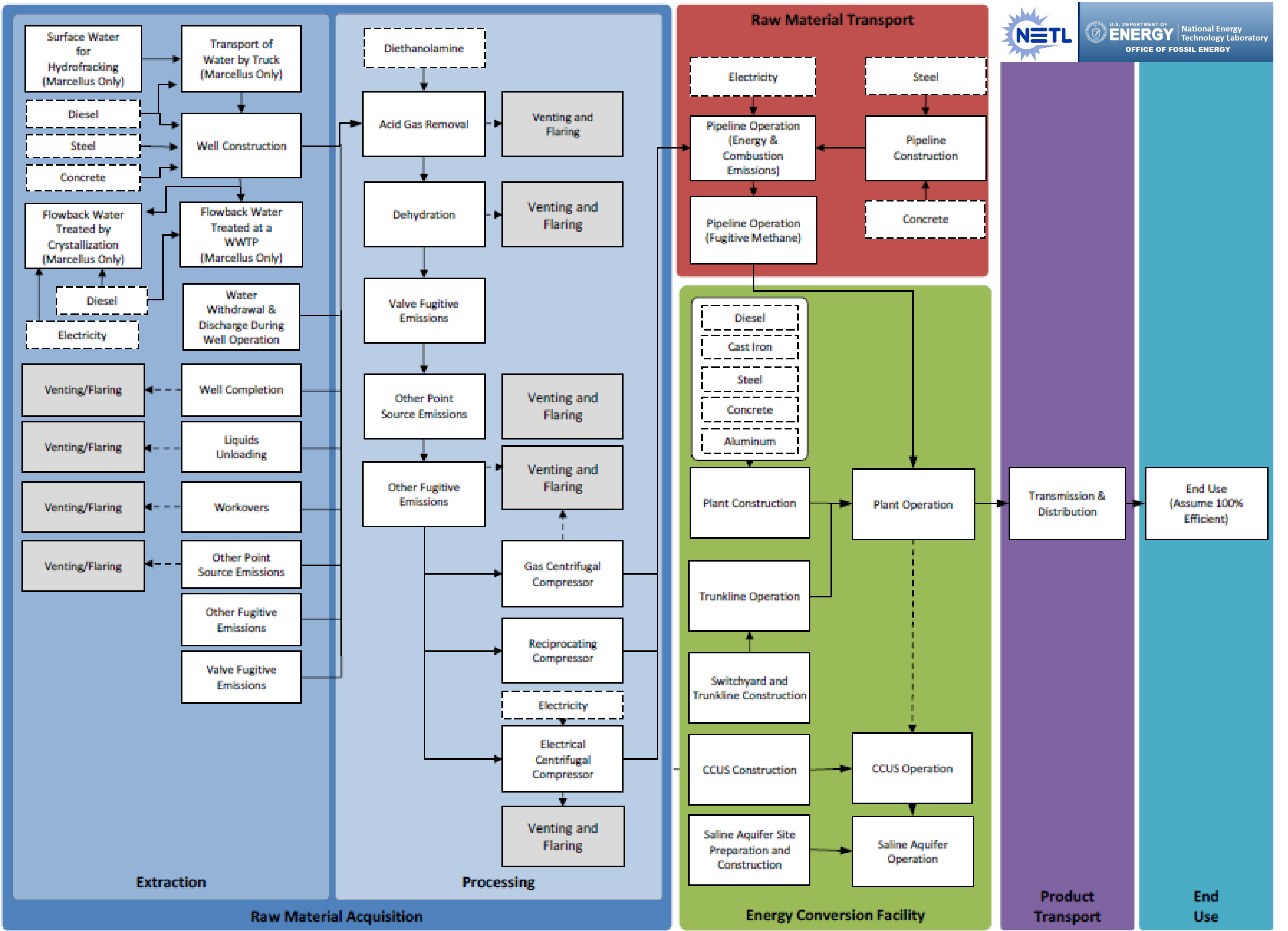


LIFE CYCLE ASSESSMENT (LCA) APPLIED TO ENERGY AND FUEL

Which energy source has the lowest Greenhouse Gas (GHG) emissions?

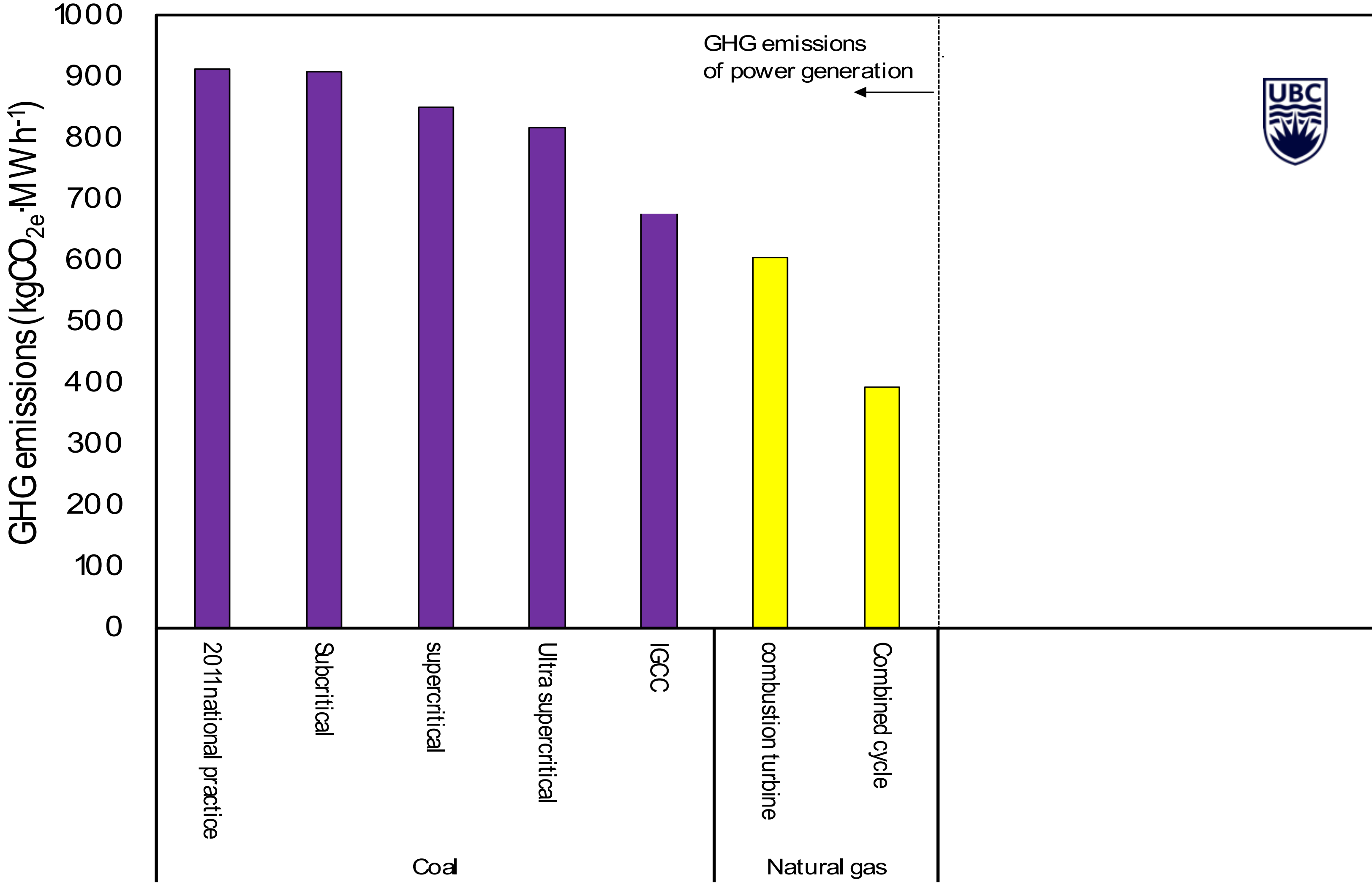


Carbon Dioxide Equivalent:
kg CO_2 x Global Warming Potential (GWP) of methane = kg CO_{2e}



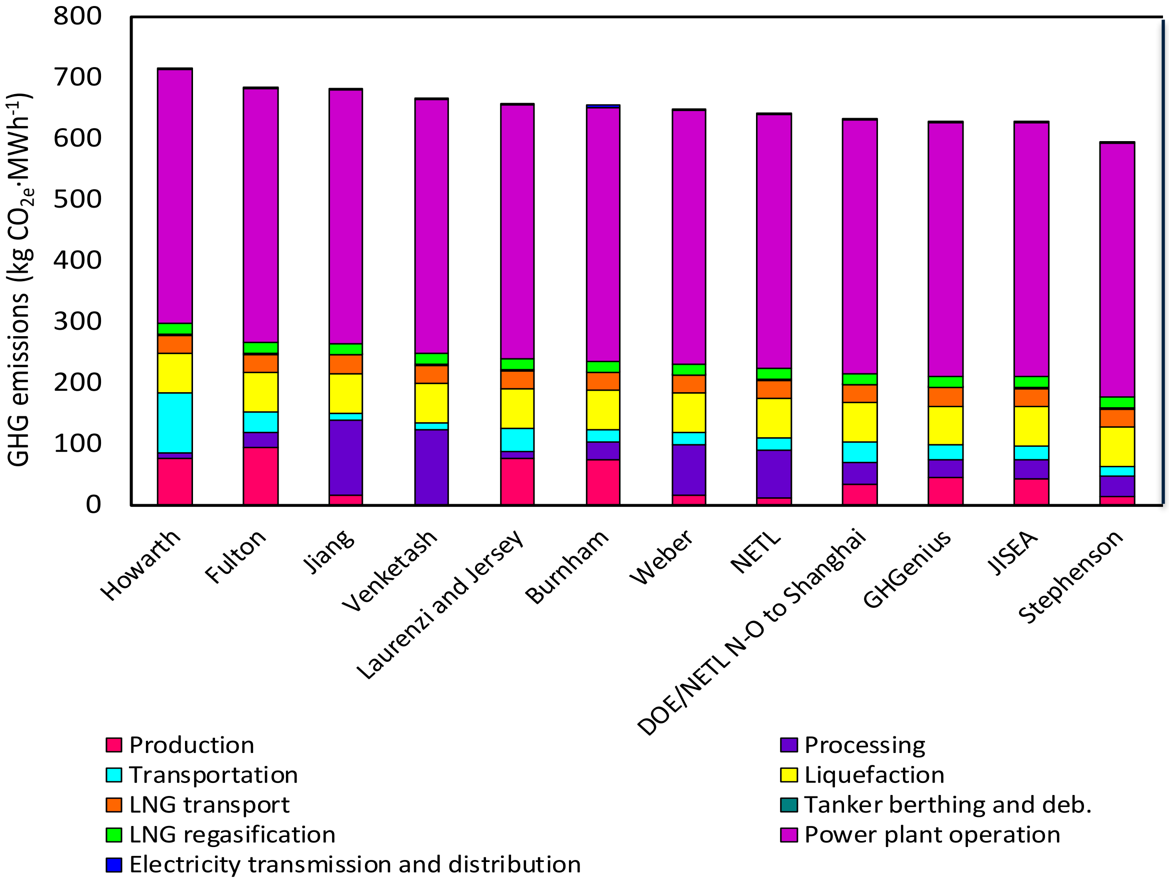
Raw Material Transport
NETL
U.S. DEPARTMENT OF ENERGY
National Energy Technology Laboratory
OFFICE OF FOSSIL ENERGY
Surface Water for Hydrofracking (Marcellus Only)
Transport of Water by Truck (Marcellus Only)
Diesel
Steel
Concrete
Well Construction
Flowback Water Treated by Crystallization (Marcellus Only)
Flowback Water Treated at a WWTP (Marcellus Only)
Diesel
Electricity
Water Withdrawal & Discharge During Well Operation
Venting/Flaring
Well Completion
Venting/Flaring
Liquids Unloading
Venting/Flaring
Workovers
Venting/Flaring
Other Point Source Emissions
Other Fugitive Emissions
Valve Fugitive Emissions
Diethanolamine
Acid Gas Removal
Venting and Flaring
Dehydration
Venting and Flaring
Valve Fugitive Emissions
Other Point Source Emissions
Venting and Flaring
Other Fugitive Emissions
Venting and Flaring
Gas Centrifugal Compressor
Reciprocating Compressor
Electricity
Electrical Centrifugal Compressor
Venting and Flaring
Electricity
Steel
Pipeline Operation (Energy & Combustion Emissions)
Pipeline Construction
Pipeline Operation (Fugitive Methane)
Concrete
Diesel
Cast Iron
Steel
Concrete
Aluminum
Plant Construction
Plant Operation
Trunkline Operation
Switchyard and Trunkline Construction
CCUS Construction
CCUS Operation
Saline Aquifer Site Preparation and Construction
Saline Aquifer Operation
Transmission & Distribution
End Use (Assume 100% Efficient)
Extraction
Processing
Raw Material Acquisition
Energy Conversion Facility
Product Transport
End Use

EMISSIONS FROM COMBUSTION ONLY



The GHG emissions of coal- and gas-fired power generation
(Chang 2015)

LIFE CYCLE ASSESSMENT (LCA)



Life cycle GHG emissions of electricity generation in China from LNG imported from North America (Coleman 2015, Kasuma 2018)

LCA MODEL CONSTRUCTION FOR LNG

Key Assumptions:

- Liquefaction plant energy source and efficiency
- Acid gas venting
- Pipeline compressor energy
- Fugitive methane emissions
- LNG tanker engine emissions
- Global Warming Potential (GWP) of methane

Converting units:

LNG production:

tonnes CO_2 / tonne LNG

Electricity:

x number of tonnes of LNG to make 1 MWh of electricity

- power plant efficiency
- energy content of the LNG
- Losses along the way

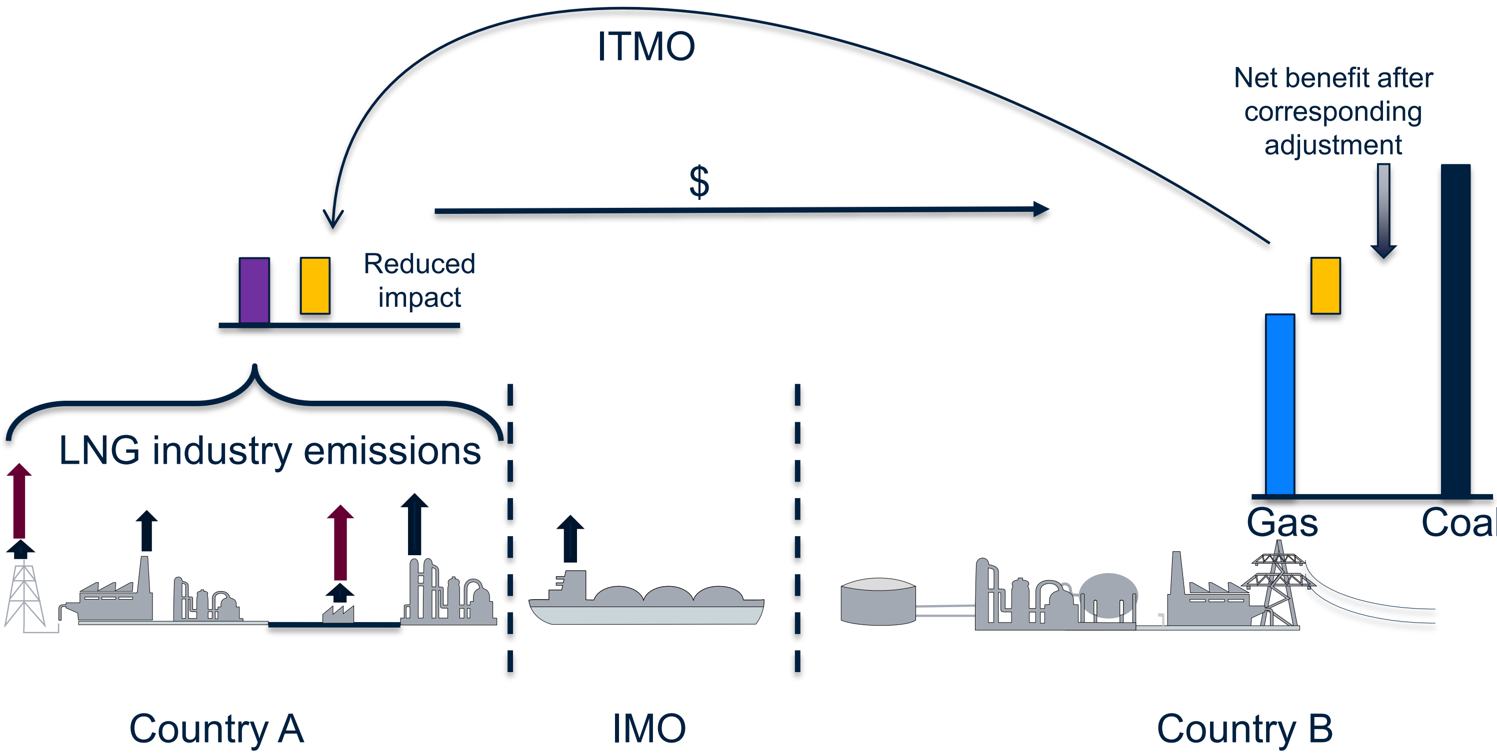
= kg CO_2e / MWh

Country emissions:

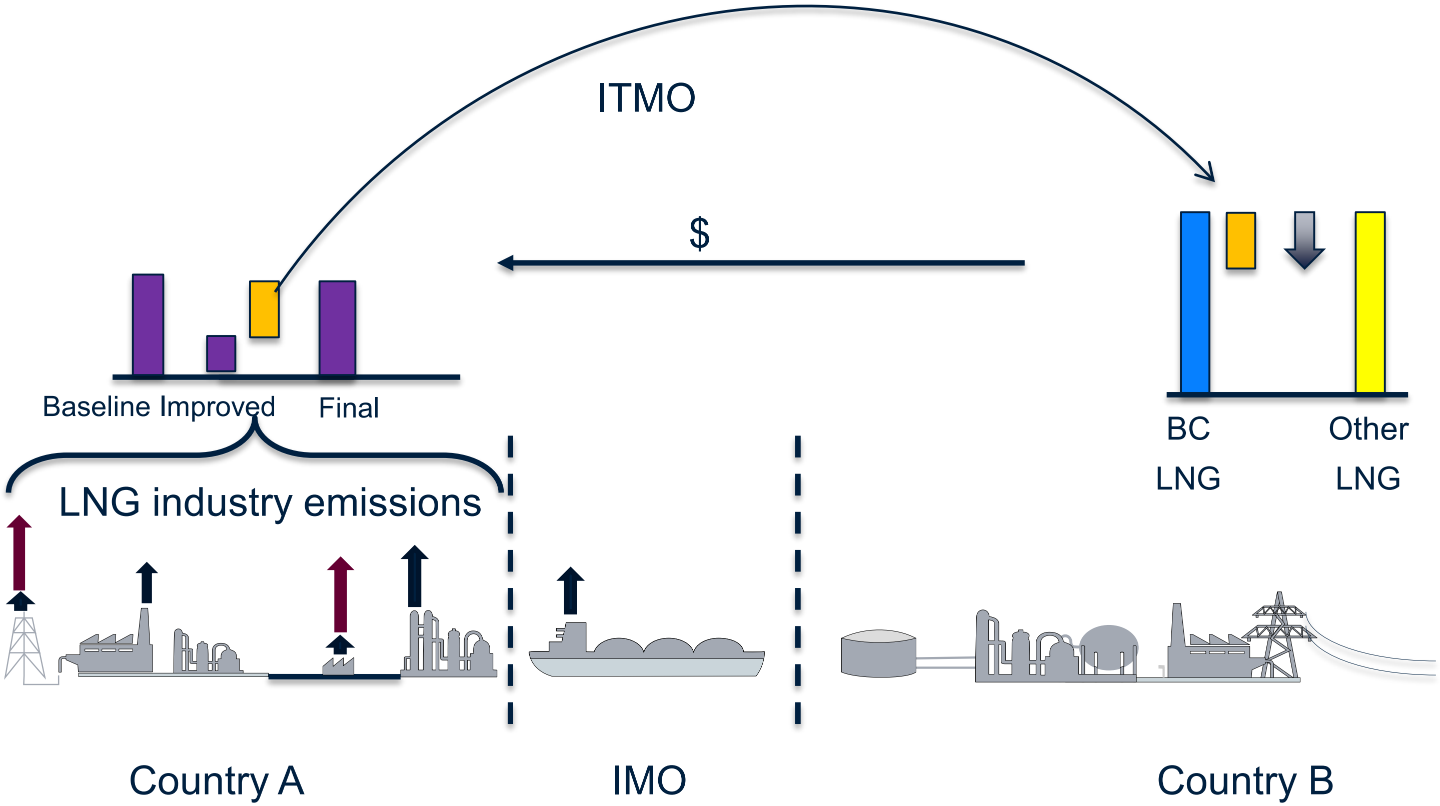
x annual LNG production

= Mt CO_2e per year

SIMPLIFIED ITMO SCENARIO



A DIFFERENT ITMO SCENARIO



COUNTRY LEVEL ITMO SCENARIO