Offshore Technology Conference 2020
4–7 May 2020
NRG Park » Houston, Texas, USA
2020.otcnet.org

OTC-30732-MS
Economic Feasibility Study of Several Utilization Alternatives for a Stranded Gas Reservoir

Khoi Trinh – University of Oklahoma, Norman, OK
Rouzbeh Moghanloo – University of Oklahoma, Norman, OK

AGENDA

- Introduction
- Stranded Gas
- LNG Market
- Gas to LNG Plant
- Gas to Wire
- Floating Liquefied Natural Gas
- Economic Comparison
- Conclusion

INTRODUCTION

- Demand for energy is always growing
- Many countries are shifting towards natural gas
- Rapid depletion and geographical constraints
- Stranded gas reservoir is plentiful
- Several utilization alternatives

STRANDED GAS

- Gas that is wasted or unused
- Differentiate from associated gas in oil reservoir

ASSUMPTIONS

- The pipeline will have the correct diameter, pressure rating and metallurgy to transport the produced gas. Only the pipe length will be considered as a variable
- OPEX of both onshore LNG and FLNG will be the same. Realistically, OPEX of FLNG will be different from that of onshore LNG
- A subsidy from the Nigerian government has been obtained for the onshore natural gas power plant.
- An assumed electricity price was used ($0.25/kWh)
- An assumed upstream cost of $2/MSCF to cover onshore LNG gas pretreatment
- Onshore LNG plant and FLNG will have the same lifespan. However, in reality, availability of FLNG can be lower than that of onshore LNG

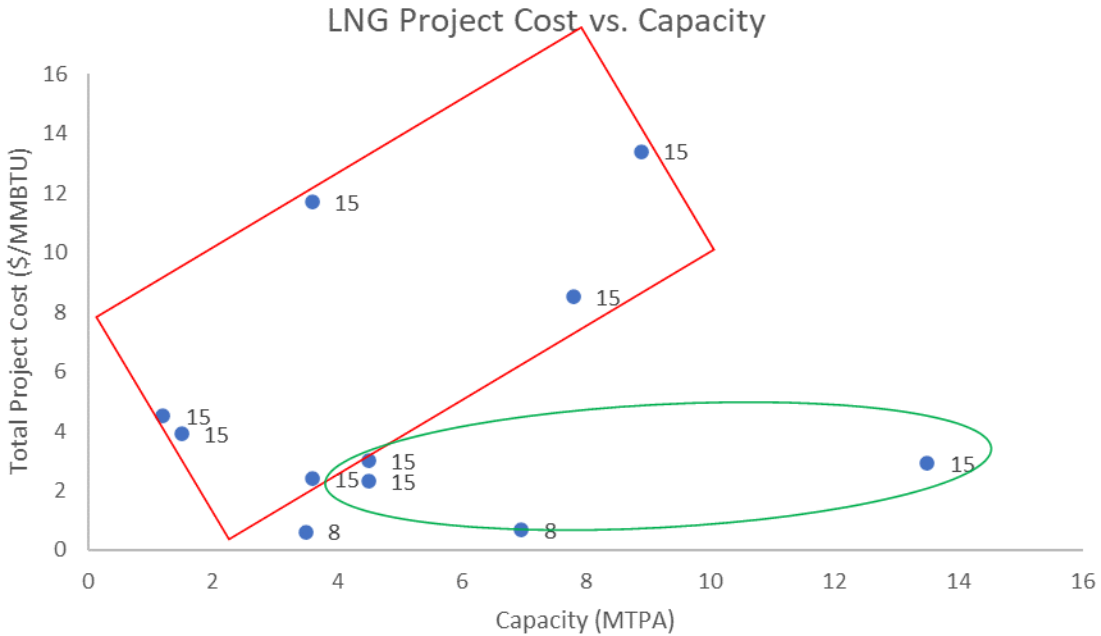
LNG MARKET

- 1975, LNG only 10% of total cross border trade
- 2005, this number is more than 25%
- 2016, Chienere Energy, first US company to export LNG
- 2018 World LNG report, 293.1 metric tonne of LNG were traded globally in 2017

GAS TO ONSHORE LNG PLANT

- LNG pricing depends on various elements along the LNG chain
- Assume a

Year	Capacity (MTPA)	$/MMBTU	Name	Reference



GAS TO WIRE

- Another alternative, gas transported to power plant, fed into gas turbine
- Useful in West African countries

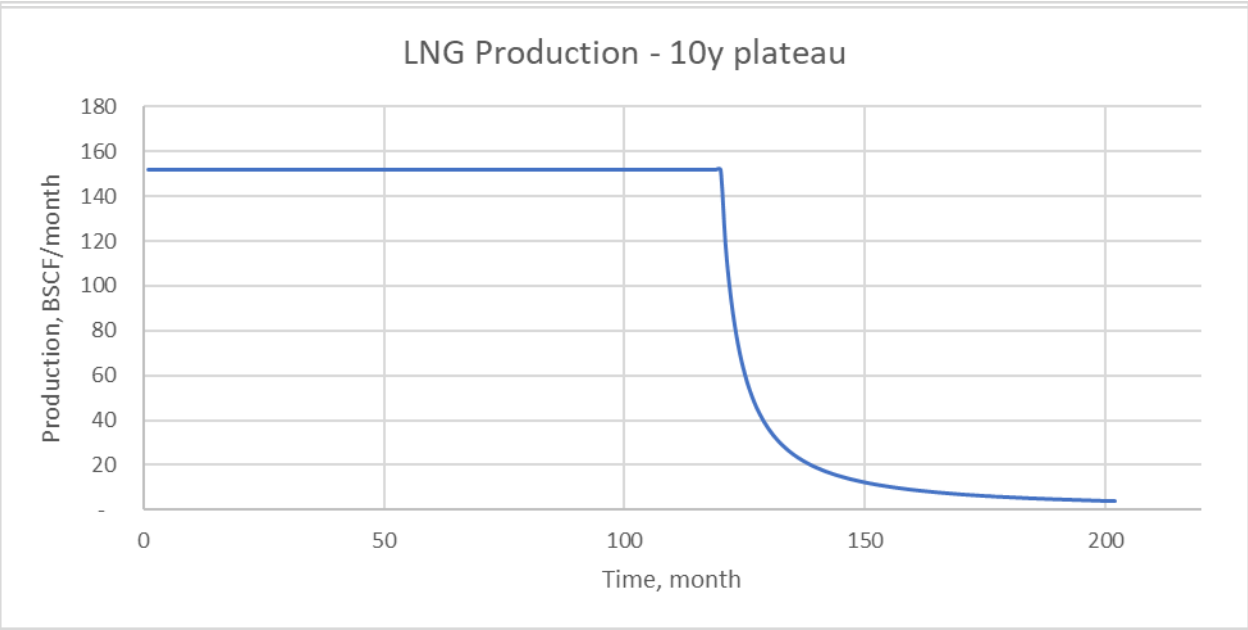
FLOATING LIQUEFIED NATURAL GAS

- Offshore processing facility
- Process and liquefy natural gas directly from a reserve
- Reduce cost, lessen environmental footprint
- Cheaper on a cost/capacity basis
- Not a lot of pricing models

ECONOMIC PARAMETERS

- Project life: 22 years
- FLNG Price: $14 billion, based on Prelude
- Pipeline: $3.1 million/mile
- LNG upstream costs: $2/MSCF
- LNG OPEX: $10 million (~3% of upstream costs)
- LNG plant $550/MTPA, Sabine Pass Train 1 to 4
- CAPEX share for Gas-to-wire: 0.001% of $958/KW.h
- Power plant OPEX: $3.5/MW.h
- LNG Price: $5/MSCF
- Natural Gas Price: $3.08/MMBTU, Nigeria
- Electricity Price: $0.025/Kw.h
- Discount rate: 5%
- Power plant efficiency: 40%

PRODUCTION PARAMETERS



NPV CALCULATION METHODOLOGY

- Initial investment for each case
  - FLNG: $3.7 billion
  - Pipeline to LNG plant: $8.93 billion
  - Gas to wire: $58.13 billion for 10-year plateau, $26.19 billion for 5-year plateau
- Cash flow for each month
  - FLNG and pipeline: sale of LNG
  - Gas to wire: sale of electricity

SENSITIVITY ANALYSIS

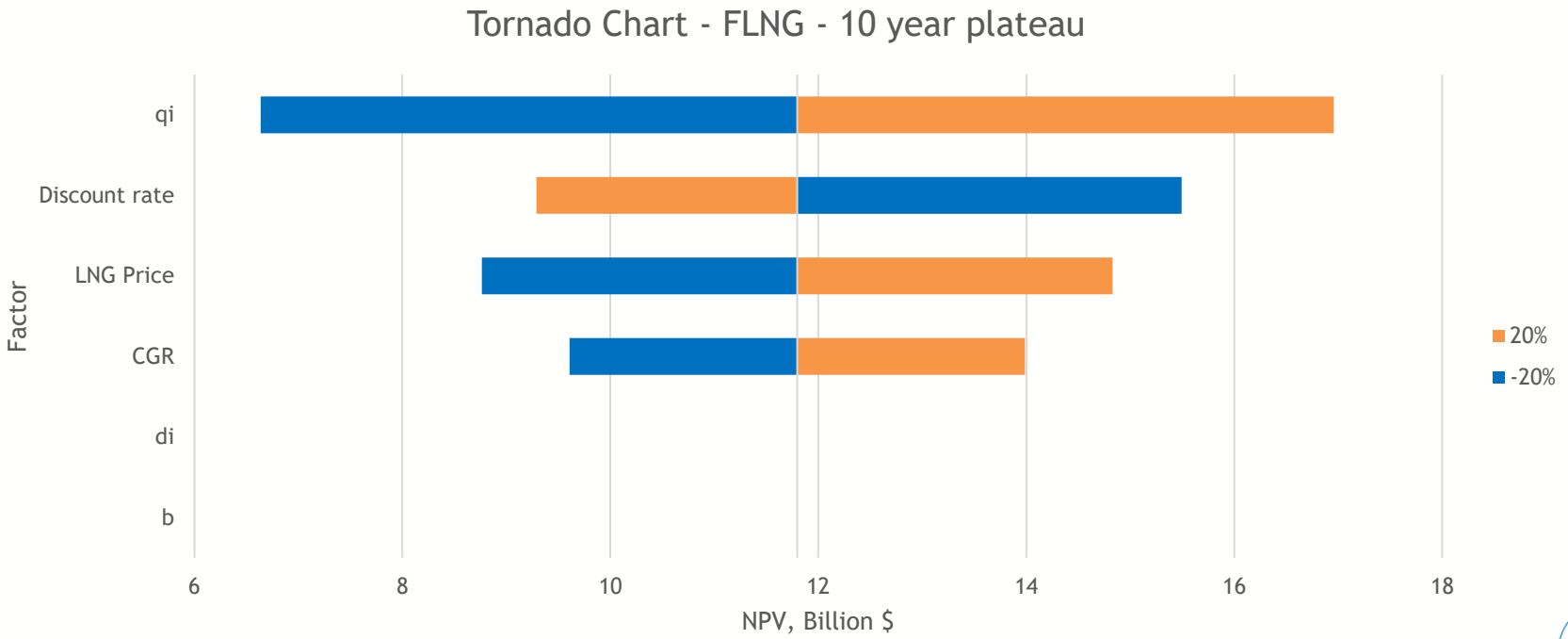
- Model that determines how a target variable is affected by changes in input variable(s)
- Assumed all parameters are independent
- Change of 20%
- 80%, 100%, 120% NPV
- Tornado charts for 6 cases total

SENSITIVITY ANALYSIS

- FLNG - Case 1 and 2: qi, discount rate, LNG price, CGR, b, di
- Pipeline to LNG Plant - Case 3 and 4: qi, discount rate, LNG price, CGR, distance to shore, b, di
- Gas to wire - Case 5 and 6: qi, discount rate, natural gas price, electricity price, CGR, b, di, capital spending, distance to shore

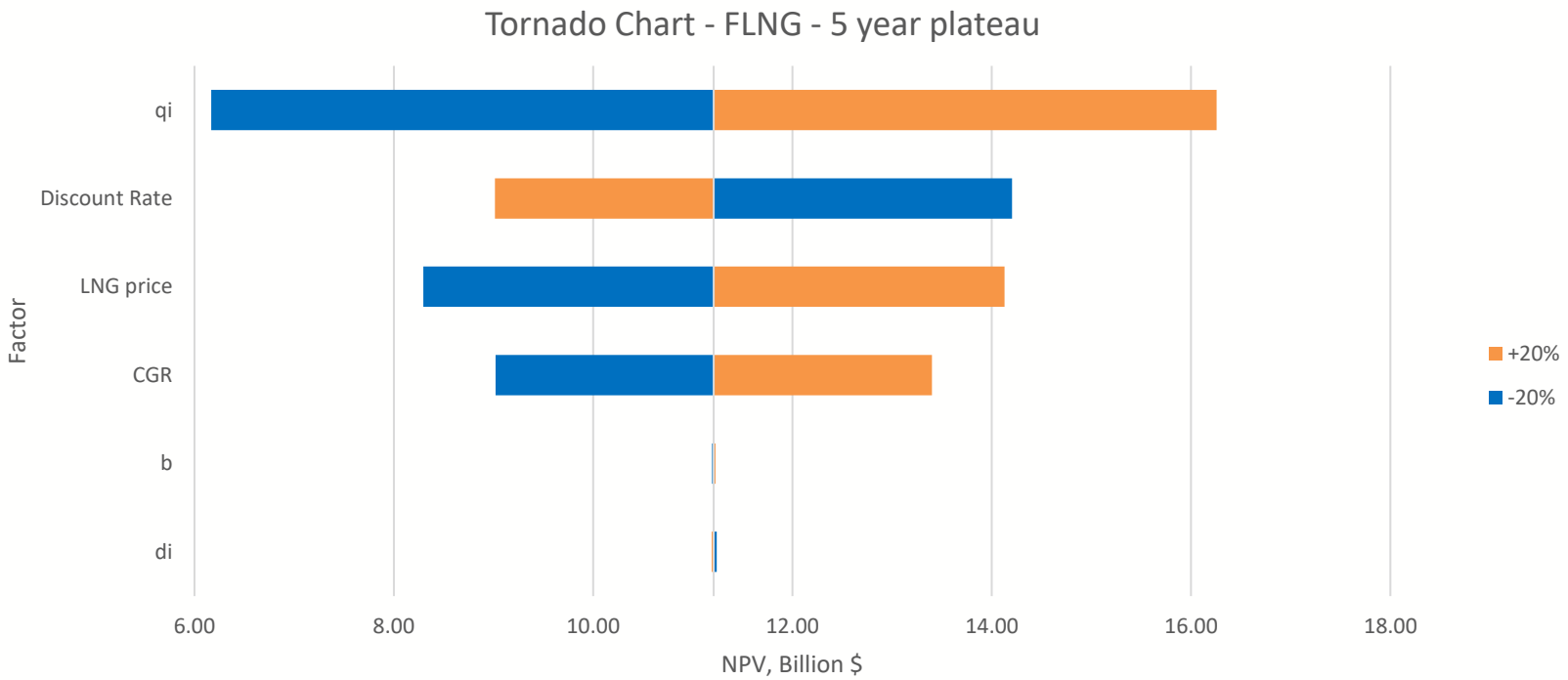
SENSITIVITY ANALYSIS

Case 1 – FLNG, 10 year plateau



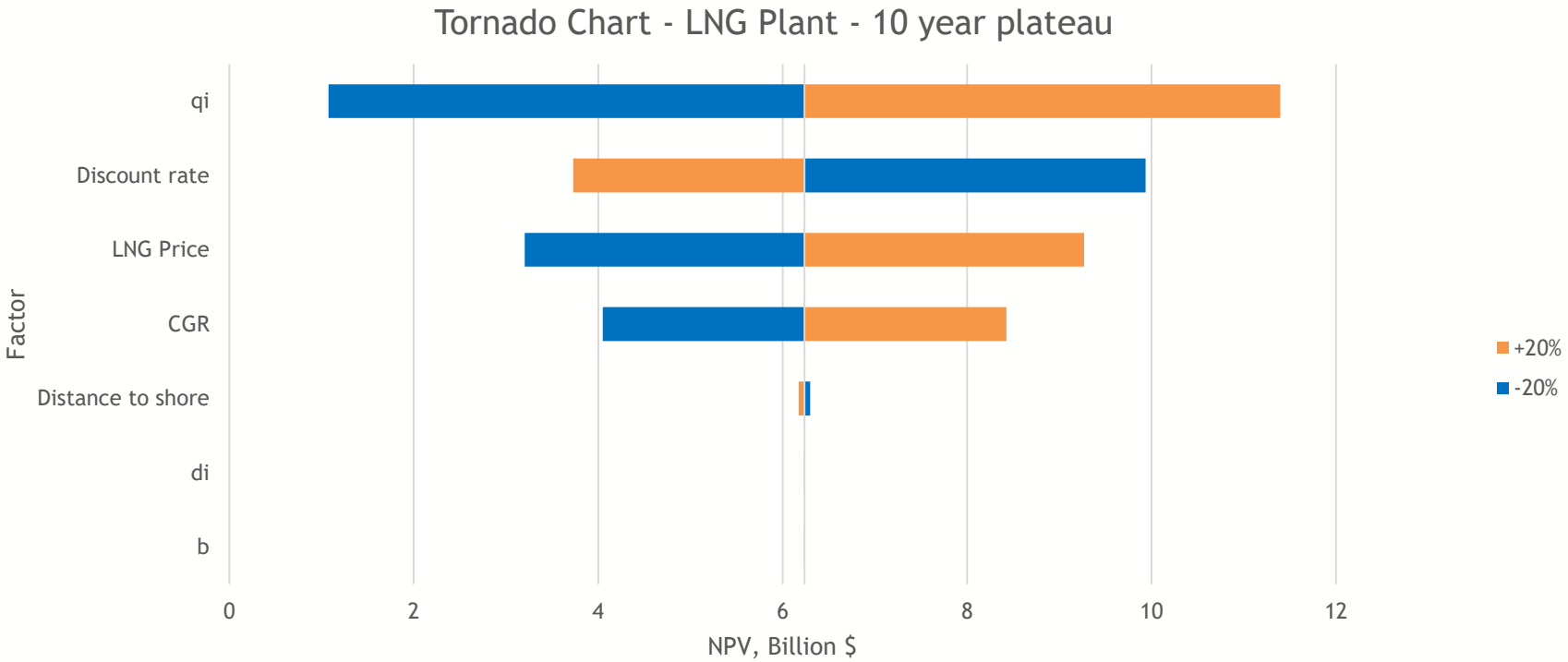
SENSITIVITY ANALYSIS

Case 2 – FLNG, 5 year plateau



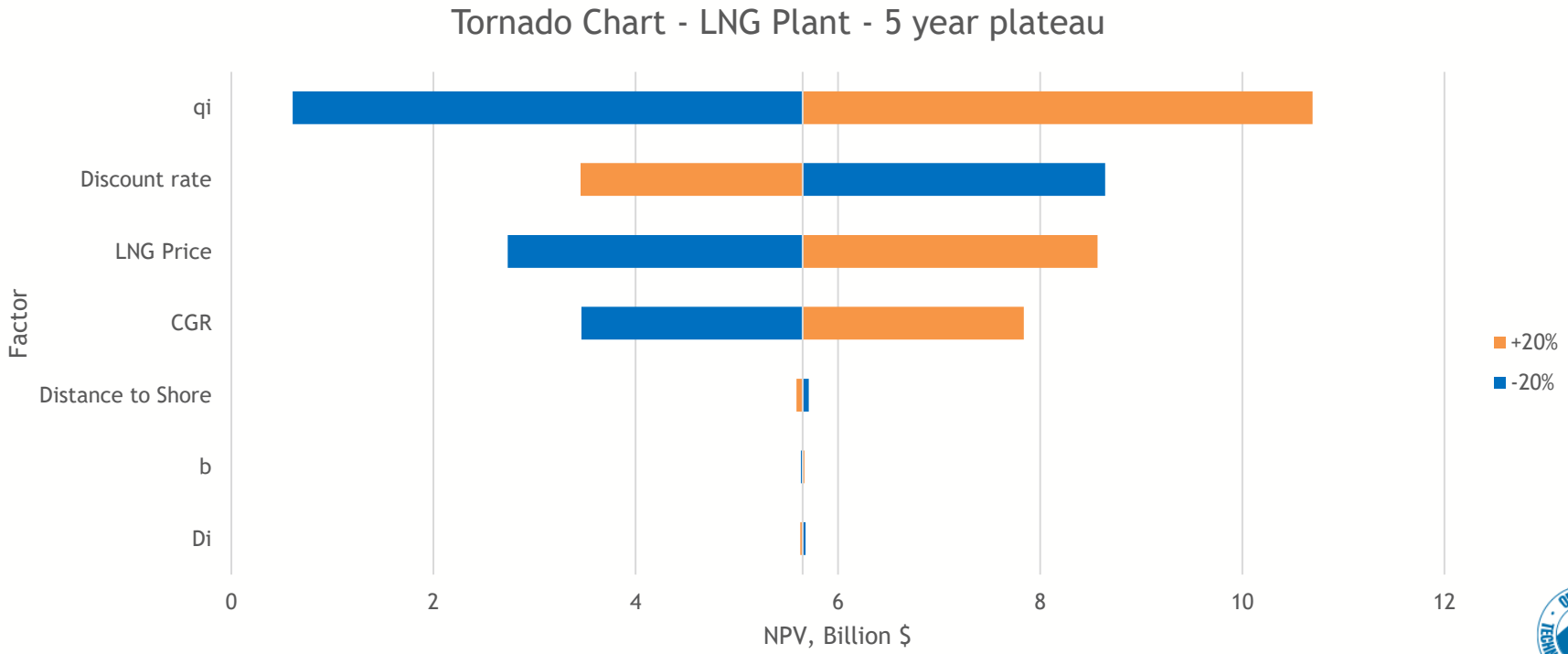
SENSITIVITY ANALYSIS

Case 3 – Gas to LNG Plant, 10 year plateau



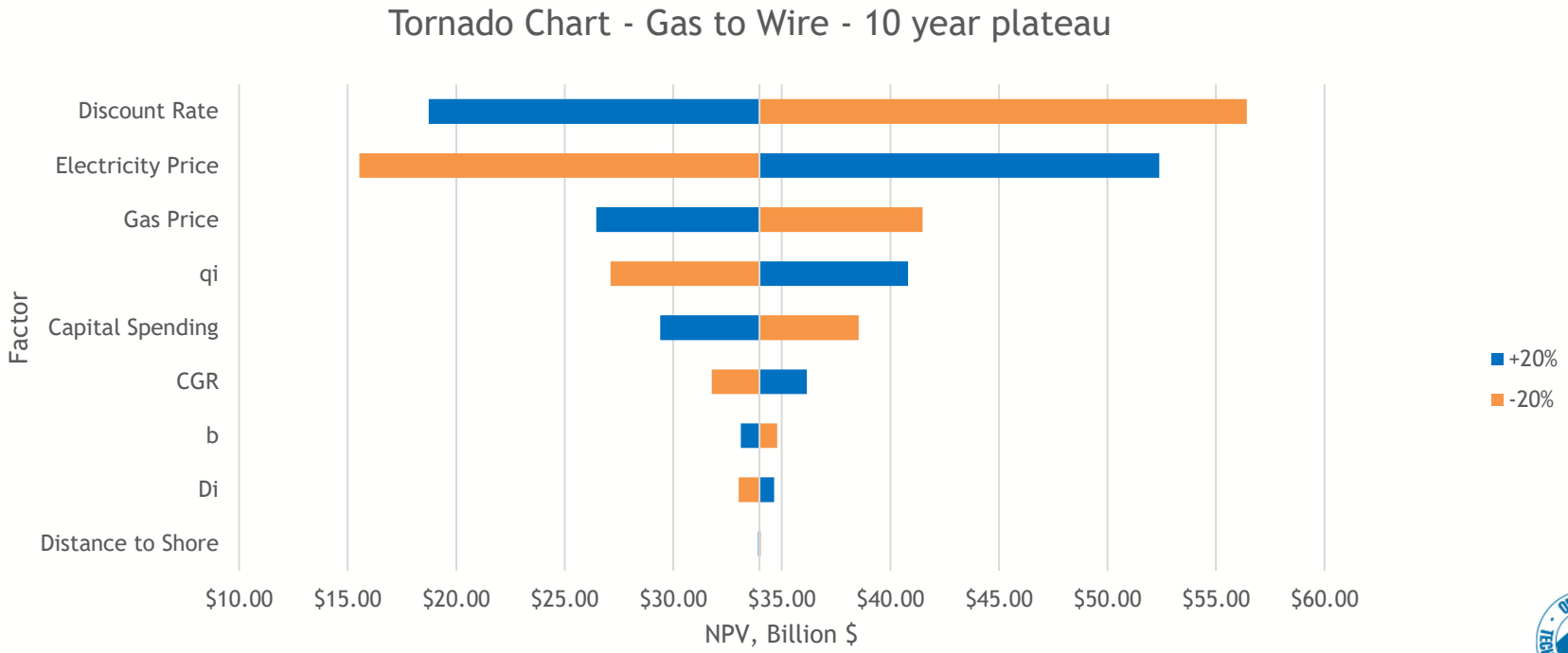
SENSITIVITY ANALYSIS

Case 4 – Gas to LNG plant, 5 year plateau



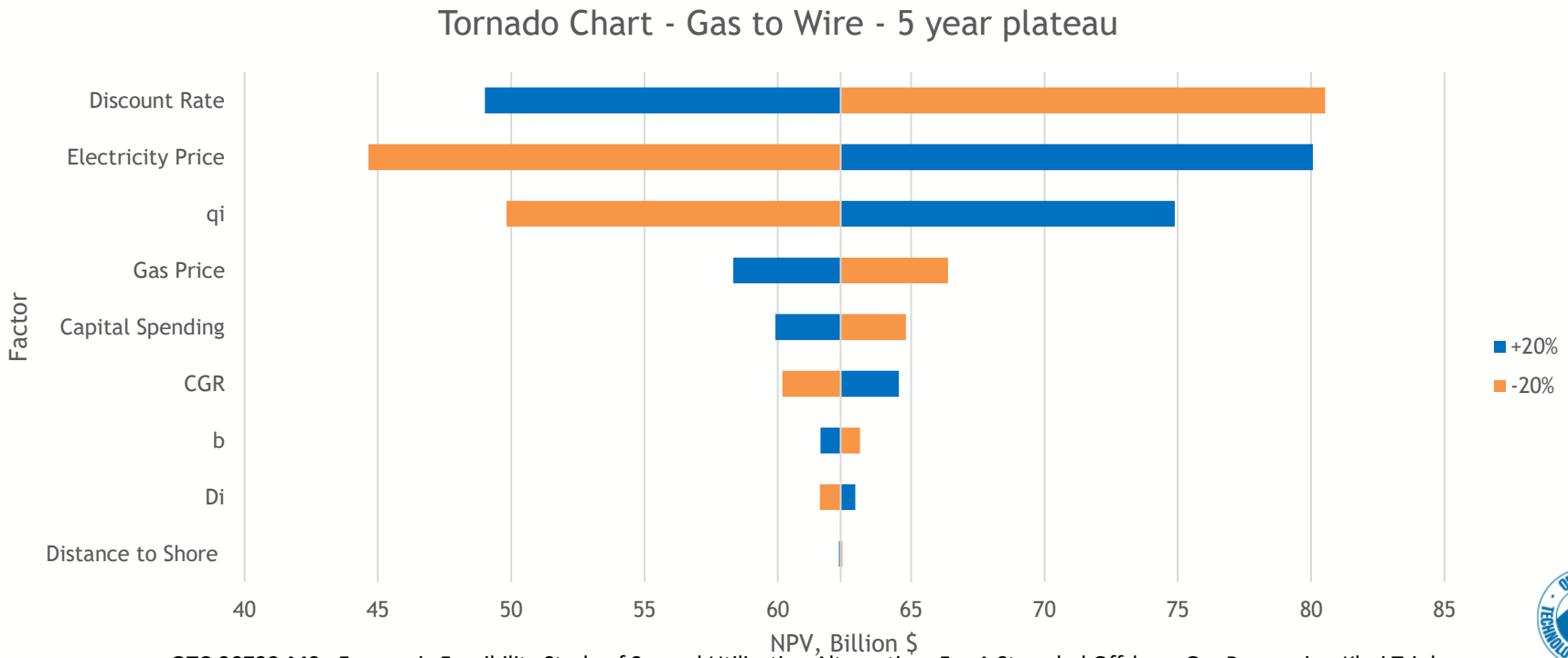
SENSITIVITY ANALYSIS

Case 5 – Gas to Wire, 10 year plateau



SENSITIVITY ANALYSIS

Case 6 – Gas to Wire, 5 year plateau



ANALYSIS

- Only a theoretical model
- Initial production rate has the most effect for first 4 cases
- Discount rate is 2nd most dominant for first 4 cases, but most dominant for last 2
- Prices also a strong factor (LNG, electricity price)

CONCLUSION

- FLNG is attractive the longer the distance to shore is
- Larger gas field would prove beneficial for LNG-related development
- Gas-to-wire most attractive, if subsidy can be obtained

Thank You