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Working Paper

Wars and Pipelines: How Armed Conflict Has Driven Oil Logistics Diversification

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Executive Summary

Recent hostilities have produced the largest oil supply disruptions in history, demonstrating Iran's ability to virtually close the Strait of Hormuz and exposing the vulnerability of roughly 20 million barrels per day (bpd) of regional exports. This working paper argues that armed conflict is a primary driver of oil logistics diversification, illustrated through four historical precedents, including the WWII Big Inch and Saudi Arabia's East-West Pipeline. Under kinetic pressure, the geography of logistics is periodically rewritten, and this could be another such period.

Route diversity is essential to hedge against future disruptions, whose cumulative impact can exceed $1 billion per day. Maintaining bypass capacity helps preserve both revenue continuity and consumer confidence in Gulf supply reliability.

To address chokepoint risk, this paper proposes a Gulf Super Express Pipeline: twin 56-inch lines with a combined capacity of 10 million bpd, terminating on Oman's Arabian Sea coast. AI-assisted modeling estimates total capital expenditure (CAPEX) at approximately $55 billion, including $10.1 billion for defense and hardening. Multiple pipeline projects will likely be implemented, targeting ports on the Mediterranean and Arabian Seas. This analysis focuses on what a "maximum project" that could serve as an oil aggregator for multiple key Gulf producers would look like.

Introduction

The current conflict is one of the largest oil supply disruptions in history, eclipsing the 1973 Arab Oil Embargo, the 1979 Iranian Revolution, and the 1991 Gulf War. It vividly demonstrates how Iran, a regional military power, has been able to virtually close the transit of oil (and multiple other critical commodities) through the Strait of Hormuz.

It has further exposed the reality that of the region's roughly 20 million bpd of exportable crude oil and refined products, there are alternative pipeline outlets for perhaps 9 million bpd that can physically bypass the Strait.

Remaining production is constrained by the Strait's closure, forcing producers to shut in fields, and posing a severe economic threat to Gulf States that depend on oil and gas exports as their primary source of revenue.[1] There is also a risk that the Houthis could enter the fight, which would imperil oil shipments through the Bab al-Mandeb and force traffic toward the Suez Canal, another potential chokepoint.[2]

The latest oil crisis, the second in four years, is likely to reinforce consumers' desire to reduce their dependence on oil as a total proportion of primary energy supply. Electrostate aspirations and implementation actions are getting a major boost. But even with more aggressive electrification and efficiency measures, oil will remain a vital global energy supply resource for decades to come.[3] This means that alternative logistical routes for getting oil to ports outside of the Persian Gulf (and likely also the Red Sea) is likely to be a priority.[4]

This paper explores four pipelines historically constructed to ensure oil could reach consumers even in the face of armed conflict. It will then conclude with a financial analysis of what an oil pipeline bypassing both the Strait of Hormuz and the Bab al-Mandeb would potentially cost to build and operate.[5]

History of Pipelines Constructed During Armed Conflict

Example #1: World War II Big Inch and Little Big Inch Pipelines

Early in World War II, oil tankers moving oil from the Gulf of Mexico to the East Coast began to be intensively targeted by German U-Boats. After a brief period of consternation and searching for alternatives, the U.S. government formed a public-private partnership with the oil industry to build pipelines to move oil and refined products in a way that the lethal U-Boats could not reach.

The project was worth $95 million in 1942 (almost $2 billion in February 2026 dollars) and included a 24-inch diameter crude oil pipeline from East Texas to Illinois and a 20-inch refined products pipeline from Texas to Philadelphia and New York.[6] As the Texas State Historical Association put it: "*A ditch four feet deep, three feet wide and 1,254 miles long was to be dug from Longview (Texas) across the Mississippi River to Southern Illinois and then east to Phoenixville, Pennsylvania, with lines from there to New York City and Philadelphia*."[7] Construction crews managed to complete the Big Inch in just 350 days — an average construction rate of 3.6 miles per day. At that build rate, one could cross the Arabian Peninsula in about 6 months.

Figure 1 — Big Inch and Little Big Inch Pipeline Routes

Source: American Oil and Gas Historical Society (AOGHS), "Oil Pipelines: Big Inch."

The Big and Little Inch pipelines came online just as Allied forces gained the upper hand in the Battle of the Atlantic and began rolling back the Nazi submarine threat. The pipelines also expanded the deliveries of oil and refined products in time to help support the D-Day Invasion.[8]

Example #2: Saudi East West Pipeline

The Saudi government saw that its single oil export route using the Strait of Hormuz could become a critical strategic vulnerability. It needed an alternative high-volume export route, as well as an efficient way to supply refineries on the Red Sea. Petromin, a Saudi corporation, contracted in 1978 with a joint venture of C.A.T (a Lebanese construction firm) and Houston Contracting Company (an American energy infrastructure builder) to build a 750 mile, 48-inch diameter pipeline from Abqaiq in eastern Saudi Arabia to the Red Sea port of Yanbu in the west.[9] The initial project was designed to move 1.85 million bpd, expandable to 2.35 million bpd, and cost $1.6 billion ($7.85 billion February 2026 dollars).[10]

As the line was under construction, the Iran-Iraq War erupted, providing additional impetus to finish the project and also affirming Riyadh's strategic reasoning that export route diversification was an existential national priority. First oil was shipped in July 1981, with 1.3 million barrels loaded onto the tanker *Yanbu Pride* at the port of Yanbu.[11]

A string of expansion decisions followed over the next 30 years that affirmed the pipeline's core purpose as a strategic national economic security asset for Saudi Arabia. First, Aramco added a second pipeline 56 inches in diameter running parallel to the original 48-inch line. This brought potential daily system capacity to 5 million bpd by 1992-1994.[12] Completion timing coincided closely with the 1991 Gulf War, which was another kinetic reminder that Saudi Arabia exists in a challenging geopolitical neighborhood.

Second, in 2014 Aramco converted the dual purpose line to emphasize crude oil transport, bringing the parallel lines to their true theoretical capacity of 5 million bpd. The system typically only runs at partial capacity, with Global Energy Monitor estimating that the 56-inch primary crude oil line carried 2 million bpd of actual flows in 2014.[13] Third, in 2019 after the Iranian attack on the Abqaiq processing facility, Aramco brought the East-West Pipeline to full capacity and also pressed a parallel natural gas liquids (NGL) line into service to transport crude.[14] This temporarily raised system capacity to 7 million bpd and highlighted the value of the additional parallel pipelines that normally carried NGLs to petrochemical plants near Yanbu but in an emergency could be converted to carry crude oil instead.

Aramco again activated the East-West Pipeline's emergency 7 million bpd surge capacity after the start of the latest regional conflict shut down most oil transit through the Strait of Hormuz. Twice now (Abqaiq attacks in 2019 and the recent conflict), the project has affirmed the value of maintaining reserve oil transport capacity to compensate for damage to infrastructure or closure of primary export routes.

Just as the Kingdom has historically maintained a cushion of spare oil production capacity, so too it has maintained very substantial reserve oil re-routing and transportation capacity. These steps are congruent with Aramco's position of seeking to assure the existence of "*unique operational flexibility*."[15]

Figure 2 — Petroline Capacity and Key Events Timeline

Petroline (East-West Pipeline) Capacity Timeline

Saudi Arabia • Abqaiq to Yanbu • 1,201 km • 1981–2026

YEAR	EVENT	CAPACITY	STATUS
1981	Original 48-inch line commissioned by Petromin during Iran-Iraq War	~1.85M bpd	Operational
1992	56-inch line added after Gulf War demonstrated Hormuz vulnerability	5M bpd (nameplate)	Operational
2014	48-inch line converted from NGL to crude oil service (EIA data)	5M bpd (realized)	Operational
2016	Aramco announces permanent expansion to 7M bpd (target: 2018)	7M bpd (planned)	Announced
May 2019	Houthi drone strike directly targets pipeline infrastructure	Temporarily shut down	Attack
Sep 2019	Abqaiq-Khurais attack; emergency NGL-to-crude conversion demonstrated	7M bpd (emergency)	Demonstrated
~2023	Permanent 7M bpd expansion presumed shelved (no updates per GEM)	5M bpd (normal ops)	Shelved
Mar 11, 2026	Full emergency activation for Hormuz closure; first sustained max flow	7M bpd (sustained)	Active — wartime

SOURCES:
U.S. EIA Country Analysis Brief: Saudi Arabia (Sep 2014); Global Energy Monitor — East-West Crude Oil Pipeline;
S&P Global Commodity Insights (Dec 2020, Nov 2024); Pipeline Technology Journal (Jun 2016);
Saudi Aramco International Bond Prospectus (2019); Engineering News-Record (Mar 2026);
Wikipedia — East-West Crude Oil Pipeline; House of Saud analysis (Mar 2026); The World Data (Mar 2026).

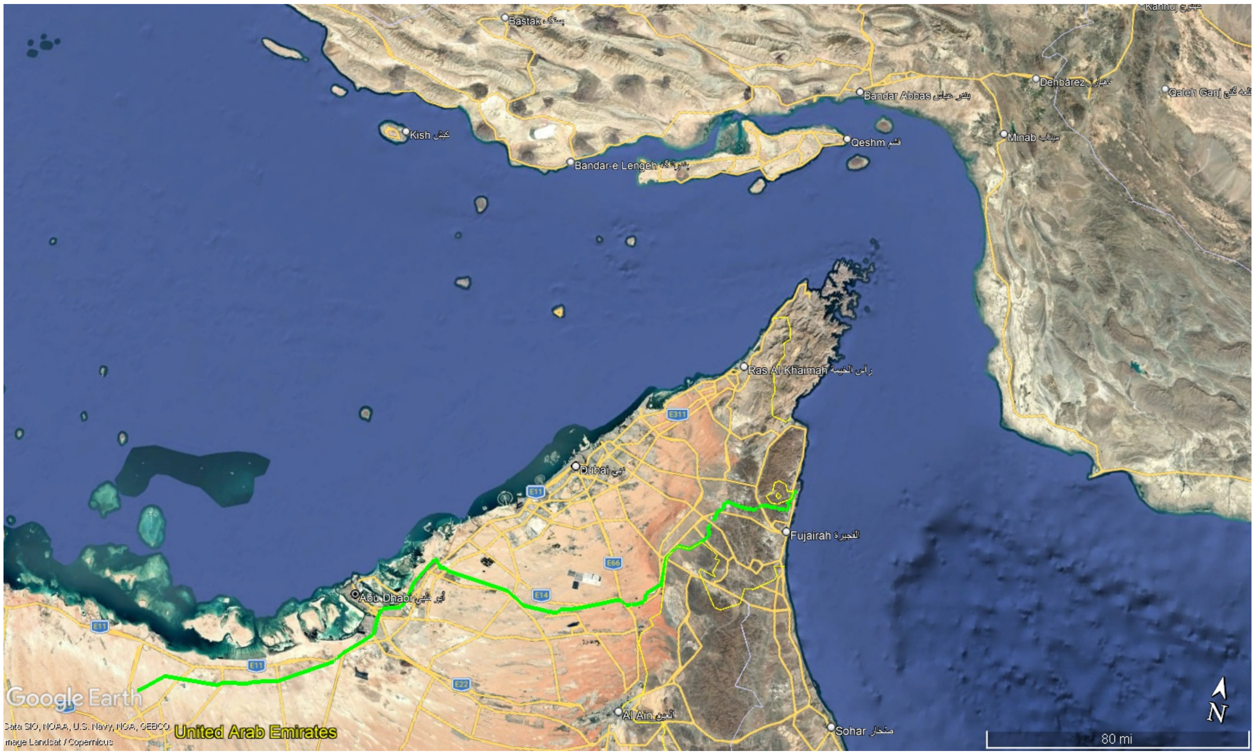
PETROLINE EAST-WEST PIPELINE CAPACITY TIMELINE • COMPILED MARCH 2026

Source: U.S. EIA Country Analysis Brief: Saudi Arabia (Sep 2014); Global Energy Monitor — East-West Crude Oil Pipeline; S&P Global Commodity Insights (Dec 2020, Nov 2024); Pipeline Technology Journal (Jun 2016); Saudi Aramco International Bond Prospectus (2019); Engineering News-Record (Mar 2026); Wikipedia — East-West Crude Oil Pipeline; House of Saud analysis (Mar 2026); The World Data (Mar 2026).

Example #3: UAE Fujairah Bypass Pipeline

In 2008, the Abu Dhabi Crude Oil Pipeline (ADCOP) commenced construction. It was built by the China Petroleum Engineering and Construction Corporation and entered service in June 2012.[16] The line covers approximately 400 km from Abu Dhabi's Habshan Oilfield to the port of Fujairah on the Arabian Sea coast and can carry at least 1.5 million bpd of oil.[17]

Figure 3 — Fujairah Bypass Pipeline Route



Source: Google Earth; author's rendering.

From its entry into service until the 2026 Iran War, the line was not heavily utilized and was maintained by its legal owner, Abu Dhabi Crude Oil Pipeline L.L.C., under a financial arrangement where it would be paid the greater of: (1) a minimum throughout quantity of 600,000 bpd at a toll of one USD per barrel or the actual number of barrels transported through the line in a year multiplied by one USD per barrel.[18]

With Iranian attacks having all but closed the Strait of Hormuz, the ADCOP pipeline is now operating as a national economic security asset for the UAE. While it cannot ship the country's entire pre-war export volume, it can ship well over half that amount, helping to buy time and space for resolution of the conflict. The conflict has illustrated the Abu Dhabi government's strategic foresight in building the pipeline but Iranian attacks on the port of Fujairah, where the pipeline terminates, show that while it bypasses the Strait, it remains vulnerable to kinetic strikes. The UAE will likely search for additional divert options in the wake of the war.

Example #4: Iraqi North and Westbound Pipelines

Iraq has had several actual and planned pipelines intended to move the country's crude oil exports to Mediterranean ports in Syria and Turkey as well as two projects leading to the Red Sea. The combined capacity of these routes would exceed Iraq's total oil production — if they actually operated. Some routes only exist on the drawing board. Others physically exist in some form but are either physically damaged by war, in disrepair, or operating far below the capacity level they could be upgraded to.[19]

With the Strait of Hormuz closed, Iraqi oil exports and production face high distress. As an indicator of how inadequate pipeline alternatives to Hormuz currently are, the Iraqi Oil Ministry in March issued tenders for trucking oil to the Syrian port of Baniyas.[20] Pipeline capacity is limited thus far, with northbound projects relying on pipelines in and near Kurdistan that suffered war damage and sabotage in the wake of the 2003 Coalition invasion of Iraq.

One asset, the Kirkuk-Faysh Khabur Pipeline has a theoretical capacity of 1.5 million bpd and is attractive to the government in Baghdad because it avoids Kurdish territory. Another pipeline goes through the Kurdistan region. After Hormuz was closed, Baghdad and the Kurdish regional authorities struck a deal to increase flows through that line, which are currently approaching 250,000 bpd and could rise to 300,000 bpd in the "near future," according to the Director General of Iraq's North Oil Company.

These numbers suggest that of Iraq's approximately 3 million bpd of pre-war oil exports, existing pipeline alternatives to the Mediterranean could presently carry perhaps 500-650 thousand barrels per day.[21] If the Kirkuk-Faysh Khabur line can be repaired and brought to full capacity (likely a multi-year process), Iraq could plausibly move half of its exports to Mediterranean ports in the event of a future Hormuz contingency.

Taken together, these cases show a consistent pattern: When chokepoints fail, states do not abandon oil — they build around geography. A key question is whether this will occur again, and at what scale.

Modelling Export Options for the Future

Energy transitions historically unfold over decades. Even if global oil demand peaks soon, decline will be gradual, with low-cost producers retaining market share. Middle Eastern oil will remain central to global supply.

If Hormuz cannot be reliably secured, exporters must build alternatives. Three pathways exist:

1. Accept continued Iranian influence over Hormuz transit.
2. Sustain a large, permanent U.S. military presence.
3. Build diversified infrastructure to reduce reliance on maritime chokepoints.

Option 3 may be the most durable and the one most congruent with the Gulf States' strong financial capacity and energy project experience.

As a young politician, Winston Churchill noted that "*safety and certainty in oil lie in variety and variety alone*."[22] A similar concept applies to transportation of oil and other energy commodities: Route diversity breeds resilience.

Accordingly, this analysis asks a question of existential importance to Bahrain, Iraq, Kuwait, Qatar, Saudi Arabia, and the UAE: *How can oil be moved to market through the routes least subject to physical disruption by Iran and its regional proxy groups*?

Parameters of a Gulf Super Express Pipeline

This analysis takes the following approach: A pipeline system beginning in the oilfields near Basra in southern Iraq, dropping through Kuwait, and paralleling the coast to pick up Saudi and Emirati oil before meeting the sea in Oman is an attractive option. The route is long and complex to be sure.

Alternative routes that move south to north through Iraq and meet tidewater on the Mediterranean coast are also possible. I do not analyze those here because the internal politics (including periodic kinetic combat involving Kurdish separatism and Iraqi militias) could make the route more politically complex than a pipeline primarily running through GCC countries. Also, meeting the ocean in Oman avoids three chokepoints at once (Hormuz, Bab al-Mandeb, and Suez) and better reflects the geographic reality that most Middle Eastern oil barrels now head eastbound to Asian markets.

By landing on the coast of the Arabian Sea at Duqm and Salalah, it avoids the Strait of Hormuz currently commanded by Iran, the Bab al-Mandeb at risk from Houthi activity, and the Suez Canal that has a rate limited bypass pipeline and draft restrictions and can also be blocked by ship accidents.

Figure 4 — Gulf Super Express Pipeline Conceptual Route

Source: Google Earth; author's rendering.

The Gulf Super Express Pipeline would sidestep these problems. Here are the parameters I modelled: twin 56-inch pipes that can each carry 5 million bpd to Duqm, a 2 million bpd spur to Salalah port, single point mooring buoys for tanker loading in the Arabian Sea to minimize port construction burdens, and 150 million barrels of combined storage capacity. It is a large-scale system reflecting the Gulf's systemic importance to the global oil and energy ecosystem.

Pipelines are not invulnerable — but unlike tankers, they can be hardened, repaired, and defended in ways that shift the cost curve over time. To that end, the pipeline capital and operating costs modelled here also include passive and active defenses and a strategic long-lead equipment reserve. This is a vital element to include given the demonstrated Iranian capabilities and willingness to target energy infrastructure. That category accounts for about 18% of estimated total project capital cost.

So what could this system cost in practice?

What a Gulf Super Express Pipeline Might Cost

Here are the basic overall project economics: AI-assisted modelling suggests total CAPEX on the order of $55 billion for the system. It's a big sum but for perspective, it is about the same amount as Saudi Arabia has spent on the Neom project thus far.[23] In other words, it is a feasible amount — especially if multiple countries chipped in to fund a project that could help move all of the oil they currently find stranded behind the Strait.

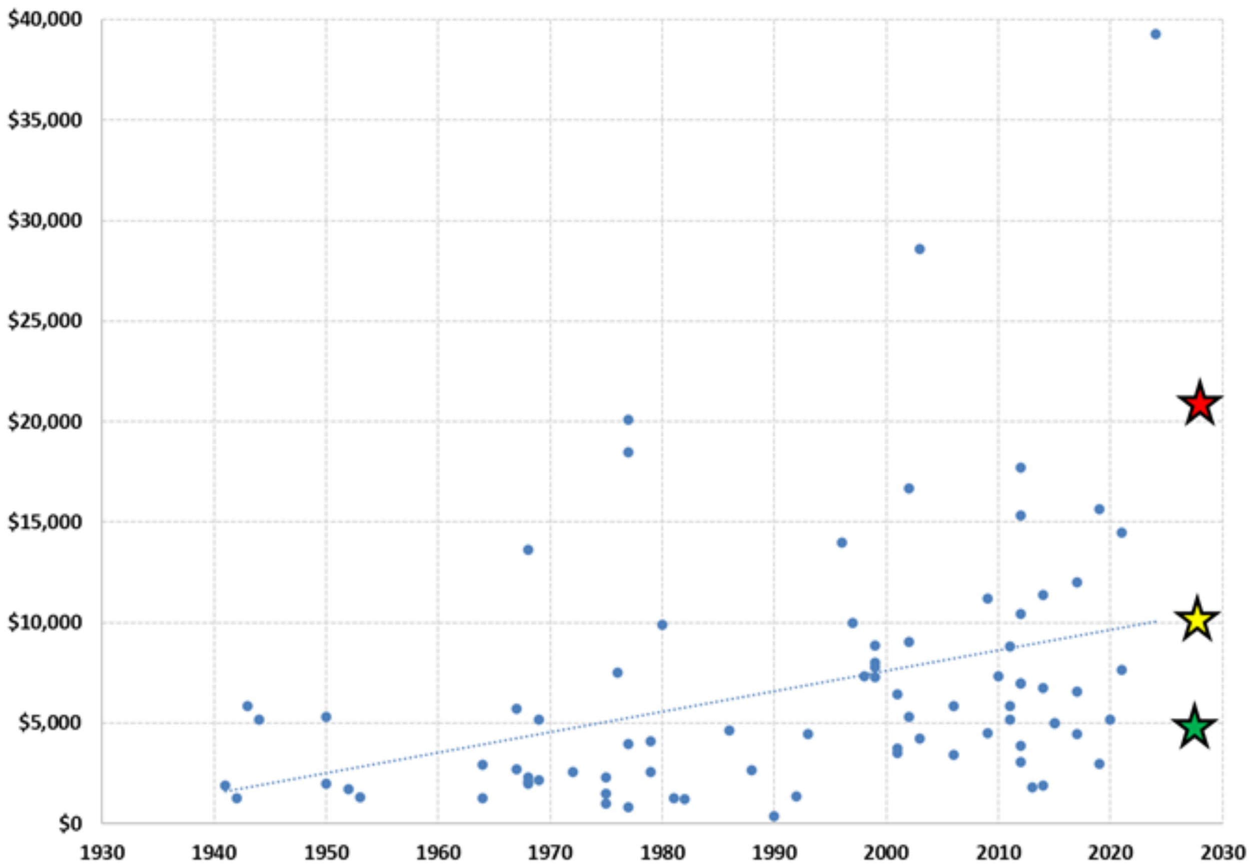
Of this, $15.7 billion is for the pipelines and pumping stations (28.3%), $11.9 billion is for soft costs and interest during construction (21.5%), $10.1 billion is for Defense, Hardening, and the Strategic Equipment Reserve (18.3%), $7.2 billion is for covering contingencies in case the project goes over time or encounter unexpected hurdles (13%), $5 billion is for the oil loading terminal at Duqm (9%), $2.8 billion is for the oil loading terminal at Salalah (5.1%), and $2.6 billion is for the spur pipeline to Salalah (4.8%).

Deeper model details are shown in the appendix below.

To translate the total CAPEX number into a metric capable of comparison with other oil pipelines, we can use the approach of finding CAPEX dollars per barrel per day of transmission capacity. On this basis, I compiled a dataset of 94 oil pipelines globally that are 500 km or longer in length. Of this total, one was suspended, two operate intermittently due to war damage, three are under construction, three were closed, four were cancelled, 5 were proposed, and 77 are operational.

The hypothetical Gulf Super Express Pipeline described in this analysis score as follows relative to actual projects: $5,564/bbl/d if used at its full 10 million bpd capacity, $11,128/bbl/d if used at half capacity, and $22,255/bbl/d if used at a maintenance level of one-fourth capacity. These cost levels are represented by the green, yellow, and red stars in the chart, respectively.

Figure 5 — CAPEX Cost of Oil Pipelines of Greater Than 500KM in Length (USD/barrel/day)



Source: Claude AI scrape aggregating data from Wikipedia (pipeline articles and lists); Global Energy Monitor Pipeline Tracker; U.S. EIA; CSIS analyses; Offshore Technology project profiles; operator reports; BLS CPI data (inflation-adjusted to Feb. 2026 dollars), and author's analysis.

Potential Tariff Levels and Structures

Even for Gulf governments intensely focused on maintaining optionality, infrastructure costs compete in an oil logistics marketplace where the benchmark is set by seaborne oil movement on very large crude carriers.

If a VLCC can be long-term time chartered for $135,000 per day and sailing from Iraq to East Asia plus loading and unloading the cargo takes 23 days one-way, this suggests a ship can make 16 trips per year.[24] With 2 million barrel cargoes, that suggests the ability to move 32 million barrels annually at a total time charter cost of $49.28 million, a per barrel transport rate of $1.54. To be conservative and account for port fees and other miscellaneous costs, it is prudent to add 25%, bringing that cost to nearly $2 per barrel of oil moved.

So how does the pipeline compare? A ship time charter rate incorporates both fixed capital payback and variable operational costs. For long-term shippers, the capital spent on a pipeline is just as much of a "sunk cost" as that spent on a tanker.[25] Energy and consumables OPEX will depend on the per barrel throughput rate, while staffing, maintenance, and defense-related costs are closer to fixed because to offer optionality in a conflict, the line must be kept in a "hot" mode that transits some volume of oil while keeping personnel and defensive posture in a high state of readiness to allow rapid scaling up of throughput in the event of a future crisis.

Figure 6 — Comparative Transport Costs, Pipeline Versus VLCC (USD/barrel)

Mode	Volume, Kbd	CAPEX	OPEX	Vessel Time Charter	Total Shipping Cost
Iraq-Oman Pipeline, tanker to East Asia	2,500	$4.76	$1.94	$1.22	**$7.92**
Iraq-Oman Pipeline, tanker to East Asia	5,000	$2.38	$1.02	$1.22	**$4.61**
Iraq-Oman Pipeline, tanker to East Asia	10,000	$1.19	$0.56	$1.22	**$2.96**
Iraq-East Asia VLCC (tanker)	-	-	-	$1.94	**$1.94**
Key assumptions: $55 billion project CAPEX, 5.0% interest rate, 10% margin charged atop CAPEX payback, 25 year finance term, $135,000/day VLCC time charter rate, 23 day voyage from Iraq to East Asia, 18 day voyage from Oman to East Asia					

Source: Author's model (available upon request).

Moving oil partway to market via a Hormuz bypass pipeline and then onwards on a VLCC is clearly significantly more expensive than doing so from end-to-end by ship alone. The cost difference effectively represents a security premium. Each $1/barrel security premium represents a reduction of approximately $3.65 billion in annual revenue, assuming that 10 million bpd of exports are truly exposed to the consequences of a Hormuz shutdown and cannot be moved through existing bypass routes like the East-West or Habshan Pipelines that are already partially amortized sunk costs and would be first in the economic dispatch order.

Determining who bears what share of capital costs will be a topic for sovereign negotiation. One starting point would be a proportional allocation based on the volume of oil that would plausibly diverted into the line during a future Strait of Hormuz emergency. As a simple illustration, if Iraq needs 2 million bpd of accessible bypass capacity, Kuwait needs 2.0 million bpd, Saudi Arabia 5 million bpd, and the UAE 1 million bpd, capital costs could be apportioned on a pro-rate basis using those numbers as the numerator and the 10 million bpd nameplate capacity as the denominator.

Key Challenges

From an engineering perspective, this project would be physically buildable. Three core challenges loom beyond the realm of digging and welding. One is how to achieve the necessary political and economic coordination between the countries on the route, which often struggle to cooperate, particularly in the absence of a coordinating external actor such as the United States.

Second is physical security, as Iran and its proxies could be expected to attack the pipeline and its support systems during future crises. Political coordination will likely prove harder to achieve and sustain that it would be to harden and build defense capabilities into the project.

Third is the time needed to build the line. Five to seven years is a reasonable baseline estimate for the time needed between project planning and actual physical construction. This assumes an elevated sense of urgency given the new strategic reality of demonstrated Iranian capacity to close the Strait of Hormuz to non-Iranian oil tanker traffic. The world can change dramatically in 5 to 7 years, introducing an additional element of risk.

Conclusion

With war now severely disrupting physical oil trade in the region, there are substantial incentives for creating more physical pathways to get Middle Eastern barrels onto global markets. The closure of the Strait and the subsequent activation of Saudi, Emirati, and Iraqi (small) bypass routes set the pacing benchmark — the need for credible capacity to move 10 million bdp of oil through a channel other than the Strait.

What seemed economically irrational mere months ago now seems sensible in the face of how difficult it is to physically and economically (via insurance) re-open a kinetically contested waterway. Conflict has historically accelerated logistics innovation. As such, it is likely that the Middle East is about to experience a significant expansion of oil export route diversification projects aimed at reducing dependence on the Strait of Hormuz and the Red Sea.

Projects like this paper's Gulf Super Express Oil Pipeline could move from planning to implementation if current conditions persist.

Appendix: Gulf Super Express Pipeline Model Snapshot

BASRAH – DUQM / SALALAH DUAL 56" CRUDE OIL PIPELINE & VLCC TERMINAL SYSTEM			
Financial Model — CAPEX & OPEX Analysis (2026 USD)			
Strategic Hormuz Bypass — 10 MMbpd Design Capacity (2 × 5 MMbpd)			
Parameter	**Value**	**Unit**	**Source / Notes**
PIPELINE ROUTE SEGMENTS			
Seg 1: Basrah (Iraq) → Kuwait Border	80	km	*Southern Iraq desert*
Seg 2: Kuwait Transit	170	km	*Flat desert terrain*
Seg 3: Kuwait → Eastern Saudi Arabia	250	km	*Coastal/desert*
Seg 4: Eastern SA → UAE Border	400	km	*Edge of Empty Quarter*
Seg 5: UAE Transit → Oman Border	350	km	*Desert terrain*
Seg 6: Oman Interior → Duqm	550	km	*Rocky desert, wadi crossings*
Total Main Line (Basrah → Duqm)	**1,800**	km	
Spur: Central Oman Junction → Salalah	650	km	*Mountainous Dhofar region*
Total System Length (single-line equivalent)	**2,450**	km	
Total Pipe-km (dual main + single spur)	**4,250**	km	*2 × main + 1 × spur*
PIPELINE SPECIFICATIONS — DUAL 56" PARALLEL MAIN LINES			
Number of Parallel Main Lines	2	lines	*Twin 56" lines in shared ROW corridor*
Main Line Diameter (each)	56	inches	*Larger than LOOP's 48"; matches Saudi E-W*
Spur Line Diameter	48	inches	*Upsized to handle higher spur flows*
Design Capacity — Each Main Line	5,000	kbpd	*5.0 MMbpd per line*
Design Capacity — Combined Main Lines	10,000	kbpd	*10000*
Design Capacity — Spur to Salalah	2,000	kbpd	*2.0 MMbpd via upsized 48" spur*
Initial Throughput — Main Lines Combined (Yr 1)	3,000	kbpd	*30% utilization at startup*
Initial Throughput — Spur (Yr 1)	600	kbpd	*30% utilization at startup*
Annual Throughput Ramp	12.0%	%	*Aggressive ramp; geopolitical demand*
Steady-State Utilization	85.0%	%	*Long-term target*
Pumping Stations — Per Main Line	15	ea	*~120 km spacing; 10,000 HP each*
Pumping Stations — Spur	8	ea	*~80 km spacing; 8,000 HP each*
Block Valve Stations — Per Main Line	36	ea	*~50 km spacing*
Block Valve Stations — Spur	13	ea	*~50 km spacing*
VLCC TERMINAL SPECS (LOOP-Style, Mega-Scale)			
Terminals	2	ea	*Duqm (primary) + Salalah (secondary)*
SPM Buoys — Duqm	6	buoys	*Double LOOP; handles 10 MMbpd system*
SPM Buoys — Salalah	4	buoys	*Handles full spur capacity*
Offshore Platforms — Duqm	2	platforms	*Dual platforms for redundancy*
Offshore Platforms — Salalah	1	platforms	*Single large platform*
Subsea Pipeline to Shore — Duqm (dual 56")	30	km	*Dual 56" to shore*
Subsea Pipeline to Shore — Salalah (48")	25	km	*Single 48" to shore*
Booster Station HP — Duqm	120,000	HP	*8 × 15,000 HP mega-pumps*
Booster Station HP — Salalah	60,000	HP	*4 × 15,000 HP*
Storage — Duqm (cavern + tanks)	100	MMbbl	*2× LOOP Clovelly; strategic reserve*
Storage — Salalah (cavern + tanks)	50	MMbbl	*Salt cavern + above-ground*
Loading Rate per SPM	100,000	bbl/hr	*High-flow SPM design for 56" feed*
Max Simultaneous VLCC Loads — Duqm	4	VLCCs	*4 of 6 SPMs active at once*
Max Simultaneous VLCC Loads — Salalah	3	VLCCs	*3 of 4 SPMs active at once*
FINANCIAL PARAMETERS			
Construction Period	7	years	*Phased mega-project; dual-line complexity*
Operating Life	30	years	*Standard concession*
Discount Rate (WACC)	10.0%	%	*EM infrastructure risk*
OPEX Escalation / Inflation	2.5%	%	*Annual OPEX growth*
Blended Tax Rate	15.0%	%	*Weighted across jurisdictions*
Pipeline Tariff — Main Line	2	$/bbl	*Slightly lower on volume; competitive*
Pipeline Tariff — Spur (incremental)	1	$/bbl	*Additional for Salalah delivery*
Terminal Loading Fee	1	$/bbl	*VLCC loading charge; volume discount*
Storage Fee	0	$/bbl/mo	*Crude storage rental*

CAPITAL EXPENDITURE (CAPEX) — GULF EXPRESS DUAL 56" PIPELINE SYSTEM

All figures in USD Millions (2026 base year)

Cost Item	Unit Cost ($M)	Total ($M)	Basis / Notes
1. DUAL MAIN LINE PIPELINES (2 × 56", Basrah → Duqm, 1,800 km each)			
Line Pipe Supply — 2 × 56", X70/X80 steel, FBE/3LPE coated	$1.3	$4,500	*$M/km per line; 56" heavy-wall; × 2 lines*
Construction & Installation — Dual trench/shared ROW	$1.8	$6,480	*$M/km per line; parallel lay; desert terrain*
HDD — Major Crossings (dual bore per crossing)	$55.0	$1,100	*20 major crossings × $55M (dual bore each)*
Right-of-Way & Permits (wider corridor for 2 lines)	$0.2	$360	*$M/km; wider ROW across 5 jurisdictions*
Pumping Stations — 2 × 15 stations × 10,000 HP	$65.0	$1,950	*30 total stations; 10,000 HP centrifugal each*
Block Valve Stations — 2 × 36 automated	$4.5	$324	*72 total; ESD, leak detection per line*
Pig Launchers & Receivers (2 × 15 sets)	$3.0	$90	*Intelligent pigging; 56" pigs*
SCADA, Fiber Optic & Distributed Sensing (dual-line)		$320	*Distributed acoustic/temp sensing both lines*
Metering & Custody Transfer (border + terminal, dual)		$240	*Fiscal metering × 2 at each border*
Intermediate Tank Farms (2 locations along route)		$400	*2 × 10 MMbbl; line pack management*
Subtotal — Dual Main Line Pipelines		**$15,764**	
2. SPUR PIPELINE (Central Oman → Salalah, 650 km, 48")			
Line Pipe Supply (48", X70 steel, coated)	$0.9	$553	*$M/km; same as original LOOP MOL spec*
Construction & Installation (mountainous Dhofar)	$1.5	$975	*$M/km; 48" in mountains = significant premium*
HDD — Mountain & Wadi Crossings (Dhofar)	$35.0	$420	*12 crossings; complex escarpment geology*
Right-of-Way & Permits (Oman only)	$0.1	$65	*$M/km; single jurisdiction*
Pumping Stations (8 × 8,000 HP)	$55.0	$440	*Closer spacing; significant elevation gain*
Block Valve Stations (13 automated)	$4.0	$52	*48" valves*
Pig Launchers & Receivers (8 sets)	$2.5	$20	*48" intelligent pigging*
SCADA & Telecom Extension		$120	*Tied to main dual-line control system*
Subtotal — Spur Pipeline		**$2,645**	
3. VLCC MEGA-TERMINAL — DUQM (Primary, 6 SPM, Dual Platform)			
SPM Buoy Systems (6 buoys, CALM, anchoring, PLEM, hoses)	$135.0	$810	*High-flow 56" feed; 700k DWT; heavy anchor*
Offshore Platform #1 — Control & Pumping (5-deck)		$650	*Main ops platform; 4×15,000HP; heli-pad*
Offshore Platform #2 — Pumping & Metering		$520	*Secondary platform; custody transfer*
Subsea Pipelines — Dual 56" Platform to Shore (30 km)	$6.0	$360	*$M/km per line × 2 lines × 30 km*
Onshore Booster Pump Station (8 × 15,000 HP)		$480	*Mega pump station; variable speed drives*
Crude Storage — Salt Cavern (60 MMbbl solution-mined)	$8.0	$480	*$/bbl; brine mgmt; strategic reserve*
Crude Storage — Above-Ground Tanks (40 MMbbl)	$14.0	$560	*$/bbl; large floating roof tanks*
Marine Terminal Control Center (onshore, expanded)		$120	*VTS, comms, dual-platform ops center*
Vapor Recovery & Environmental Systems		$110	*6-SPM scale; VOC, flare, monitoring*
Fire Protection, Safety & Emergency Response		$140	*Enhanced for mega-terminal scale*
Breakwater, Jetty & Marine Works		$350	*Tug berths, supply vessel dock, aids to nav*
Dedicated Power Plant (gas turbine, 200 MW)		$400	*Self-sufficient power for terminal ops*
Subtotal — Duqm Mega-Terminal		**$4,980**	

4. VLCC TERMINAL — SALALAH (Secondary, 4 SPM)			
SPM Buoy Systems (4 buoys, CALM type)	$135.0	$540	*Same high-flow spec as Duqm*
Offshore Control & Pumping Platform (4-deck)		$580	*Full LOOP-equivalent platform*
Subsea Pipeline — 48" Platform to Shore (25 km)	$4.5	$113	
Onshore Booster Pump Station (4 × 15,000 HP)		$320	
Crude Storage — Salt Cavern (30 MMbbl)	$8.0	$240	
Crude Storage — Above-Ground Tanks (20 MMbbl)	$14.0	$280	
Marine Terminal Control Center		$85	
Vapor Recovery & Environmental Systems		$80	
Fire Protection, Safety & Emergency Response		$100	
Breakwater, Jetty & Marine Works		$280	
Dedicated Power Plant (gas turbine, 100 MW)		$220	
Subtotal — Salalah Terminal		**$2,838**	
5. DEFENSE SYSTEMS, HARDENING & STRATEGIC EQUIPMENT RESERVE			
Mantis 35mm C-RAM Systems — Main Line Pump Stations (30 units)	$95.0	$2,850	*Full MANTIS: 6×35mm guns, radar, GCU, AHEAD a*
Mantis 35mm C-RAM Systems — Spur Pump Stations (8 units)	$95.0	$760	*Same spec; mountain-hardened installation*
Patriot PAC-3 Battery — Duqm Terminal (2 batteries)	$560.0	$1,120	*2 batteries; 8 launchers; PAC-3 MSE + GEM-T mix*
Patriot PAC-3 Battery — Salalah Terminal (1 battery)	$560.0	$560	*1 battery; 4 launchers; PAC-3 MSE + GEM-T*
Mantis C-RAM — Duqm Terminal (3 systems)	$95.0	$285	*Inner-layer point defense; 18 guns total*
Mantis C-RAM — Salalah Terminal (2 systems)	$95.0	$190	*Inner-layer; 12 guns total*
Mantis C-RAM — Intermediate Tank Farms (2 systems)	$95.0	$190	*1 per tank farm along main route*
PAC-3 MSE Missile Inventory (150 missiles)	$4.5	$675	*50 per battery; reload stock*
PAC-2 GEM-T Missile Inventory (90 missiles)	$4.0	$360	*30 per battery; anti-aircraft/cruise*
35mm AHEAD Ammunition Initial Stock (2M rounds)	$0.0	$1,120	*$560/rd; ~45k rds per system × 45 systems*
Hardened Pumping Stations — Blast Walls (38 stations)	$8.0	$304	*Reinforced concrete blast walls, berms, bunkers*
Hardened Terminal Infrastructure (both terminals)		$450	*Blast-resistant control rooms, pump bldgs*
C2 Bunkers & Secure Comms (2 terminals + HQ)		$180	*Hardened command centers, redundant comms*
Radar & Sensor Network (early warning integration)		$350	*3D radar, EO/IR sensors, drone detection*
Perimeter Security — All Stations & Terminals		$280	*Fencing, cameras, access control, lighting*
Strategic Pump Reserve — 10,000 HP Spares (10 units)	$12.0	$120	*Pre-built pump assemblies, rapid swap*
Strategic Pump Reserve — 15,000 HP Spares (6 units)	$18.0	$108	*Terminal booster pump spares*
Strategic Pump Reserve — 8,000 HP Spares (4 units)	$10.0	$40	*Spur line pump spares*
Reserve Equipment Depot & Mobilization Base		$150	*Climate-controlled warehouse; heavy-lift crane*
Rapid Response Transport (heavy haul vehicles, heli-pad)		$80	*Mobile heavy-lift, road transport fleet*
Subtotal — Defense, Hardening & Reserve		**$10,172**	
6. PROJECT DEVELOPMENT & SOFT COSTS			
FEED & Detailed Engineering (3.5% of hard costs)		$1,274	*Multiple EPC consortia*
Project Management — Owner's Team (7 years)	$200.0	$1,400	*$200M/yr; expanded for defense integration*
ESIA — Environmental & Social Impact (5 countries)	$35.0	$175	*$35M per country; expanded scope*
Survey, Geotech & Route Investigation		$150	*4,250 pipe-km route + terminals*
Legal, Regulatory & Transit/Defense Agreements		$250	*5-nation framework incl. defense cooperation*
Insurance During Construction (~2% hard costs)		$728	*Builder's all-risk; mega-project + defense*
Commissioning, Hydrotesting & Startup		$800	*Line fill ~40 MMbbl (2 × 56" × 1800 km)*
Interest During Construction (IDC)		$7,206	*7-yr build, 50% avg drawn*
Subtotal — Soft Costs		**$11,982**	
7. CONTINGENCY			
Contingency — 15% of all costs above		$7,257	*Mega-project + defense systems risk*
TOTAL PROJECT CAPEX		**$55,638**	

Source: Capital and operating cost estimates are benchmarked against comparable operational systems including the Saudi East-West Pipeline (Petroline), LOOP (Louisiana Offshore Oil Port), ESPO Pipeline, Trans-Alaska Pipeline System, Caspian Pipeline Consortium, and BTC Pipeline, with unit costs cross-referenced against IPA pipeline benchmarking data, Wood Mackenzie cost trackers, IHS Markit offshore platform databases, and manufacturer pricing from SOFEC, Rheinmetall, Flowserve, and Raytheon/RTX. Financial parameters draw on FERC tariff filings, Clarkson Research VLCC charter rates, Damodaran emerging-market WACC data, and GCC industrial electricity tariffs, with all figures expressed in 2026 USD and escalated using the IHS CERA Upstream Capital Cost Index. This is a conceptual-level estimate (AACE Class 4–5) intended for strategic analysis; investment-grade accuracy would require detailed FEED engineering, geotechnical surveys, and sovereign negotiations across five jurisdictions.

Note: Ukraine is now experimenting with allowing private entities to provide their own kinetic air defenses, while remaining under the ultimately command and control of the military. Iran's extensive targeting of energy infrastructure and the reality that national militaries may have to prioritize protection of targets other than energy export systems — especially under heavy attack — likely means that more private infrastructure owners will consider exploring higher levels of active defense capability.[26]

Notes

[1] Kristian Coates Ulrichsen and Jim Krane, "Maritime Chokepoints and Risks to Global Shipping and Energy Security," Rice University Baker Institute for Public Policy, March 16, 2026, https://www.bakerinstitute.org/research/maritime-chokepoints-and-risks-global-shipping-and-energy-security.
[2] Fully-laden Very Large Crude Carriers cannot transit Suez and must partially offload cargoes through the Su-Med Pipeline and reload them after transiting the canal northbound. https://www.eia.gov/todayinenergy/detail.php?id=61025.
[3] Oil exporters are aware of rising competitive pressures from electrification and alternative transport fuels. As such, they will likely conclude that it makes sense to invest in ensuring physical oil supply resilience within price ranges that dissuade consumers from making large collective investments in oil-substitution technologies. Such thinking has long underpinned core OPEC price strategy, as well as sovereign strategic decisions by key OPEC producers to bear the capital costs of maintaining space production capacity buffers. It is not a major leap to expect such thinking to also inform bypass pipeline infrastructure investment decisions in the wake of the hottest phase of the Iran War.
[4] Kenneth Medlock III, "Hormuz Strait Energy Iran War," *The New York Times*, March 27, 2026, https://www.nytimes.com/2026/03/27/opinion/hormuz-strait-energy-iran-war.html.
[5] One of our former Rice colleagues, Dr. Dagoberto Brito wrote an excellent analysis in the late 1990s examining the potential to use drag reducing agents to boost pipeline flows through the East-West Pipeline as a way to diversify away from reliance on the Strait of Hormuz. Brito, D. L., & Sheshinski, E. (1998). "Alternatives to the Strait of Hormuz." The Energy Journal, 19(2), 135-147, https://doi.org/10.5547/ISSN0195-6574-EJ-Vol19-No2-9. This paper was written in a pre-Houthi world. The paper we write now assumes that for maximum security benefits, it would be most prudent for future additional pipelines to seek destinations on coasts unconstrained by chokepoints that have been interdicted for demonstrably political reasons in the past 80 years.
[6] B. A. Wells and K. L. Wells, *"Big Inch Pipelines of WW II,"* American Oil & Gas Historical Society, originally published April 25, 2014, last modified November 5, 2025, https://aoghs.org/petroleum-in-war/oil-pipelines-big-inch/.
[7] Ibid.
[8] Ibid.
[9] PeriscopeFilm. "EAST WEST PETROLINE" Construction of Petromin Oil Pipeline Across Saudi Arabia GG40925. YouTube video. Accessed March 18, 2026. https://www.youtube.com/watch?v=ToR_0J4jkuM; Dietsch, D, "Massive petroline project of Petromin is under way in Saudi Arabia," Pipeline News; (United States) 51:5 (1979).
[10] Ibid.
[11] "Foundations: The Underpinning," Saudi Aramco World 33, no. 6 (November/December 1982), https://archive.aramcoworld.com/issue/198206/foundations-the.underpinning.htm.

[12] During the early 1990s expansion, the 56 inch line became the primary crude oil carrier while the original 48 inch line had the dual capacity to move either crude oil or natural gas, which could supply turbines along the route that powered the pipeline's pumps.
[13] Global Energy Monitor. "East-West Crude Oil Pipeline." *GEM Wiki*. Last modified December 4, 2024. https://www.gem.wiki/East-West_Crude_Oil_Pipeline#Expansion_Projects.
[14] Katie McQue, "FEATURE: Saudi Crude Keeps Flowing to Red Sea as East-West Pipeline Repairs Continue," *S&P Global*, December 22, 2020, https://www.spglobal.com/energy/en/news-research/latest-news/shipping/122220-feature-saudi-crude-keeps-flowing-to-red-sea-as-east-west-pipeline-repairs-continue.
[15] Saudi Arabian Oil Company (Saudi Aramco). *Annual Report 2025*. Dhahran, Saudi Arabia: Saudi Aramco, March 9, 2026. https://www.aramco.com/-/media/publications/corporate-reports/reports-and-presentations/2025/fy/saudi-aramco-ara-2025-english.pdf (49).
[16] Embassy of the United Arab Emirates in Washington, DC, "Abu Dhabi Crude Oil Pipeline Project," *UAE Embassy*, July 11, 2012, https://www.uae-embassy.org/news/abu-dhabi-crude-oil-pipeline-project.
[17] Abu Dhabi National Oil Company (ADNOC), "Who We Are," ADNOC Pipelines, accessed March 30, 2026, https://www.adnoc.ae/en/adnoc-pipelines/about-us/who-we-are.
[18] Abu Dhabi Crude Oil Pipeline L.L.C., *Audit Report and Financial Statements for the Year Ended 31 December 2024*, May 5, 2025, https://www.adnoc.ae/-/media/adnoc-v2/sub-brands/adnoc-pipeline/files/abu-dhabi-crude-oil-pipeline-2024final-145.ashx.
[19] Iraq funded construction of the Iraqi Pipeline through Saudi Arabia (IPSA) in the 1980s after the Iran-Iraq Tanker War began and after Iran attacked Iraqi crude export terminals on the Gulf. This line operated briefly at significant capacity before Saddam Hussein invaded Kuwait in 1990. It has since been mothballed for 36 years. After more than three decades of no maintenance, no cathodic protection upkeep, exposure to desert conditions, and internal corrosion from trapped air and moisture, IPSA would almost certainly require a full rehabilitation amounting to a near-rebuild — likely taking years and costing billions. It is not a viable response option for the present crisis. Global Energy Monitor. "Iraqi Pipeline in Saudi Arabia (IPSA)." *Global Energy Monitor Wiki*. Last modified January 28, 2026. Iraqi Pipeline in Saudi Arabia (IPSA).
[20] Kawach, Nadim. "Iraq Targets 650,000 Barrels per Day Oil Exports via Turkey." *AGBI (Arabian Gulf Business Insight)*, March 26, 2026. https://www.agbi.com/oil-and-gas/2026/03/iraq-targets-650000-barrels-per-day-oil-exports-via-turkey/.
[21] Lee, John. "Iraq Announces Oil Exports for February." *Iraq Business News*, March 26, 2026. https://www.iraq-businessnews.com/2026/03/26/iraq-announces-oil-exports-for-february-2/; Kawach, Nadim. "Iraq Targets 650,000 Barrels per Day Oil Exports via Turkey." *AGBI (Arabian Gulf Business Insight)*, March 26, 2026. https://www.agbi.com/oil-and-gas/2026/03/iraq-targets-650000-barrels-per-day-oil-exports-via-turkey/.
[22] Winston Churchill qtd. in Covatariu, Andrei, and Morgan Bazilian, "Variety Is Not Enough: Why Can Diversification No Longer Guarantee Energy Security," Payne Institute

for Public Policy, February 20, 2026. https://payneinstitute.mines.edu/variety-is-not-enough-why-can-diversification-no-longer-guarantee-energy-security/.

[23] Croft, Alex, "Saudi Arabia 'Scales Back Plans for 100-Mile Desert Megacity' After Concerns Raised over Billions Spent," Independent, January 27, 2026. https://www.independent.co.uk/news/world/middle-east/neom-megacity-desert-saudi-arabia-mbs-b2907508.html.

[24] Seatrade Maritime News, "VLCC Rates – How High and for How Long?" *Seatrade Maritime News*, February 27, 2026, https://www.seatrade-maritime.com/tankers/vlcc-rates-how-high-and-for-how-long-.

[25] For this and other points I am indebted to my colleagues Skip York and Mark Finely, who have generously shared a wealth of insights. Any errors in expression are mine alone.

[26] Altman, Howard, "Ukraine Using Private Air Defense Teams to Protect Industry Against Russian Drones," The War Zone, March 30, 2026, https://www.twz.com/land/ukraine-using-private-air-defense-teams-to-protect-industry-against-russian-drones.