



# State of Industry R&D in India

An R&D investment and disclosure analysis of Indian and global firms in six key strategic sectors



## Energy

Foundation for Advancing Science and Technology India

**FAST India**

in collaboration with **IIFL Securities**

This brief builds upon the findings of the [State of Industry R&D report](#) that presented overall and sector-level findings for selected firms. The present brief provides a detailed examination of the Energy Sector at the firm level, comparing the findings of Indian and Global firms. The continuity between these reports ensures a thorough understanding of macro and micro factors influencing R&D in Indian Energy sector firms.

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# Energy

## Key takeaways

- Global firms outperformed Indian firms for Research and Development (R&D) intensity and for proportion of PhD employees by **2.5x** and **4.0x** respectively.
  - Despite global firms performing better overall, three Indian energy firms (Coal India, RIL and ONGC) ranked amongst the top five firms for R&D intensity.
  - Indian firms do not perform as well for the proportion of PhD qualified employees.
- Global firms produced **9.9x** patents per USD billion revenue and **0.9x** publications per USD billion revenue as compared to Indian firms.
  - Indian firms perform better in terms of publications by revenue, as compared to patents by revenue indicators.
  - Coal India maintains its first rank in publications per USD billion revenue by publishing more than **3.4x** the second-ranked firm, Tata Power, indicating a strong focus on research and dissemination amongst all firms studied. NHPC Limited ranks fourth in this parameter. Indian firms perform well in publications per revenue parameter, competing well with global firms.
  - While Reliance Industries Limited (RIL) performs well for patents by revenue as compared to other Indian firms, it does not rank amongst the top five global and Indian firms overall.

## 1.1 Introduction

India ranked as the world's third-largest primary energy consumer in 2021, accounting for 6% of global primary energy consumption.<sup>1</sup> Coal and oil meet 87% of Indian energy demands, with nuclear and renewable energy contributing 4%.<sup>2</sup> India relies heavily on imported oil, with over 80% of its petroleum demands being met by external sources.<sup>3</sup> The financial repercussions of this import dependence are enormous. In 2019-20, India's import expenditure for coal, Liquefied Natural Gas (LNG), and finished petroleum products was USD 40.2 billion.<sup>4</sup>

At the same time, India has seen promising improvement in its renewable energy capability. India ranks fourth globally for total renewable power capacity and saw the highest year-on-year growth in renewable energy additions of 9.83% in 2022.<sup>5</sup> The installed solar energy capacity has skyrocketed 30 times in just the last nine years, reaching 75.57 GW as of February 2024, up from 2.6 GW.<sup>6</sup>

The Energy sector in India is governed at union and state level. The union ministries that govern key energy sectors are Ministry of Power (MoP), Ministry of New and Renewable Energy (MNRE), Ministry of Coal (MoC) and Ministry of Petroleum and Natural Gas (MPNG). Union government has Public Sector Enterprises (PSEs) across the energy sector, notably in mining and exploration (crude oil, coal and natural gas), petroleum refining and marketing, power generation, nuclear energy and power transmission.<sup>7</sup>

We now present our findings on R&D-related inputs and outputs for energy sector firms. Firms that deal in energy, oil, gas and consumable fuels, electric utilities, independent power and renewable electricity producers were selected as a part of the sector.

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<sup>1</sup>Ministry of Petroleum & Natural Gas (n.d.). "India has been ranked the third largest primary energy consumer in the world". In: *Press Information Bureau* (). URL: <https://pib.gov.in/PressReleasePage.aspx?PRID=1809204>.

<sup>2</sup>NITI Aayog, Government of India (2024). "Climate and Energy Dashboard". In: (). URL: <https://iced.niti.gov.in/energy> (visited on 06/13/2024).

<sup>3</sup>International Trade Administration (2024). "India - Renewable Energy". In: (). URL: <https://www.trade.gov/country-commercial-guides/india-renewable-energy> (visited on 05/06/2024).

<sup>4</sup>International Trade Administration (2024). "India - Renewable Energy". In: (). URL: <https://www.trade.gov/country-commercial-guides/india-renewable-energy> (visited on 05/06/2024).

<sup>5</sup>Invest India (2024). "Renewable Energy". In: (). URL: <https://www.investindia.gov.in/sector/renewable-energy#:~:text=India's%20installed%20non%20fossil%20fuel,additions%20of%209.83%25%20in%202022.> (visited on 07/01/2024).

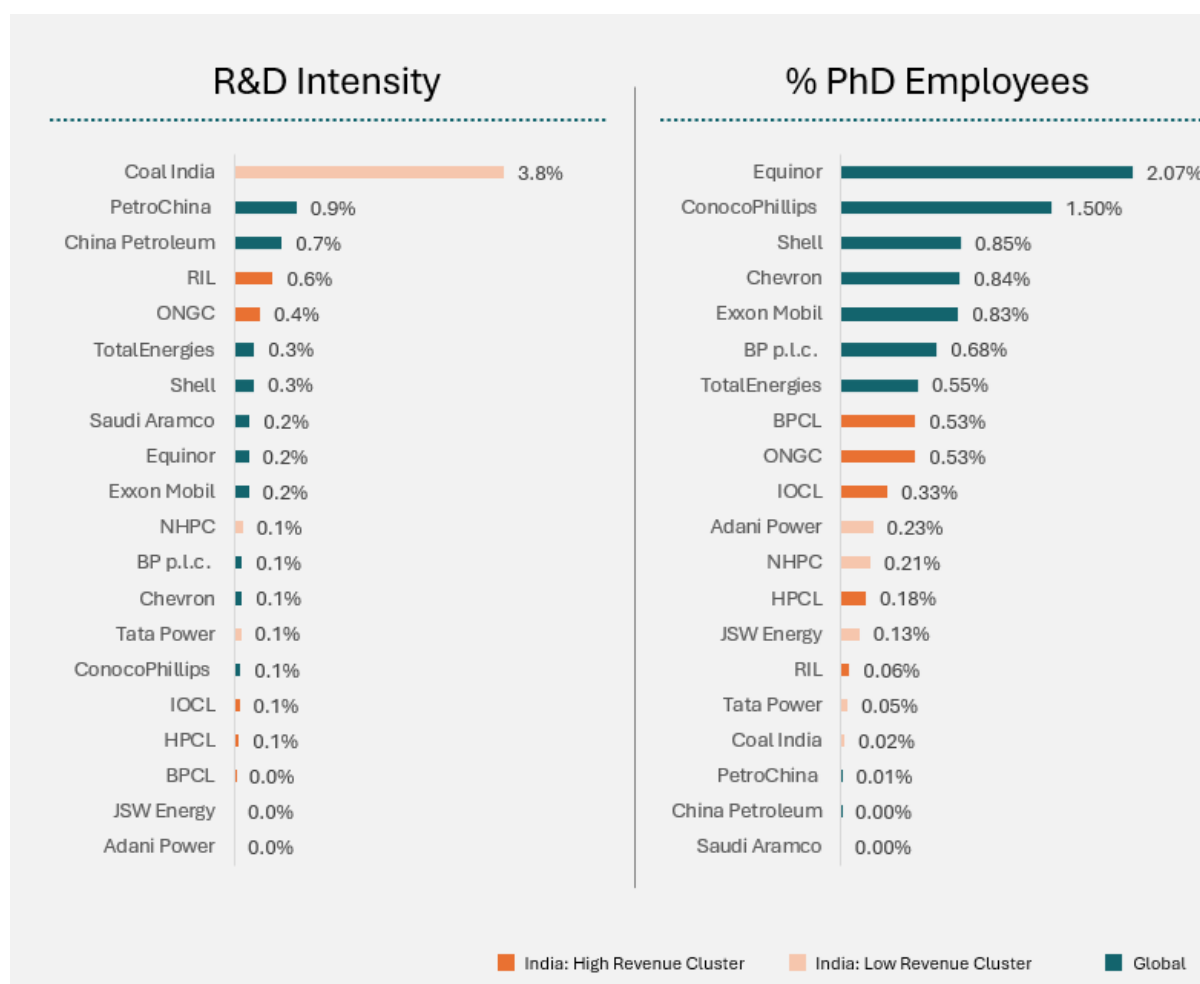
<sup>6</sup>"Invest India - Renewable Energy" (n.d.). In: *in India: Investment Opportunities in the Pow...* (). URL: <https://www.investindia.gov.in/sector/renewable-energy>.

<sup>7</sup>International Energy Agency (2024). "India 2020: Energy Policy Review". In: (). URL: [https://www.niti.gov.in/sites/default/files/2023-02/IEA-India%202020-In-depth-EnergyPolicy\\_0.pdf](https://www.niti.gov.in/sites/default/files/2023-02/IEA-India%202020-In-depth-EnergyPolicy_0.pdf) (visited on 07/01/2024).

## 1.2 India vs. Global Comparison

For inputs, we study R&D intensity and PhD employees as a proportion of total employees. R&D intensity helps us to identify the proportion of revenue input in R&D activities, while the PhD employee number represents an approximate number of researchers in the firm. For outputs, we present our findings on the number of patents and publications per billion USD in revenue. The information regarding input parameters, i.e. R&D intensity and proportion of PhD employees is presented for the latest available year, while the information regarding outputs, Patents and Publications per billion USD revenue is presented for the study period i.e. FY 2015-16 and FY 2022-23. For firms that do not provide information on a financial year basis, corresponding annual years are considered.

Figure 1.1 presents the performance of all firms studied on input parameters.

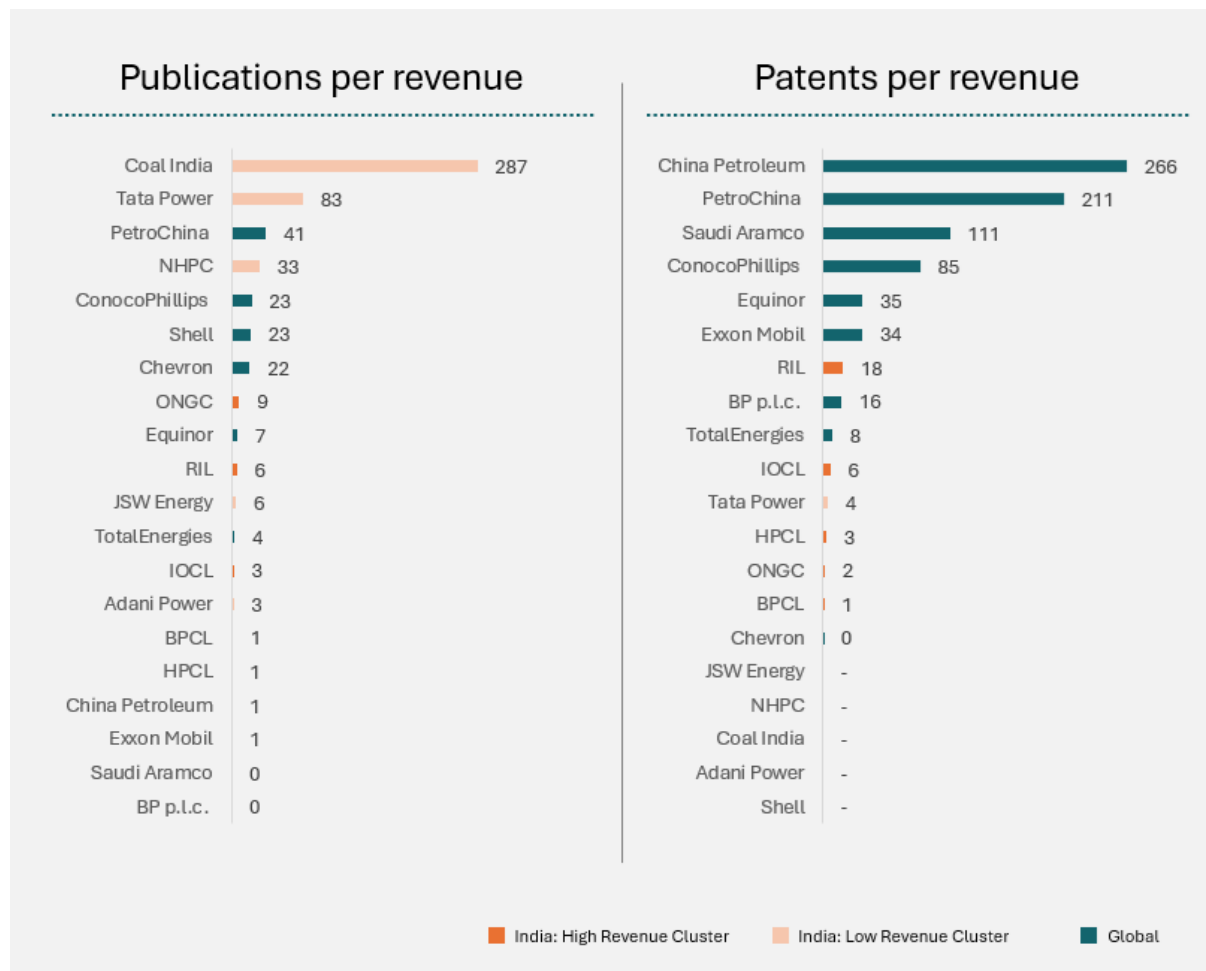


**Figure 1.1:** India vs. Global Energy Sector Firms Comparison on R&D intensity and proportion of PhD employees

Coal India has the highest R&D intensity at 3.8%, significantly ahead of other firms. Indian firms compete well with global firms for this parameter. RIL and Oil and Natural Gas Corporation (ONGC) rank fourth and fifth for R&D intensity across all firms studied.

On the other hand, global firms lead ahead of Indian firms in the percentage of PhD employees. Bharat Petroleum Corporation Limited (BPCL) and ONGC has the highest proportion of PhD employees amongst Indian firms. However, it ranks eighth when compared with global firms. Many firms have negligible to no PhD employees.

Figure 1.2 presents the performance of all firms studied on output parameters.



**Figure 1.2:** India vs. Global Energy Sector Firms Comparison on publications per USD billion revenue and patents per USD billion revenue

Coal India maintains its first rank in publications per USD billion revenue by publishing more than 3.4x the second-ranked firm, Tata Power, indicating a strong focus on research and dissemination. NHPC Limited ranks fourth in this parameter. Indian firms perform well in publications per revenue parameter, competing well with global firms.

Global firms occupy the top six positions in patents per USD billion revenue parameter, emphasising innovation and intellectual property strongly. Global energy firms generally have a higher number of patents per revenue compared to Indian firms.

### 1.3 India Energy Sector: A Firm-Level Analysis

To enhance the depth and relevance of our analysis of the Indian energy sector, we have segmented the firms into high-revenue and low-revenue clusters. This bifurcation is based on the median of the average revenue of firms within the sector. By categorising the firms in this manner, we aim to provide a more nuanced and meaningful examination of their innovation inputs and outputs. The following is the cluster-wise firm-level comparative analysis of top market capitalisation energy sector firms in India.

#### 1.3.1 High Revenue Cluster

##### 1.3.1.1 R&D Intensity

Figure 1.3 below compares R&D intensity, defined as the ratio of a firm’s R&D expenditure to its revenue, across Indian energy sector firms forming a part of the high revenue cluster.

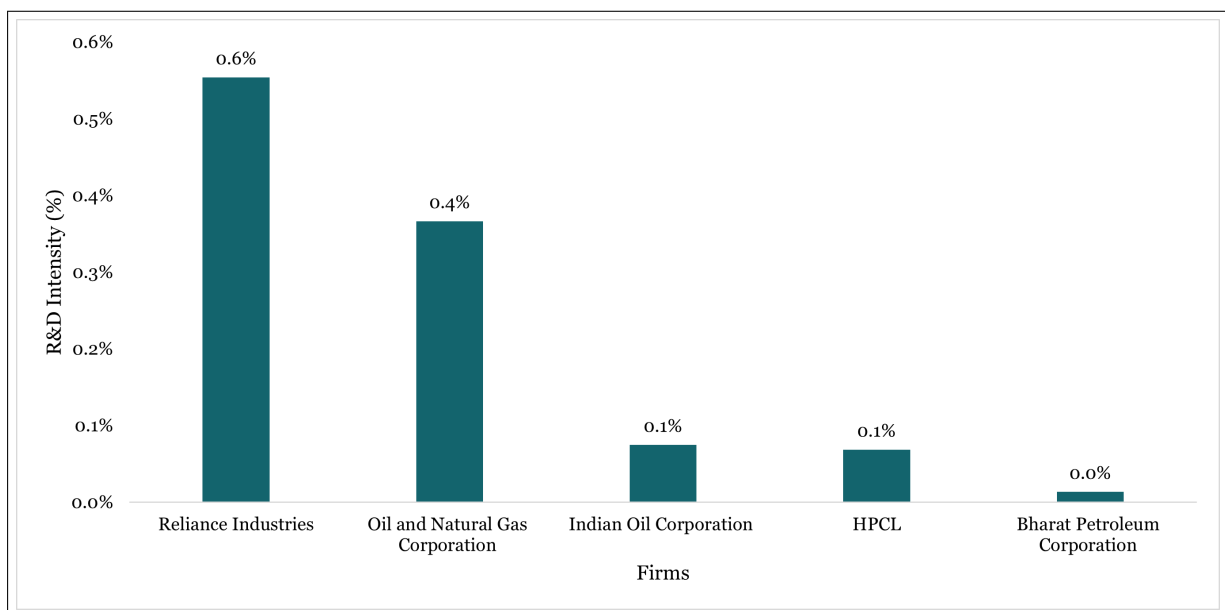


Figure 1.3: R&D Intensity: High Revenue Cluster

RIL performs best on R&D intensity within this cluster and has the second-highest revenue amongst Indian firms. The absolute value of R&D expenditure of RIL is USD 361.6 MM for Financial Year (FY) 2022-23, which is the highest among all the Indian firms

studied. Indian Oil Corporation Limited (IOCL) ranks third in R&D intensity within this cluster and has the highest revenue amongst Indian firms. BPCL ranks last in both R&D intensity and absolute R&D expenditure.

### 1.3.1.2 PhD employees as a proportion of total employees

Figure 1.4 below presents the proportion of PhD-holding employees in Indian energy sector firms in the high-revenue cluster.

BPCL and ONGC have the maximum proportion of PhD employees. RIL has only 0.1% PhD qualified employees and ranks last amongst high-cluster firms for this indicator, despite ranking first in R&D intensity. This could be due to a large workforce employed by RIL.

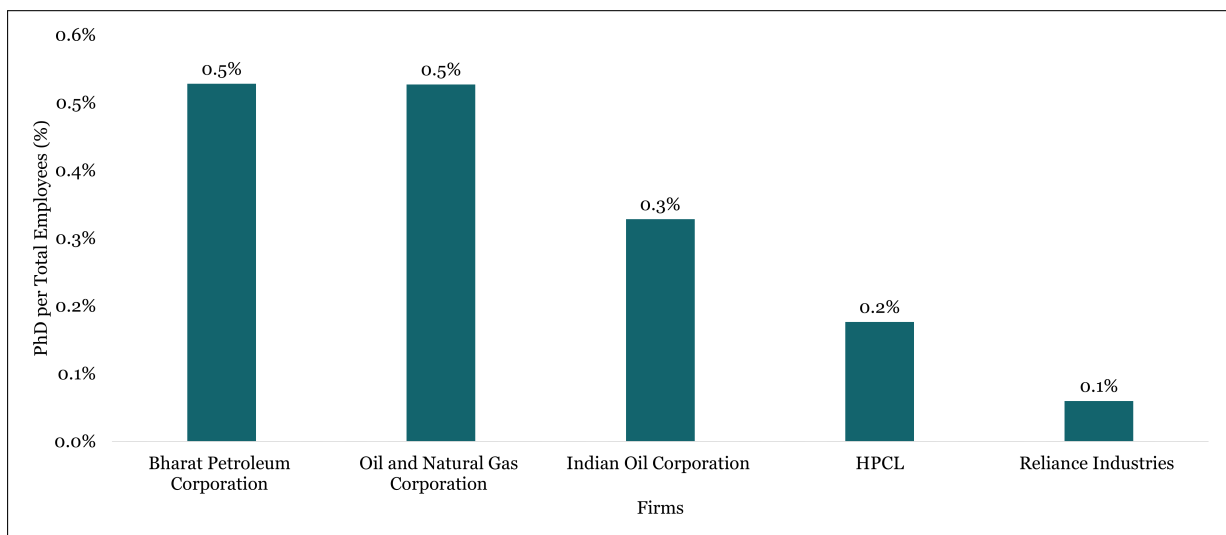


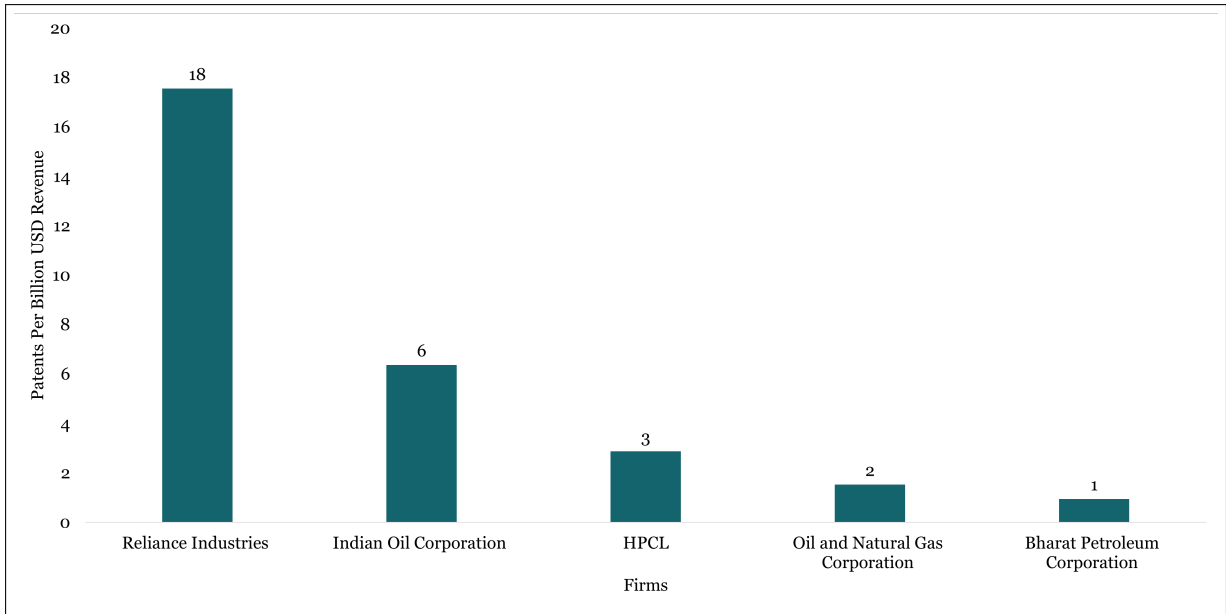
Figure 1.4: PhD per Total Employees: High Revenue Cluster

Hindustan Petroleum Corporation Limited (HPCL) did not perform well in this indicator despite having the lowest number of total employees as compared with other firms in the cluster.

### 1.3.1.3 Patents by USD billion revenue

Figure 1.5 below depicts patents per billion USD revenue for high-cluster firms.



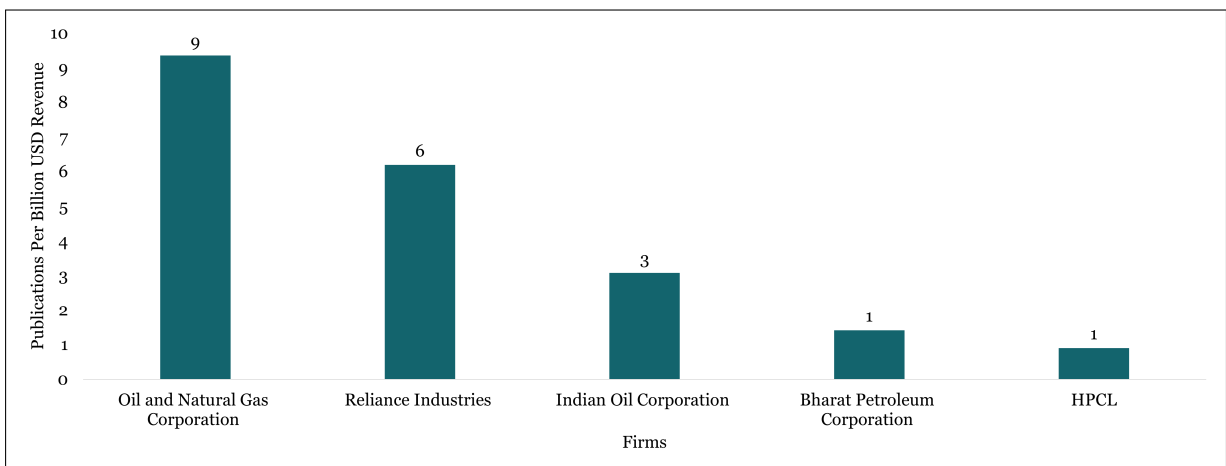


**Figure 1.5: Patents per Revenue: High Revenue Cluster**

RIL ranks first in patents per billion USD revenue in the high revenue cluster, followed by IOCL. During the study period, RIL had 743 patents, **1.6x** the second highest number, which was recorded by IOCL. BPCL ranks last in the cluster for patents by revenue.

#### 1.3.1.4 Publications by USD billion revenue

Figure 1.6 below presents publications per USD billion revenue of high-revenue cluster firms.



**Figure 1.6: Publication per Revenue: High Revenue Cluster**

ONGC ranks first amongst its peers for the parameter, publishing **1.5x** as compared to RIL that ranks second when adjusted for revenue.

RIL and IOCL have the maximum absolute number of publications over the study period, at 262 and 218 respectively. HPCL ranks last amongst the high-cluster firms for publications by revenue and also has the least number of publications.

### 1.3.2 Low Revenue Cluster

#### 1.3.2.1 R&D Intensity

Figure 1.7 below compares R&D intensity among the Indian energy sector firms in the low-revenue cluster.

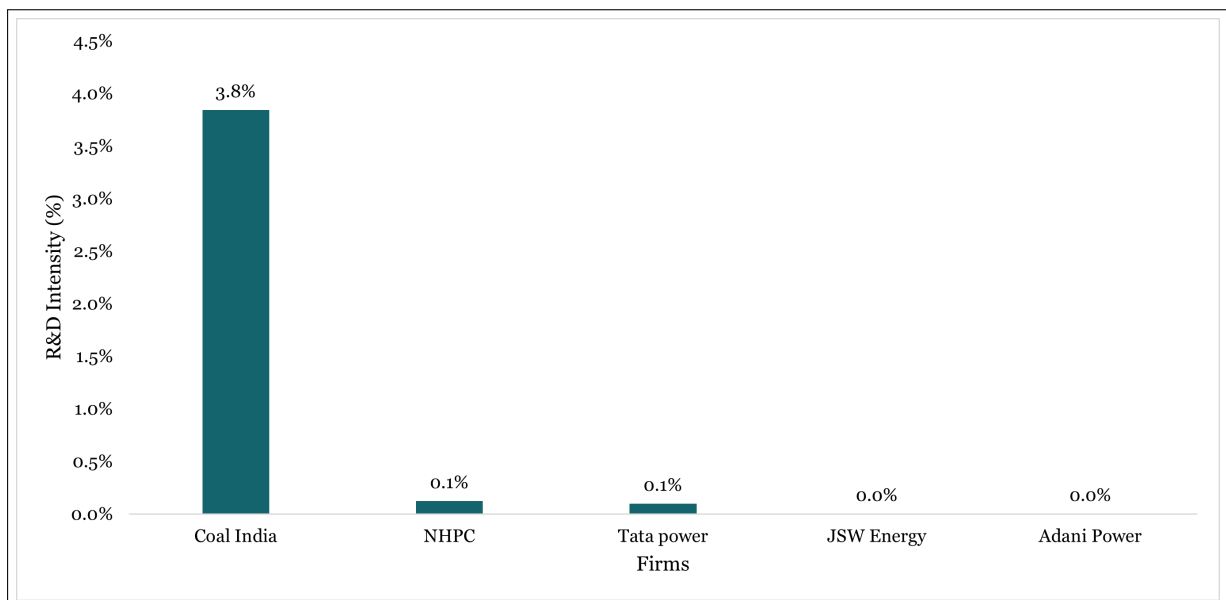


Figure 1.7: R&D Intensity: Low Revenue Cluster

The highest R&D intensity for the cluster of Coal India (3.8%), is also highest amongst all firms studied for the sector. The variation between R&D intensity of Coal India and other firms in the cluster is large. JSW Energy and Adani Power had zero R&D intensity for FY 2022-23.

#### 1.3.2.2 PhD employees as a proportion of total employees

Figure 1.8 below illustrates the percentage of total PhD-holding employees across Indian energy sector firms in the low-revenue cluster.

Adani Power ranked first for the parameter, closely followed by NHPC. Coal India, which had the highest R&D intensity, recorded the lowest proportion of PhD employees. However, this is likely due to the large workforce employed by Coal India. In terms of the absolute number of PhD qualified employees, Coal India ranks first in the cluster with 57 employees, 5.7x the second highest number, 10 of Tata Power.

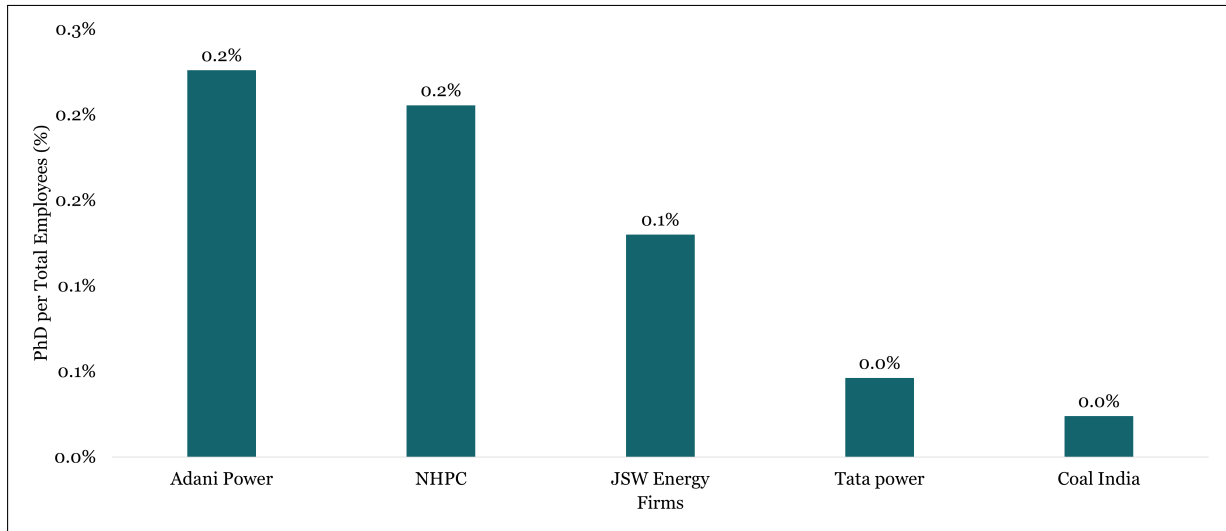


Figure 1.8: PhD per Total Employees: Low Revenue Cluster

### 1.3.2.3 Patents by USD billion revenue

Figure 1.9 below illustrates the patents by USD billion revenue across Indian energy sector firms in the low-revenue cluster.

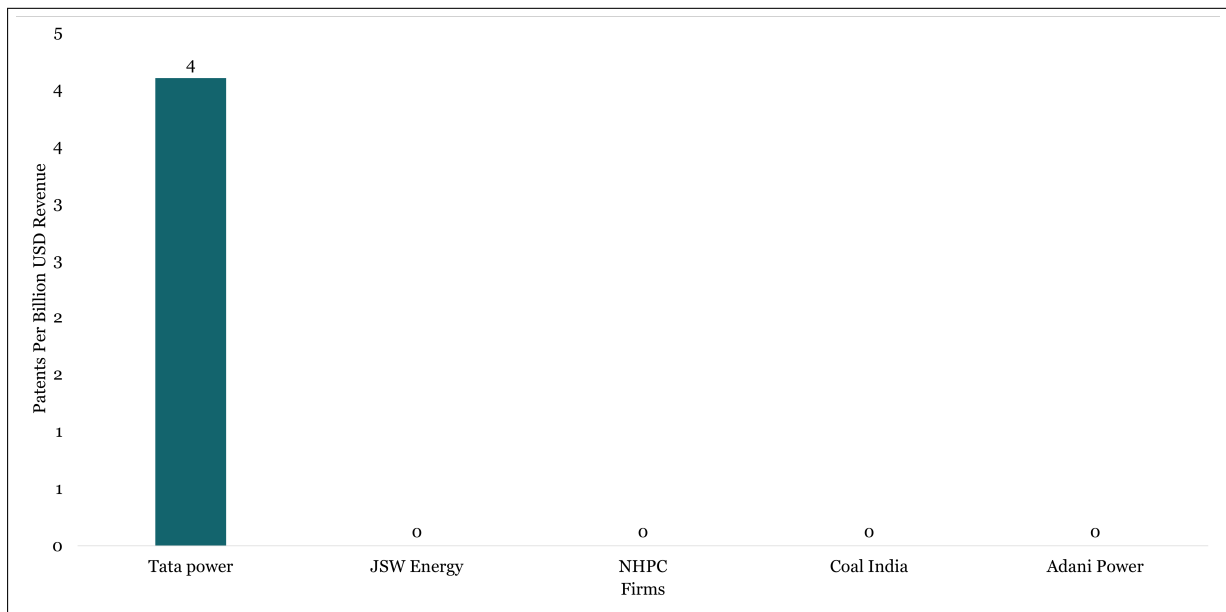


Figure 1.9: Patents per Revenue: Low Revenue Cluster

No patent information was available for JSW Energy, NHPC, Coal India or Adani Power. Tata Power is the only firm within this cluster to hold patents.

### 1.3.2.4 Publications by USD billion revenue

Figure 1.10 below presents the publication per USD billion revenue of low-revenue cluster firms.

Coal India ranks first in the low revenue cluster with the highest publication count across clusters. It is followed by Tata Power and NHPC. Coal India leads Tata Power, which ranks second by a factor of **3.5x**. JSW Energy and Adani Power rank fourth and last respectively for this parameter.

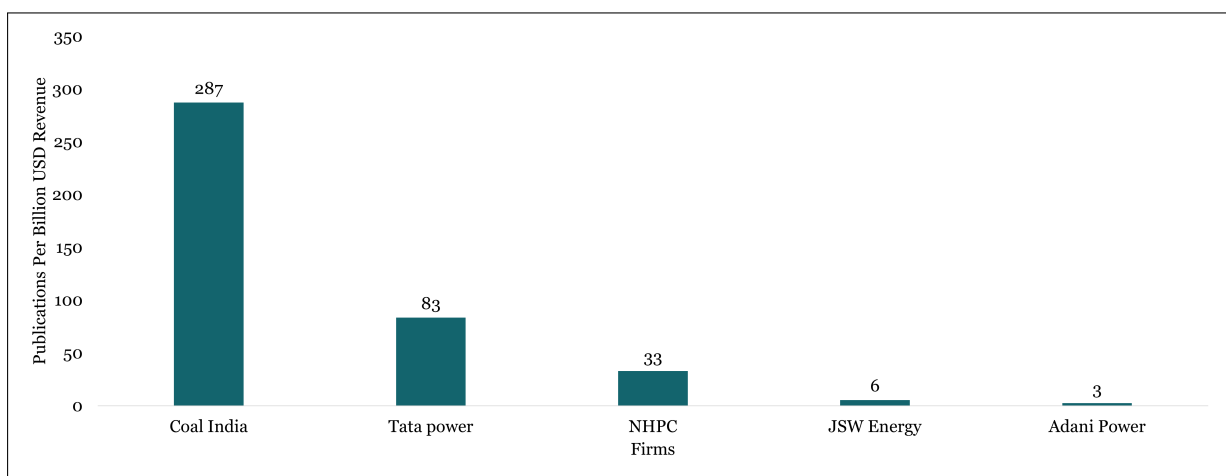
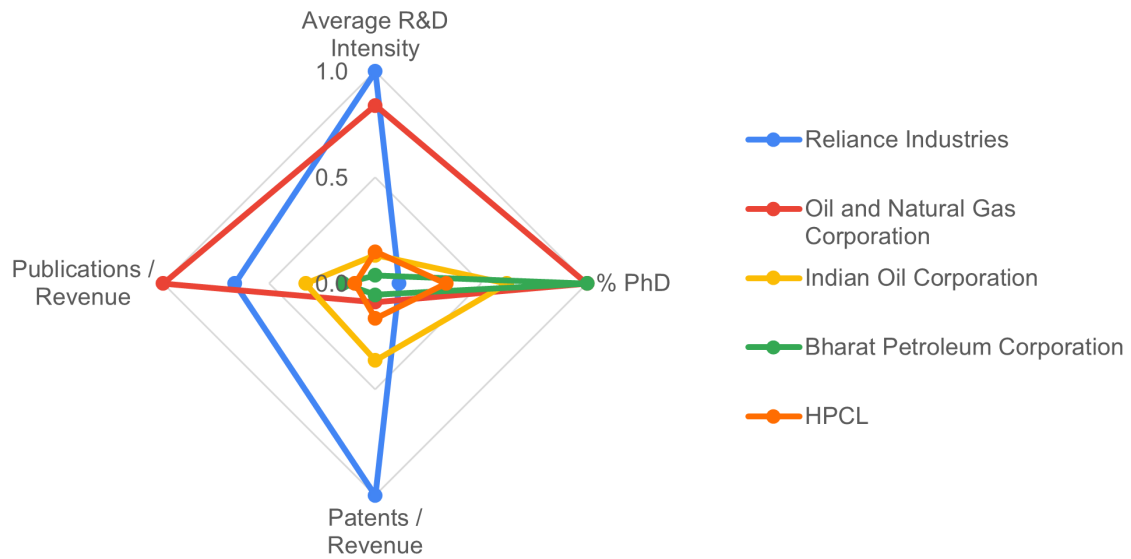
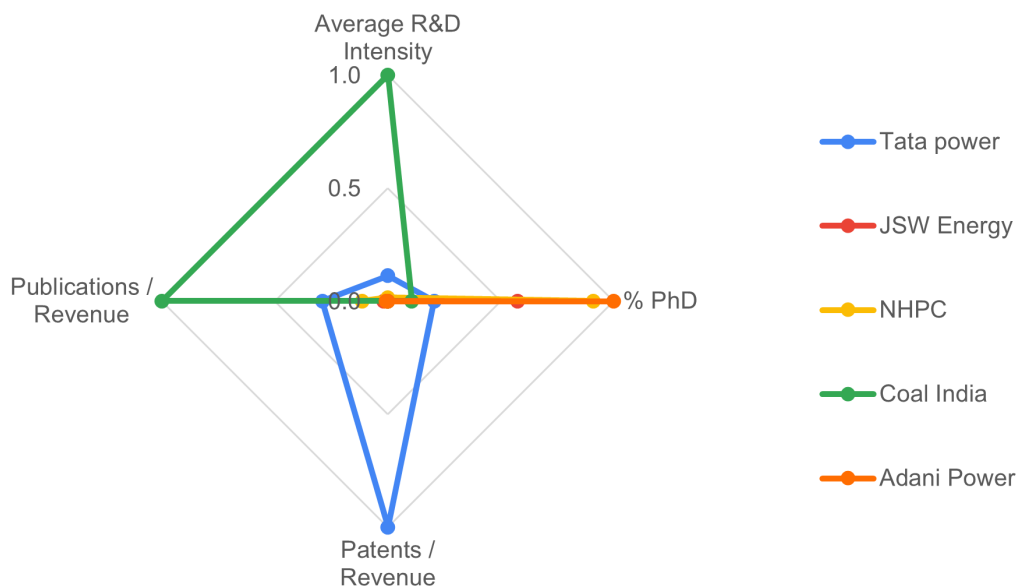


Figure 1.10: Publication per Revenue: Low Revenue Cluster

In summary, figures 1.11 and 1.12 below present a graphical representation of a firm's performance across the four parameters, R&D intensity, PhD employees as a proportion of total employees, patents and publications per USD billion revenue for high revenue and low revenue cluster firms.



**Figure 1.11:** Indian Energy Sector Firms' performance in the High Revenue Cluster



**Figure 1.12:** Indian Energy Sector Firms' performance in the Low Revenue Cluster

## 1.4 Conclusion

The Indian energy sector, largely dependent on fossil fuels, is slowly moving towards increasing the use of renewable energy and improving efficiency for use of non-renewable fuel. A large proportion of high market capitalisation firms in the sector in India are PSEs, which compete well with global peers for R&D intensity.

However, when compared to global counterparts, Indian firms generally have fewer proportion of PhD qualified employees and patents by revenue, highlighting the need for increased focus on innovation and intellectual property.

# Annexure

**Table 1.1:** Firms included in the study

No.	Firm	Market Cap (USD Bn)	Avg. Standalone Revenue (USD MM)	Revenue Cluster
1	Indian Oil Corporation Limited (IOCL)	14.0	70,923	High
2	Reliance Industries Limited (RIL)	192.0	42,317	High
3	Bharat Petroleum Corporation Limited (BPCL)	9.5	40,214	High
4	Hindustan Petroleum Corporation Limited (HPCL)	4.5	35,404	High
5	Oil and Natural Gas Corporation (ONGC)	25.3	11,755	High
6	Adani Power	11.3	1,564	Low
7	Coal India	17.6	1,539	Low
8	Tata Power	8.0	1,222	Low
9	NHPC	5.4	973	Low
10	JSW Energy	5.2	540	Low
	<b>Median</b>	<b>10.4</b>	<b>6,659</b>	

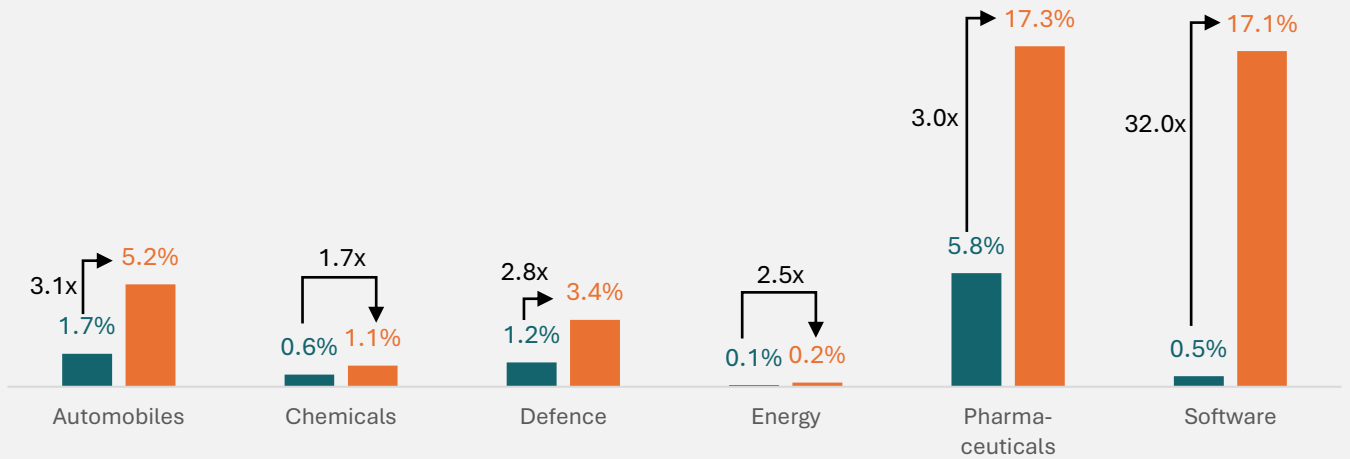
Note: Market Capitalisation data obtained from <https://www.capitaliq.com/> as of May 2023. Revenue data for the latest year as obtained from Company Annual Reports and Bloomberg.

**Table 1.2:** Firms excluded from the study and rationale

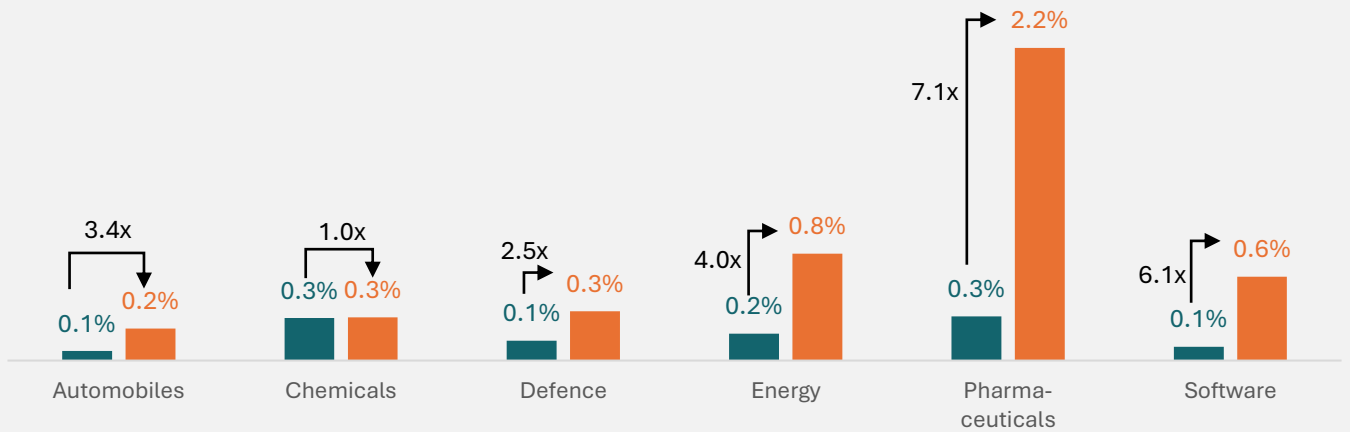
No.	Firm	Region	Rationale for exclusion
1	NTPC	Indian	Standalone financial data prior to 2022 not found
2	Power Grid Corporation of India	Indian	Financial information regarding R&D could not be found
3	Adani Green	Indian	Financial information regarding R&D could not be found
4	Adani Energy	Indian	Financial information regarding R&D could not be found

# Sectoral Comparisons: Inputs & Outputs

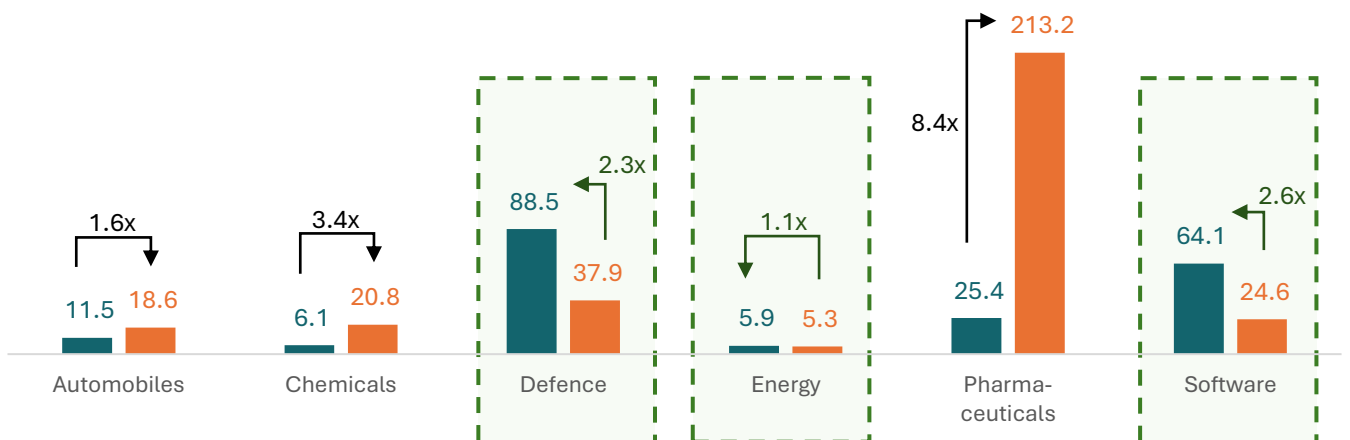
## R&D Intensity



## % PhD Employees



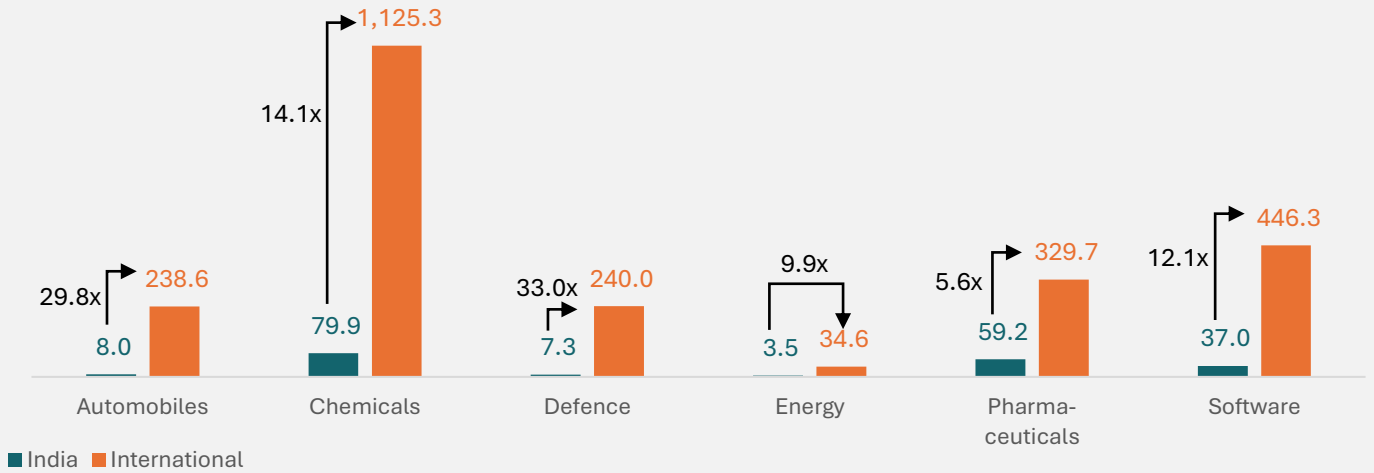
## Publications per revenue



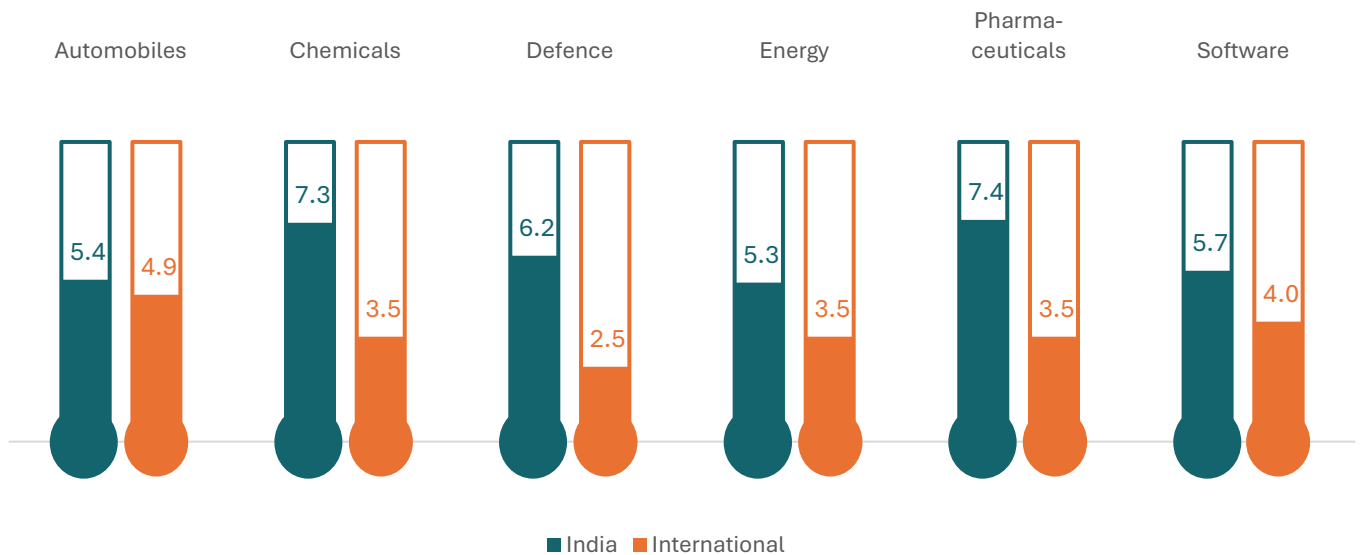


# Sectoral Comparisons: Inputs & Outputs

## Patents per revenue



## R&D Disclosures



### Notes:

1. % PhD Employees is the number of PhD employees as a proportion of total employees.
2. The publications per revenue metric indicates the number of publications in the study period per billion USD revenue.
3. The patents per revenue metric indicates the number of patents published in the study period per billion USD revenue.

# Bibliography

- International Energy Agency (2024). “India 2020: Energy Policy Review”. In: (). URL: [https://www.niti.gov.in/sites/default/files/2023-02/IEA-India%202020-In-depth-EnergyPolicy\\_0.pdf](https://www.niti.gov.in/sites/default/files/2023-02/IEA-India%202020-In-depth-EnergyPolicy_0.pdf) (visited on 07/01/2024).
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- Invest India (2024). “Renewable Energy”. In: (). URL: <https://www.investindia.gov.in/sector/renewable-energy#:~:text=India's%20installed%20non%20fossil%20fuel,additions%20of%209.83%25%20in%202022.> (visited on 07/01/2024).
- “Invest India - Renewable Energy” (n.d.). In: *in India: Investment Opportunities in the Pow...* (). URL: <https://www.investindia.gov.in/sector/renewable-energy>.
- Ministry of Petroleum & Natural Gas (n.d.). “India has been ranked the third largest primary energy consumer in the world”. In: *Press Information Bureau* (). URL: <https://pib.gov.in/PressReleasePage.aspx?PRID=1809204>.
- NITI Aayog, Government of India (2024). “Climate and Energy Dashboard”. In: (). URL: <https://iced.niti.gov.in/energy> (visited on 06/13/2024).



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