ANTICIPATORY STRATEGIES FOR EASTERN EUROPEAN NATURAL GAS SECURITY

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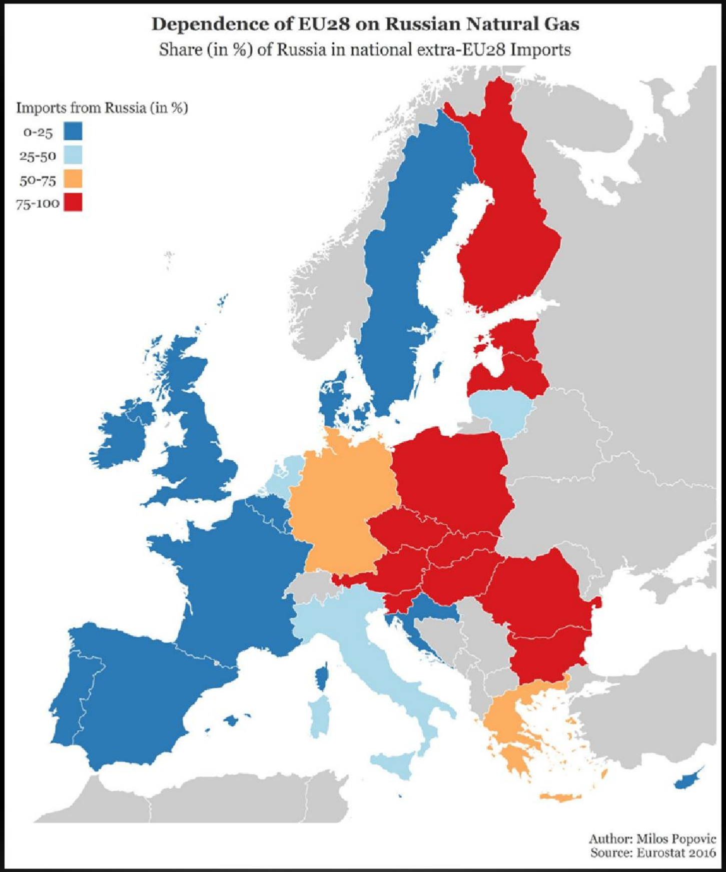
ENERGY AND EARTH RESOURCES
GRADUATE PROGRAM

OUTLINE

I. Background
II. International Relations/Economic Theory
III. Methodology
IV. Case Studies
V. Conclusions/Recommendations

INTRODUCTION

INTRODUCTION



RESEARCH QUESTION

- What strategy is most cost effective for Eastern European countries dependent on Russian natural gas imports to diversify supply?

ANTICIPATORY STRATEGIES, KELANIC (2016)

Coercive Vulnerability

- % of Demand Requirements from Single Source
- Susceptibility to Disruption

→

Anticipatory Strategies

- Self Sufficiency
- Indirect Control
- Direct Control

ANTICIPATORY STRATEGIES

- The strategies differ depending on countries' geographic location, the amount of gas imported, domestic natural gas production, access to alternative natural gas supply and alternative sources of energy, and historic political relations with Russia, among other factors.

- The willingness of countries affected by the Ukraine-Russia supply disruptions to pay for infrastructure to reduce vulnerability to future disruptions indicates state preferences and the threat, actual or perceived, to the state by potential supply disruptions.

- This falls within Paul Samuelson's Theory of Revealed Preferences, where a consumer's preferences are revealed based upon their purchases

REVEALED PREFERENCE, SAMUELSON (1938)

Observed Choices in State Infrastructure Spending → **State Preferred Energy Security Strategy**

EASTERN EUROPEAN ANTICIPATORY STRATEGIES

LNG/Baltic Strategy

- Coastal states can construct LNG import facilities to gain access to increasingly global LNG market, requires trade partner and access to storage

Reverse Flow/Visegrad Group Strategy

- Landlocked states aim to become regional hub or connect to regional hub, by maximizing domestic transport capacity and diversification of supply source
- Reverse flow of existing pipeline infrastructure or building new pipeline capacity extending to non-Russian supply hub

LNG/BALTIC STRATEGY

LNG/BALTIC STRATEGY

Reverse Flow/Visegrad Group Strategy

Country	West-East flow into Country (bcm/yr)	Domestic production (bcm/yr)	Domestic Consumption (bcm/yr)	Excess capacity in event of disruption (bcm/yr)
Czechia	61.2	0.3	7.9	53.6
Hungary	13.3	1.8	9	6.1
Poland	15.5	6.1	18.3	3.3
Slovakia	19.1	0.1	4.6	14.6
Ukraine	22.2	19.0	41.1	0.1

INTERDEPENDENCE

CASE STUDY METHODOLOGY

- Initial conditions of infrastructure determined using International Energy Agency (IEA) interactive map entitled *Gas Flow Trade in Europe,* the European Network of Transmission System Operators for Gas (ENTSOG) map, the European Commission's *Projects of Common Interest* interactive map, and the Gas Infrastructure Europe (GIE) LNG Import Terminal Database.

- These maps and the accompanying data were used to determine each country's natural gas consumption, transmission infrastructure import and export capacity, underground storage capacity, reverse flow capabilities, and the locations of current infrastructure.

- Trade journals, press releases, news articles, and academic publications were consulted to estimate infrastructure capital and operating costs for onshore/offshore pipelines, reverse flow modifications, compressors, LNG import facilities, and storage expansion

PRICING ASSUMPTIONS

Coastal Regasification Facility CAPEX
FSRU 170 kcm Storage Capacity……US$236-280 M
Onshore Interface/Infrastructure……US$30 M
Construction of Jetty and Piping……US$80 M

Coastal Regasification Facility OPEX
Operations & Maintenance……2.5% of CAPEX/yr
LNG Surcharge……US$162 -216 M/bcm
Lease Surcharge……US$189,000/day

Pipeline CAPEX
Onshore High Estimate East-West Turkmenistan……US$2274/km-mm
Onshore Middle Estimate EU Project Average……US$1229/km-mm
Onshore Low Estimate Turkmenistan-China……US$933/km-mm
Offshore High Estimate Nord Stream……US$2622/km-mm
Offshore Low Estimate Langeled……US$1305/km-mm
Addition of Bidirectional Compression……US$2-5 M per facility

Pipeline OPEX
Compression cost……US$3.52 M per bcm/yr
Transit fee……US$2.19/kcm-100km

Underground Gas Storage CAPEX
Salt Expansion……US$236.6 M/bcm
Salt New Facility……US$296.6 M/bcm
Depleted Expansion……US$173.0 M/bcm
Depleted New Facility……US$233.0 M/bcm
Aquifer Expansion……US$384.9 M/bcm
Aquifer New Facility……US$480.2 M/bcm

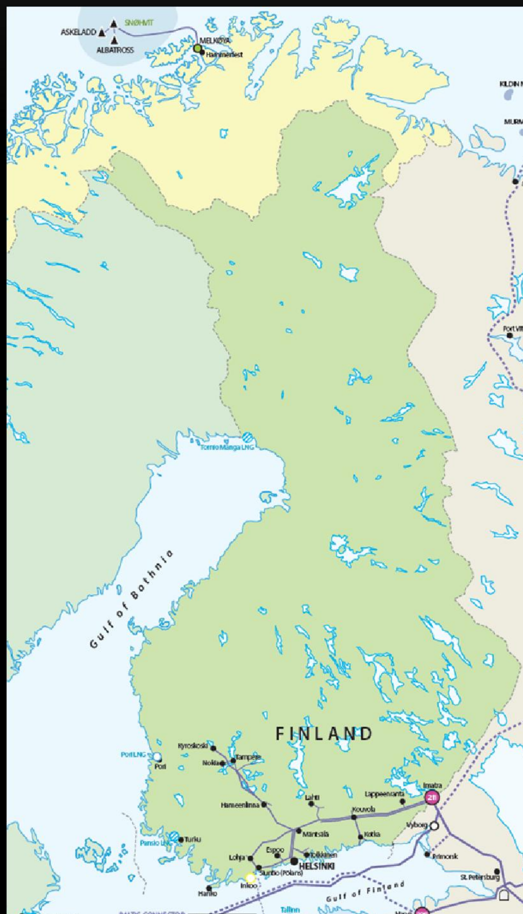
Underground Storage OPEX
Injection/Withdrawal Cost……US$365/Mcm

Discount Rate……10%

CASE STUDY: FINLAND

- 2015 Demand: 2.7 bcm
- 100% Supplied by Russia
- 7.4% of Primary Energy
- $0 in Transit Fees

FINLAND: CASE STUDY RESULTS



Estimated Cost over 30 Year Life	High ($B)	Low ($B)
Helsinki-Hammerfest Pipeline	2.53	1.14
Inkoo LNG 2.5	5.57	4.25
Inkoo LNG 0.5	1.5	1.19
Balticonnector	0.55	0.4
Inkoo-Denmark Offshore	2.78	1.72
Inkoo 0.5 and Balticonnector	2.05	1.59

CASE STUDY: BULGARIA

- 2015 Demand: 3.1 bcm
- 100% Supplied by Russia
- 13% of Primary Energy
- $880M in Transit Fees

BULGARIA CASE STUDY: RESULTS

Estimated Cost over 30 Year Life	High ($B)	Low ($B)
Interconnection Bulgaria-Serbia	0.64	0.5
Black Sea Pipeline Georgia-Bulgaria	2.79	1.73
Interconnection Greece-Bulgaria	2.58	2.49
Alexandroupolis LNG 2.5 with IGB	6.06	4.52
Alexandroupolis LNG 0.5 with IGB	3.98	3.58

CONCLUSIONS/RECOMMENDATIONS

- Anticipatory strategies contingent upon geography, existing infrastructure, and state preferences
- LNG import facilities remain a strategy for coastal states, though redundant LNG capacity unnecessary if already provided regionally
- LNG OPEX surcharge make it a costly long term replacement strategy, though building backup import capacity appears cost effective when combined with pipeline interconnection
- Reversing flow of and connecting to existing pipeline infrastructure reduces capital costs in comparison to new pipeline construction, but involves potential transit fees or loss of transit revenue
- Further interconnection of the internal EU gas market appears to be the most cost effective strategy, though dependent on continued cooperation with neighboring transit states

THANK YOU! QUESTIONS OR COMMENTS?

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