

# Commercialization of Indigenously Developed Technologies

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## 1.0 Introduction

The current rate at which scientific and technological changes and innovations are taking place worldwide, is creating many challenges while providing enormous benefits to human kind. Science and Technology are closely inter-linked with our lives and the studies and developments in both these areas are essential for human development. We all are also aware of the positive impact on our lives brought about by the advancements in these fields.

Technology Commercialization is a process of transferring know how generated in the research centers to the industry with a business model of increasing profits. Hence, technology commercialization has to be thought of in relation to appropriate technology transfer activities to increase the success rate of technology commercialization.

The successful commercialization of new technologies and processes from labs to industry in order to reap fruits of investments in R&D for the larger benefit of the society , however, remains an area of concern.

## 2.0 The Importance of Technology Commercialization

In a society based on knowledge, technology innovation is being appraised as the most important factor for national competitiveness and corporate competitiveness. As a result, governments of various countries around the world are becoming increasingly involved in technology innovation with a keen interest and active involvement in technology commercialization. Technology innovation can be seen in two ways: technology development and technology commercialization including technology transfer (technology spread concept). Domestically and internationally, up until the 1980's, it was believed, in line with R&D expansion, that technology development policy would bring technology innovation. However at present, the recognition that developed technology itself is not the result but that technology must create additional value through proliferation & commercialization has set in, and technology commercialization policy has taken the core position of industrial technology policies of each country.

The global position of any country depends on its technological development. It is essential to develop and implement indigenous technologies in the country to realize true and sustainable Independence. India is an expanding economy and expected hub of manufacturing industries. Considering this, there is a tremendous potential to develop and commercialize indigenous technologies in India. Research institution (academic, corporate) and Industries and supportive Government policies can play important role in commercialization of indigenous technologies.



### 3.0 Research Institutions in Downstream Oil Sector in India

In view of the authors' expertise in the downstream sector, this document would focus on issues related to technology development and commercialization in the downstream oil sector. However, the issues that have been discussed are of broad nature, and are equally applicable to the upstream sector without any exception.

There are various institutions in India who are currently engaged in research and development in downstream oil and petrochemicals sector. These are:

#### ❖ Corporate Research Centers

- Indian Oil Corporation Ltd.
- Bharat Petroleum Corporation Ltd
- Hindustan Petroleum Corporation Ltd.
- Engineers India Ltd.
- Gas Authority of India Ltd.
- Chennai Petroleum Corporation Ltd.
- Reliance Industries Ltd.
- Etc.

#### ❖ National Laboratories

- CSIR-Indian Institute of Petroleum, Dehradun
- CSIR-National Chemical Laboratory, Pune
- CSIR-Indian Institute of Chemical Technology, Hyderabad
- CSIR-Central Institute of Mining and Fuel Research, Dhanbad
- CSIR-North East Institute of Science & Technology, Jorhat

#### ❖ Academic Institutes

- IIT Kanpur, IIT Mumbai, IIT Delhi, IIT Guwahati, IIT Kharagpur, IIT Chennai, IIT Roorkee
- Indian Institute of Science, Bangalore
- Institute of Chemical Technology, Bombay
- The National Institutes of Technology
- BITS, Pilani (Various campus)
- Other Universities and Institutes

The academic institutes broadly focus on basic research, some of which is related and is of interest to the hydrocarbon industry. Most of this research ends up in publications in peer review journals and may be of use in the industry, perhaps, not in the near future. Several of these institutes have collaborated with the industry or the corporate research centres to undertake joint research leading to development of a technology. In this case, while the academic institutes provide valuable inputs in basic sciences the industry/corporate research laboratories centres provide the vital input for its industrial application.



The corporate research centres have largely concentrated on industry specific short term research which is of immediate application. Several of these corporate laboratories also provide valuable support to the corporate operations in terms of evaluating catalyst, troubleshooting, value addition to certain streams and high ended technical services. Several technologies have been developed by these laboratories and are available for commercialization.

The National laboratories such as Indian Institute of Petroleum, National Chemical Laboratory, Indian Institute of Chemical Technology etc. have invested heavily since the middle of 20<sup>th</sup> century in creating a world class infrastructure which is designed to carry out both basic and applied research as well as technology development. In this respect, CSIR established the Indian Institute of Petroleum in 1960 with the primary aim to support the oil industry in terms of cutting edge research and technology development. Over the last 54 years this institute has developed and commercialized very large number of technologies some of them against international competition.

### **Networking**

There is an attempt to network amongst the above organizations with the purpose to leverage expertise across the organizations with the primary aim to develop a technology. There have been both successful and unsuccessful attempts in the past. The successful attempts such as collaboration between EIL and IIP, EIL and IIT Kanpur, EIL and IIT Mumbai, IOC R&D and IIT Delhi etc have led to development of cutting edge technologies. There is an urgent need to felicitate a system by which this networking becomes more natural and productive. There is also an urgent need for collaboration between the corporate research laboratories and the national laboratory system; in fact, this collaboration can accelerate development and commercialization of technologies; some of these technologies can find a place in the organization itself. Also, as depicted in Figure-1 and Figure-2, in view of the fact that in today's research, a large number of skills are required which are of diverse nature, such collaborations are indeed a necessity to create a useful technology or a product. Above all, such collaborations are essential to create a critical mass required to deliver a competitive technology.

### **4.0 Funding of Research**

At present, there are several agencies which fund research as well as have funds for technology development and also have schemes for demonstration of the technologies.

These funding agencies are listed below:

#### **Government Agencies**

- a) Department of Science & Technology (DST)
- b) Department of Biotechnology (DBT)
- c) Ministry of New and Renewable Energy (MNRE)



## International Funding

DST has agreements with various countries around the world for collaborative research. Some of the major countries are: USA, UK, Germany, Japan, Australia, Norway etc.

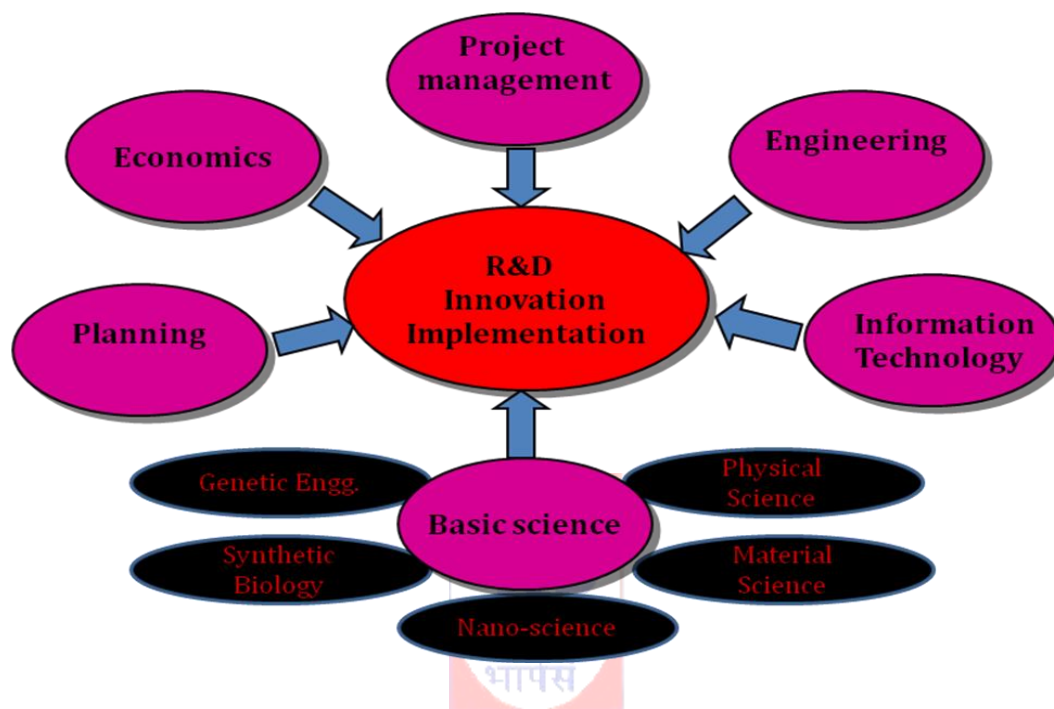


Figure-1: Diverse Skills Needed – Not available under one roof

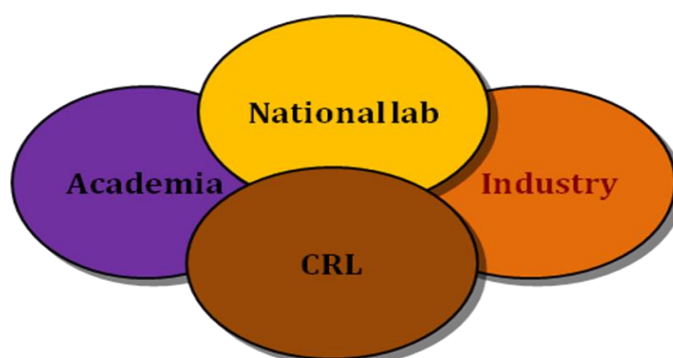


Figure-2: Networking among Academia, research centres and Industry

There are calls for proposals at frequent intervals highlighting the areas of interest by the two countries. The academic institutes and the national laboratories are encouraged to apply. This is a huge opportunity for leveraging international expertise to develop world class technologies.

### **Funding by OADB**

OADB by itself and through its various agencies such as CHT, PCRA, DGH etc funds research encouraging development and commercialization of technologies. CHT through Scientific Advisory Committee to the Ministry of Petroleum & Natural Gas has funded a very large number of projects over the last 35 years; a few of them have already been commercialized.

### **Corporate Research Centres**

The corporate research laboratories such as Indian Oil Ltd., Bharat Petroleum Corporation Ltd., Hindustan Petroleum Corporation Ltd., Engineers India Ltd. etc provide their own source of funding for their research. Several of these collaborate with academic institutes to leverage their expertise. In this case, the corporate labs provide funding to the academic institutes/national laboratories.

It has been seen that there has been no dearth of research funding. In fact, over the last 10 years it has been seen that there is an acute shortage of projects and proposals which are eligible for funding. Overall, there has been an acute shortage of new ideas for funding.

## **5.0 Commercialization of Technologies**

As mentioned above, it is extremely important for the true independence of a country that it commercializes its own research as well as commercializes the same worldwide. In fact, the ultimate purpose of any scientific discovery and invention is in its commercialization and that is the ultimate dream of any scientist. This requires a seamless integration of science, engineering and economics.

The successful commercialization of a technology has its roots in the following:

- Innovativeness
- Should survive strong competition
- Should address volatile market
- Should provide profits even in thin margins
- Should meet dynamic product specifications
- Should meet tight time scales and
- Should be environmental friendly

The planning at the inception of technology development should take care of the above aspects on a long term basis.



## Major Concern of Customers

There are several issues which act as roadblocks for commercialization of indigenous technology. The first and foremost is the requirement of our industry for a proven track record. It has been seen that whenever the industry puts out a tender or an enquiry, one of the essential requirement is that there should be two or three units which are operating of similar capacity. This has a highly negative impact on commercializing anything new. Also, the industry looks for a proven track record with similar feed and similar capacity. Although, there is an indigenous technology which has been commercialized but since it may not be processing similar feed or is not of same capacity it does not qualify to compete.

The industry also has a perceived notion that the indigenous technology is not state-of-the-art and is inferior to an imported technology. This is a very strong negative perception in the minds of the people in the industry. There is a general feeling that if it is indigenous, it has to be second rate.

The industry also has a concern whether the developers of indigenous technology will be able to provide a long term support to the technology and are capable of hand holding and troubleshooting whenever required. In fact, they are even concerned about whether the developers would continue to invest in further development of the technology to keep it competitive throughout its life cycle.

## Issues in technology development which need to be addressed

While some of the above concerns of the industry could be genuine, several of these, however, are only their perception. It is however, important to note that the developers of the technologies should offer a complete technology solution. Such complete technology solution is indeed available to the industry from the foreign licensors. There is a need by the developers to address such concerns. In fact, in addition to the development of core technologies, the developers should also focus on developing enabling technologies such as material of construction, process engineering, catalyst re-generation, analytical support, effluent treatments, environmental impact, catalyst disposal etc. This is just a short list of areas which need to be looked at by the developer and a solution offered as a complete technology package.

It is often seen that the developer announces the development of a technology just because he has developed a catalyst. This is indeed a beginning. The development of the reactor system, the flow sheet and the complete basic design engineering package is what constitutes a technology.

## Barriers/ Constraints

There are genuine problems and constraints faced by the developers in India while developing and offering a complete technology solution. As compared to the developed nations such as Europe and USA there is a complete lack of facilities in India for demonstrating the development know-how. Unlike the West, we lack heavily in pilot plant facilities. There is a need to create several general purpose pilot scale facilities which can be used to demonstrate technologies. There is a lack of cutting edge engineering research which can enable high ended engineering designs and



overall there is a lack of engineering support. Also the country lacks in database for carrying out techno commercial feasibility of new research ideas. Above all, there is complete lack of facilities in the country for scale up of indigenous catalyst and its manufacturing.

While the perception of the industry may be real, it is also important that the developers are not provided with the right kind of infrastructure and support to be able to overcome not only the concern of the industry but also to overcome the barriers and constraints faced by them in commercializing research and to run that most important last mile.

## 6.0 How to make it happen (commercialization of indigenous technologies)

The research and development activities carried out by the corporate research labs, national laboratories, and academia, either, individually, or in collaboration can be clearly divided in the following three categories:

1. Technology for production of certain products and chemicals
2. Commercialization of products such as catalyst, adsorbents, additives etc.
3. Specialized technical services such as energy optimization, product improvement, training etc.

The following paragraphs provide the foundation on which government policies can be framed and enforced which will lead to increasing commercialization of indigenous developments and know-how. The discussion is with respect to the above three categories.

### 6.1 Technology for production of certain products and chemicals

There are a very large number of technologies, which have been developed, and several of these, have also been commercialized. There is a need for separate policy and government intervention based on the following:

- **Technologies which are already licensed and commercialized**

National laboratories such as IIP, NCL as well as corporate research labs of Indian Oil Corporation Ltd., Bharat Petroleum Corporation Ltd. have already commercialized a few technologies; the first to be commercialized was the IIP/EIL sulfolane based BTX extraction technology at BPCL, Mumbai in early 80s. Since then several technologies related to solvent extraction, visbreaking, delayed coking, FCC, hydrotreating etc have been commercialized. It is seen that in spite of the availability of a successful and proven indigenous technology, the industry keeps on repeatedly importing these technologies from abroad. Sometimes these technologies are imported under the pretext that the indigenous technologies are not processing the same feed or are not of similar capacity. These are simple technical issues which can be addressed and overcome, since, as a part of overall development of a technology these are naturally addressed. On other occasions it is seen that the already commercialized technology is repeatedly imported because it is a component of a larger complex on which the industry seeks guarantee from the licensor. With the right policies and the intervention of the government this can be easily avoided and resolved.



It is suggested that the government should not allow any import of technology if an indigenous technology is already operating successfully and has a proven track record. Needless to say that the developers of these technologies secure the same by taking IPR's and over a period of time try to build an impressive portfolio which should be taken notice of.

- **Technologies which are ready to be commercialized**

There are several technologies that are available which have been developed at the bench/mini pilot scale level and can be easily scaled up with zero risk. Generally, these technologies are ignored because of the requirement of proven track record. Given the right kind of encouragement by the government these technologies can be brought to the market place, and in fact, once proven, have the potential to be marketed worldwide. It is suggested that in order to provide the incentive to the industry to accept and commercialize such technologies, the government should announce zero custom duty on imported equipments and zero excise duty on indigenous equipments that are procured to commercialize these technologies. This would provide strong economic incentive to the industry. In addition, OIBD can provide escrow or hedge funds to cover any perceived risk in the unlikely event of non performance of the technology.

- **Technologies requiring scale up**

There are, indeed, several technologies which have been proven at the lab scale, and also at the mini pilot scale, but need a large scale pilot plant for demonstration and to generate scale up data. These technologies generally involve a catalyst, and it becomes necessary to run a demo unit for long duration in order to establish the effectiveness of the catalyst as well as any re-generation requirement etc. It is suggested that funding agencies such as OIBD and CHT should identify such promising technologies and fund the creation of such pilot plants preferably within an operating unit or a refinery so that the feed stocks are easily available as well as the products can be usefully utilized. This would also reduce the cost of the pilot plant since the infrastructure and utilities would be available from within the refinery. Moreover, since the pilot unit will be operating inside the refinery there is a strong possibility of the industry adopting the technology.

## 6.2 Commercialization of Indigenous Products

The research and development units of the oil sector as well as the national laboratories have developed a very large number of specialty products such as, catalyst, adsorbents, additives and performance chemicals. It is suggested that proper policies should be put in place to commercialize such products after due diligence and comprehensive performance comparison with imported products. Once these products are commercial and are proven in the industry, the government should make a policy of not importing these products but insist on the developer to continuously innovate and develop such products in line with international standards.





It is seen on several occasions, that although, the catalyst developed indigenously has been used very successfully by the industry, but the procurement department of the oil industry still tries to go for competitive bidding and procures an imported catalyst based on pricing. I believe that the pricing of an indigenous product can be negotiated and the developer would be more than happy to match the price of his product with the corresponding international product. It is important to mention that India should be developed as a manufacturing hub of such specialty products, such as, catalysts, chemicals etc so that the same can be exported to both developing and developed economies of the world.

### 6.3 Specialized technical services

The oil industry, to remain competitive seeks a number of specialized technical services from both India and abroad. In view of the high energy cost, large emphasis is on energy efficiency improvement, performance improvement, global bench marking etc. For this purpose the industry seeks services from companies such as Shell Global, SOLOMON, Japanese Consultants etc. Within the country, companies such as Engineers India Limited, IOC R&D, national laboratories such as IIP, NCL have a large data base and expertise which can be utilized. In case such study is conducted for the first time, it should be made mandatory to involve Indian organizations along with the foreign consultants to absorb the know-how and to develop it further, specifically, dovetailing it to our requirements. A very successful example is the transfer of advanced control technology by EIL / CPCL from SETPOINT in the late eighties. With the right encouragement, the Indian companies would be able to come up to the satisfaction of the oil industry and moreover the entire knowledge and the know-how, that otherwise is given away by the industry to the foreign consultant can be avoided. It is important to note that the foreign consultants while doing the projects learn tremendously from us and enrich their own data bank. On the top of it they charge for their services. Once the Indian companies develop this expertise the same can be also offered to several refineries at least in the developing economies.

The Indian Institute of Petroleum has made a remarkable contribution in terms of training oil industry personnel in various subject areas. Such activities should be encouraged and training of people abroad or bringing the foreign trainer should be avoided to the extent possible.

### 7.0 How does India loose (if indigenous technologies are not encouraged)

It is important to discuss the fall out of not encouraging commercialization of indigenous technologies and repeated import of foreign technologies. Although the oil industry might debate the need to import technologies to remain competitive at a world level; it is important to realize that this would cripple slowly and finally, permanently the research base of the country. As mentioned before, the only dream of a scientist is to see his/her technology commercialized. In the absence of support from the industry, the scientist will take an alternative route to glory in terms of publishing their research and thereby proving how good they are individually. The research that they would publish will be picked up by companies abroad who will then convert them to a technology and the same would be exported back to India for which we will have to pay huge license fees. This also destroys the team



spirit and a team effort, which is required to develop a technology. Publishing papers is more often an individual pursuit and does not, to a very large extent, contribute to the development of the nation and its independence with respect to a technology.

Development and commercialization of technologies also encourages the developers to protect their invention by taking patents in India and around the world. All developed economies and the companies in such economies, such as SHELL, EXXONMOBIL, UOP, AXENS, IFP, CHEVRON, LUMMUS etc have a huge portfolio of patents worldwide. They also aggressively protect their intellectual property, many a times, even with litigation, in case they discover infringement of their IPR. IPRs or patents is a true indication of the country's wealth in today's economy. Repeated import of technologies will systematically end this effort by the research organizations.

It has been seen in the past that in some sectors of the economy, namely: Defence, Nuclear, and Space, there has been technology denial and these sectors have strived to expand their own research base to overcome such a barrier and the success stories are several and known to everybody. Time is not very far when India may be denied cutting edge technologies in the energy sector as well, particularly, those, which are green and can replace fossil fuels effectively and sustainably. This may happen perhaps three decades from now, but, by that time we would have already crippled our R&D infrastructure and reduce to a paper publication machine. It is about time that we do not allow our research institution particularly the one in the corporate research labs and the national laboratories to de-generate. This, therefore needs a strong intervention by the government to support and encourage indigenous technologies.

Finally, I would like to add that strong support to indigenous technology by the industry will encourage the developers to bring new and innovative technologies at a faster pace to the market place without the fear of being rejected for one reason or the other. This, in turn, will create a strong innovation system in the country and develop and support the complete research infrastructure, which we so dearly lack. It may be mentioned that in the energy industry, it is extremely difficult to predict future technology innovations; a comprehensive innovation based technology supply ecosystem is thus absolutely essential to survive around the year 2050 and beyond.

## 8.0 Conclusion

India is the 4<sup>th</sup> largest processor of crude oil with 22 refineries processing close to 235 MMTPA of crude oil. We export more than 70 MMTPA of petroleum products. Today, India is an acknowledged hub of petroleum refining, petrochemicals and other specialty products. All of this is based on imported technologies. It is high time that India promotes its own technologies to manufacture petroleum products and petrochemicals and export these technologies and licenses them to companies abroad.



India also has a very large technical base in terms of highly skilled manpower as well as large number of academic institutions at the level of IIT etc as well as a strong system of national laboratories. Also the industries have state-of-the-art research laboratories. In spite of such facilities available in the country and the highly skilled technical manpower, it is extremely unfortunate that we still keep on importing technology from abroad. It is about time that the government creates policies and provides intervention in order to facilitate commercialization of indigenous technologies, products and technical services. As brought out above, it is suggested that appropriate incentives need to be provided to the industry in terms of tax free import of equipments as well as exemption of excise duty on equipments which are used to commercialize an indigenous technologies. It is also suggested that a high power committee chaired by the Secretary, Ministry of Petroleum and Natural Gas may be constituted in order to oversee the need for import of any technology that is being done by the oil industry and to suggest how to avoid the same by commercializing indigenous technology in case there is an opportunity. The committee should also direct OIIB to create an escrow or a HEDGE fund to cover the perceived risk to new technologies which the industry might like to commercialize. Such funds have been created in the past and should again be revived across all sectors.

Non support of indigenous technologies can be fatal for the economy in the long term, and can also render the Indian hydrocarbon industry obsolete. Further, it will kill the innovation system of the country.

