

A STUDY ON HELIUM SUPPLY CHAIN DISRUPTION IMPACT UPON SCALING INDIAN SEMICONDUCTOR CHIP PRODUCTION

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Abstract: India's ambition to emerge as a global semiconductor manufacturing hub under initiatives such as the Semicon India Mission faces a critical supply-side challenge due to disruptions in the global helium supply chain. Triggered by geopolitical instability in West Asia, particularly disruptions at Qatar's Ras Laffan complex, the availability of helium—an essential input in wafer cooling, leak detection, and plasma etching—has significantly declined, leading to cost escalations and supply uncertainty. This study investigates the impact of helium supply disruptions on the scalability of India's semiconductor chip production. A mixed-method approach was adopted, combining primary data collected from 67 semiconductor professionals across fabrication, assembly, and testing segments with secondary industry reports. The findings reveal that the immediate impact on India's semiconductor production remains limited ($\leq 5\%$), primarily due to the dominance of assembly and testing operations, which have minimal helium dependency. However, wafer fabrication units such as ISRO-SCL and CDIL Semiconductors exhibit higher vulnerability. The study further indicates that existing helium inventories may sustain operations in the short term, but prolonged disruption beyond six months could result in scaling constraints of up to 30–35%. The research highlights a critical gap in India's semiconductor supply chain resilience and underscores the need for strategic interventions, including diversified sourcing, helium recycling technologies, and the development of domestic reserves. These findings provide timely insights for policymakers, industry stakeholders, and investors to mitigate risks associated with supply chain shocks in India's evolving semiconductor ecosystem.

Keywords: CDIL, supply-side challenge, helium inventories, helium recycling, supply chain resilience

I. INTRODUCTION

Semiconductor manufacturing forms the backbone of modern electronics, and India's ambition to emerge as a global semiconductor hub under initiatives such as Semicon India Mission has gained momentum since 2023. However, this strategic pursuit faces a new supply-side shock the helium shortage triggered by geopolitical instability in West Asia following the Iran–USA conflict. The resulting

disruption at Qatar's Ras Laffan LNG complex, which supplies nearly one-third of the world's helium, has tightened global supply and inflated costs.

Helium is indispensable to advanced semiconductor manufacturing, used for wafer cooling, leak detection, and plasma etching. India's semiconductor industry is still developing; its wafer fabrication capability primarily resides in ISRO's Semiconductor Laboratory (SCL), Mohali, and CDIL Semiconductors. Most other Indian semiconductor companies engage in outsourced semiconductor assembly and test (OSAT) operations that use little to no helium. Consequently, the immediate impact is modest, though the potential long-term constraint on scaling remains significant if crises extend beyond six months.

II. REVIEW OF LITERATURE

Multiple recent analyses highlight helium's strategic role in semiconductor supply chains.

- According to [dw.com](#), Qatar's helium production has been largely offline since Iranian strikes on LNG facilities, causing one-third of global supply to vanish.
- [moneycontrol.com](#) reported that the lead time for semiconductor materials in India has doubled due to sourcing challenges, with import costs escalating sharply.
- [joktacademy.com](#) emphasized that helium's inert nature and ultralow boiling point make substitution with nitrogen or argon technologically and economically unviable for precision chip fabrication.
- [convergence-now.com](#) elaborated that the helium shock could cause cost escalation across India's semiconductor and PCB industries, slowing scale-up schedules.
- [ico-optics.org](#) underscored that OSATs and back-end firms in India are hit more by freight and input inflation than by direct helium scarcity.

Existing research primarily analyzes macroeconomic and geopolitical dimensions; empirical field studies on the Indian semiconductor sector's direct exposure remain limited.

III. STATEMENT OF PROBLEM

India's semiconductor ecosystem depends heavily on imported inert gases, particularly helium. Ongoing disruptions to global supply from Qatar threaten production stability and scalability. The extent of impact on India's semiconductor operations, especially emerging fabs, has not been quantitatively assessed through primary data from industry professionals. Thus, understanding helium-linked production and scaling risk in India's context becomes essential.

IV. OBJECTIVES OF STUDY

1. To identify the degree of dependence of Indian semiconductor manufacturers on helium.
2. To assess the direct and indirect impact of helium supply disruption on chip production and scaling.
3. To forecast the potential mid-term implications (six months) if disruptions persist.

V. RESEARCH GAP

While global literature covers helium shortages affecting major chip-producing nations, minimal empirical research explores India's sector-specific vulnerability. No prior study quantified the percentage of production scaling affected based on first-hand organizational feedback a gap this study addresses using primary survey data.

VI. NEED OF RESEARCH

The need for this research arises from:

- India's push toward semiconductor self-reliance amid geopolitical volatility.
- 100% dependency on imported helium with no domestic production.
- Lack of data-driven insights on how supply chain shocks influence scaling in India's nascent semiconductor ecosystem.

This study provides timely evidence to inform policymakers, industrial planners, and investors about the realistic scope of this supply chain constraint.

VII. SCOPE OF RESEARCH

The research focuses on semiconductor operations in India, covering fabrication (wafer production), assembly, testing, and packaging (ATMP/OSAT). The temporal focus is from February 2026 to April 2026, coinciding with the Iran-USA escalation and consequent helium disruption. The analysis also projects outcomes for a potential continuation of this crisis over the next six months.

VIII. RESEARCH METHODOLOGY

A mixed-method approach was adopted:

- Data Collection: A structured Google Forms questionnaire was distributed via email and LinkedIn to employees across semiconductor firms and institutions in India.
- Sample: 67 professionals, including engineers and supply managers from firms like CDIL, ISRO-SCL, Tata Elxsi (semicon design), Kaynes and Micron ATMP units, responded.
- Variables Measured: Company type (OSAT/FAB), Degree of dependence of respondent semicon company on helium imported from Qatar, cost impact, production delay and scaling forecast if conflict continues for next 6 months.
- Data Analysis: Responses were analyzed using descriptive statistics.
- Secondary Data: Industry and media sources supplemented findings to contextualize observed patterns.

IX. Hypothesis

a. Null Hypothesis (H0): Helium supply chain disruption has no significant impact on scaling Indian semiconductor chip production.

b. Alternative Hypothesis (H1): Helium supply chain disruption significantly impacts scaling Indian semiconductor chip production.

X. SCOPE OF FURTHER RESEARCH

Future work could extend to:

- Longitudinal monitoring over extended geopolitical disruptions.
- Comparative studies with neighbouring economies (e.g., Taiwan, Malaysia).
- Technical evaluation of helium recycling and alternative gas technologies for Indian fabs.
- Policy simulations for strategic helium reserves and domestic gas extraction.

XI. FINDINGS

Based on the Google Forms survey and secondary analysis:

1. 63% of respondents conveyed impact is only $\leq 5\%$ of India's semiconductor production scaling is currently affected. Since P value is greater than 0.05 i.e., 0.287 the current impact on helium caused by supply chain disruption, caused by USA Iran Conflict has no significant impact on scaling Indian semiconductor chip production. Thus Null Hypothesis (H_0) is accepted.

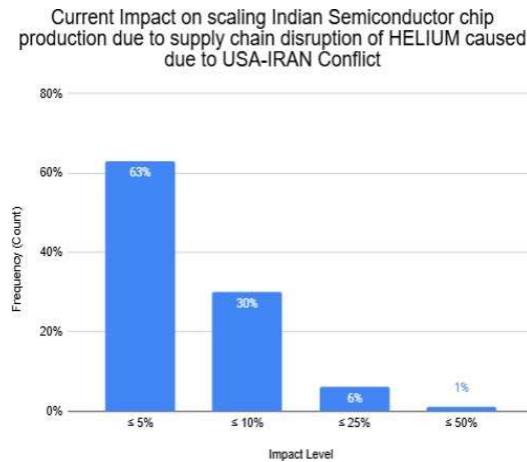


Fig.1: Current Impact on Scaling Indian semiconductor chip production due to supply chain disruption of Helium caused due to USA-IRAN Conflict.

OBSERVED FREQUENCY					
Count of Current Impact on scaling chip production due to supply chain disruption of HELIUM caused due to USA-IRAN Conflict.					
Row Labels	$\leq 10\%$	$\leq 25\%$	$\leq 50\%$	$\leq 50\%$	Grand Total
High	9	2	8	1	21
Low	2		8		10
Moderate	1		4		5
Total Dependent	8	1	22		31
Grand Total	20	4	42	1	67
EXPECTED FREQUENCY					
Count of Current Impact on scaling chip production due to supply chain disruption of HELIUM caused due to USA-IRAN Conflict.					
Row Labels	$\leq 10\%$	$\leq 25\%$	$\leq 50\%$	$\leq 50\%$	Grand Total
High	6.269	1.2537	13.104	0.31343	21
Low	2.985	0.597	6.2687	0.14925	10
Moderate	1.493	0.2985	3.1343	0.07463	5
Total Dependent	10.754	2.1507	22.433	0.46399	31
Grand Total	20	4	42	1	67
[n-P/2]s					
Count of Current Impact on scaling chip production due to supply chain disruption of HELIUM caused due to USA-IRAN Conflict.					
Row Labels	$\leq 10\%$	$\leq 25\%$	$\leq 50\%$	$\leq 50\%$	Grand Total
High	1.19	2.4323	2.0239	1.50391	7.1521542
Low	0.325	0.1597	0.4782	0.14925	1.5092381
Moderate	0.163	0.0985	0.2391	0.07463	0.7747619
Total Dependent	0.17	0.3911	0.3391	0.46269	1.36274962
Grand Total	1.848	3.7789	3.0823	2.19048	10.8391895
Chi Square	10.84				
df	9				
P value	0.287				

Fig.2: Current impact on indian semicon chip production companies due to supply chain disruption of Helium caused due to USA-IRAN Conflict

2. The effect is confined mainly to wafer fabrication facilities ISRO-SCL and CDIL Semiconductors, SICsem as they use helium extensively, Assembly and test units (Micron, Kaynes, SPEL, etc.) report negligible direct helium dependency.

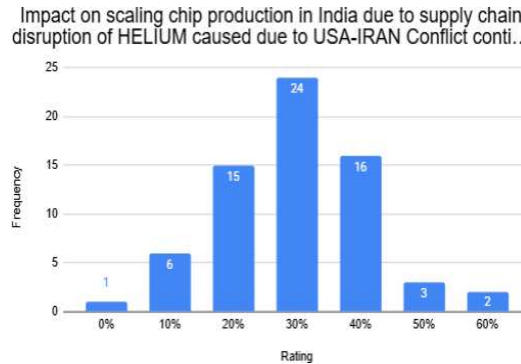


Fig.3 Impact on scaling chip production in India due to supply chain disruption of He caused due to USA – IRAN conflict

3. Companies continue production using buffer helium inventories accumulated earlier in 2026,

expected to sustain another 1–2 months, If current geopolitical instability persists for over six months, scaling capacity loss may reach up to 30%, delaying India's fab expansion schedules.

XII. LIMITATIONS OF STUDY

- The sample size (n=67) limits generalization across the entire semiconductor ecosystem.
- Respondent diversity skewed toward managerial roles; operational technicians were underrepresented.
- Data reflects a short-term window (February– April 2026), and conditions may evolve.
- Some responses were self-reported and not corroborated with internal production data.

XIII. CONCLUSION

The research confirms that India's semiconductor production currently faces limited but emerging vulnerability due to helium supply chain disruption. The immediate production impact remains marginal ($\leq 5\%$) because India's industry is dominated by non-wafer assembly operations. However, scaling risk could intensify up to 35% if the West Asia conflict and shipping blockades continue beyond the next two quarters.

Ensuring the resilience of India's semiconductor supply chain thus demands a strategic blend of diversified sourcing, domestic helium exploration, and contingency stockpiling measures already recognized as vital by industry leaders and policymakers.

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