



# CSIR-IIP : A Global Leader



Creating Future Fuels

Unilube , KSA &  
DeMenno Kerdoon, USA  
Paramount Grindly, KSA  
Gulf Petrochemicals, KSA

## Re-refining of Used Lube Oil

- Improving Colour and Colour Stability
- Basic Design Engineering Package (BDEP)

## SABIC, UK

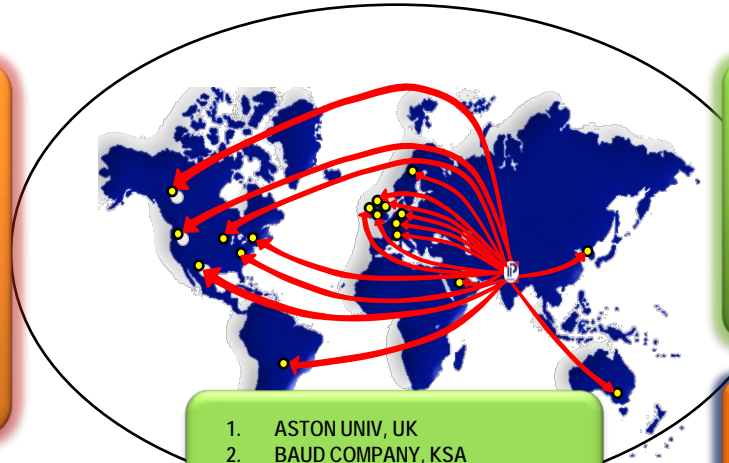
- Pure BTX from Straight Run Naphtha
- Revamp of Sulpholane Extraction Unit
- Transfer of CSIR- IIP BTX simulation model

## SABIC, KSA

- Signing of Master Research Alliance Agreement (MRAA)
- Benzene to Phenol

## ASTON UNIVERSITY, UK

- Pyrolysis Technology



- ASTON UNIV, UK
- BAUD COMPANY, KSA
- BP, UK
- DeMENNO / KERDOON, USA
- ENVERGENT TECHNOLOGY, USA
- EXXON MOBIL, USA
- FAU FRIEDRICH-ALEXANDER UNIVERSITAT ERLANGEN GERMANY
- FARABI, KSA
- GULF PETROCHEMICALS, KSA
- IMDEA ENERGIA, SPAIN
- MONASH UNIVERSITY, AUSTRALIA
- PATCHAM, UAE
- PRATT & WHITNEY, CANADA
- RTI, USA
- SABIC, UK
- SHELL TECHNOLOGIES
- SINTEF, NORWAY
- SOAT-LTT, GERMANY
- SwRI, USA
- TECH. UNIV. MUNCHEN, GERMANY
- UIUC, USA
- UKIERI, UK
- UNILUBE, KSA
- UNIV. OF ALBERTA, CANADA
- UNIV. OF ILLINOIS, USA
- UNIV. OF HUDDERSFIELD, UK
- UNIV. OF NEW CASTLE, UK
- UOP, USA
- RMIT UNIVERSITY, AUSTRALIA
- MELBORNE UNIVERSITY, AUSTRALIA

## Baud Company, KSA

- Processing of Group II Lubricating Base Oil

## FARABI, KSA

- Dearomatization of Kerosene

## SINTEF, NORWAY

- Sulphur reduction in the naphtha product
- Adsorption technology for ultra low sulphur diesel production
- Adsorption technology for recovery of CO<sub>2</sub>

## Clariant Corporation, USA

- Testing of FT Catalyst



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# Recent Achievements



# Simultaneous Production of US Grade Gasoline And High Purity Benzene from FCC Naphtha : CSIR IIP & RIL Technology



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## Need for this Technology

- ❖ MSAT – II regulations which became active on January 1<sup>st</sup>, 2011 (“EPA Regulatory Announcement” – EPA420-F-07-017, FEBRUARY 2007) , restricts the annual average benzene level in Gasoline sold in U.S, to 0.62 % vol.
- ❖ Surplus shale / ethane sources resulting in conversion of Naphtha crackers to Gas Crackers. Need to process alternative feedstocks to compensate for decreases in PyGas production.

## Salient Features of Technology

- Produces :
  - ❖ Gasoline having: (i) Sulphur < 10ppm (ii) Benzene < 0.3%
  - ❖ High purity benzene
- First time in the world and first indigenous technology Implemented in RIL, Jamnagar
- Capacity: ~0.7 MMTPA
- Capex: ~300 Crores INR
- Payback Period: Est. 2.5 Years

## Accolades

- ❖ CSIR Technology Award for Innovation, 2014
- ❖ US Patent 8722952, May 2014



**Plant successfully Commissioned at  
RIL Jamnagar in May 2016**



# Production of Paraffin & Microcrystalline Waxes at NRL



Numaligarh Refinery has installed a Wax D-eoiling Unit with an investment of Rs.676 crore using CSIR-IIP Technology.

## Production Capacity

- 45,000/50,000 TPA Paraffin Wax
- 5000 TPA Microcrystalline Wax
- Basic Design data generated at CSIR-IIP
- PEDP by EIL with IIP's Technical Support

Honourable Prime Minister Shri Narendra Modi dedicated the Wax Plant at Numaligarh Refinery Limited (NRL) to the nation on 5<sup>th</sup> February, 2016



Wax production unit , NRL, Assam

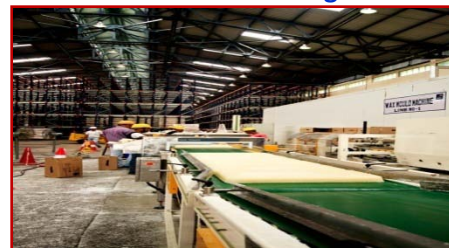


Dewaxing-Deoiling Pilot Plant at CSIR-IIP

Tanks of NRL Wax Plant



View of Wax Slabbing Unit





# Economic and Societal Benefits of Commercialization

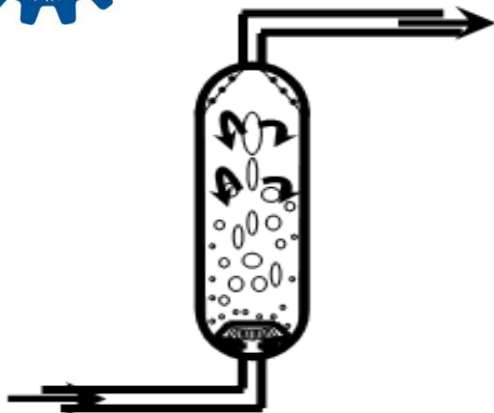


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- Increase in NRL profitability by Rs. 77.0 crores/annum equivalent to enhanced gross refinery margins by US \$ 0.53 per barrel.
- Significant savings on fixed capital investment and energy consumption compared to foreign technologies
- Wax production at NRL cut down wax import by 50% and saved foreign exchange of ~ US \$ 38 million.
- NRL has started export of paraffin wax to about 20 countries such as Nepal, Kenya, Bangladesh, Mexico, Nicaragua, Thailand and China
- **Societal Benefits** : Wax plant has generated direct jobs (125 persons) and created a new wave of wax entrepreneurs and cottage industries using wax in the **North-East**



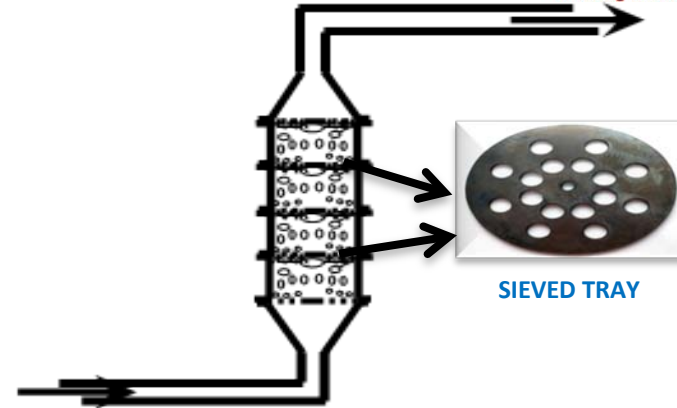
*Production of paraffin wax at NRL is a great success under 'Make in India'*



CONVENTIONAL SOAKER

## Benefits

- More distillates
- Improved fuel oil stability
- Better temperature profile
- Enhanced run length



SOAKER WITH INTERNALS

## Commercialisation and Economic Benefits

	HPCL, Vizag	IOCL, Mathura	IOCL, Haldia
Technology Transfer	August, 2011	January, 2013	September, 2014
Installation of internals	September, 2012	October, 2013	February, 2016
Commissioning	October, 2012	November, 2013	March, 2016
Status	Running smoothly	Running smoothly	Running smoothly
Economic Benefit (Rs. Cr/annum)	9.3	8.5	6.2
Payback Period (months)	<3	<4	<5

Thoxcat ES is useful for sweetening of LPG and other lighter petroleum fractions like LSRN/light cracked naphtha. Sweetening is a process for reduction/conversion of mercaptan sulfur.

Sweetening Unit

Commercialization



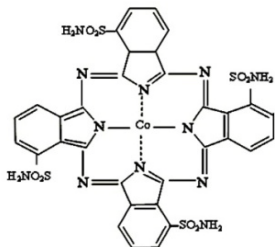
Catalyst Production Unit



Commercial Users of Thoxcat ES :

- ❖ BPCL, Mumbai (2008)
- ❖ HPCL, Mumbai (2009)
- ❖ HPCL, Vizag (2010)
- ❖ BORL, Bina (2011)
- ❖ HMEL, Bhatinda (2011)
- ❖ MRPL, Mangalore (2012)
- ❖ IOCL, Digboi (2012)
- ❖ RIL, Jamnagar (2012)

Catalyst Molecule  
Thoxcat ES



Licensed to  
M/s Lona Industries  
Ltd, Mumbai

- Globally competitive.
- Low cost
- Less consumption
- No additional investment
- Applicable in conventional & fiber-film sweetening processes

• Patents: Foreign	06
Indian	03
• Publications:	10

❖ License Fee & Royalty



# Modified Gur Bhatti



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## Development & Popularization of Improved Gur bhatti

- Improved 3- & 4- Pan *Gur Bhatti* developed & installed in rural areas (*over 35 installations*)
- Nearly 23% increase in daily *Gur* production observed.
- 12% savings in fuel consumption observed.
- Reduction in emissions (Smoke) clearly observed.

### Being popularized & installed under CSIR 800 mission



CSIR-IIP improved Gur bhatti installed near Meerut, U.P.



CSIR-IIP team with Gur Bhatti owner

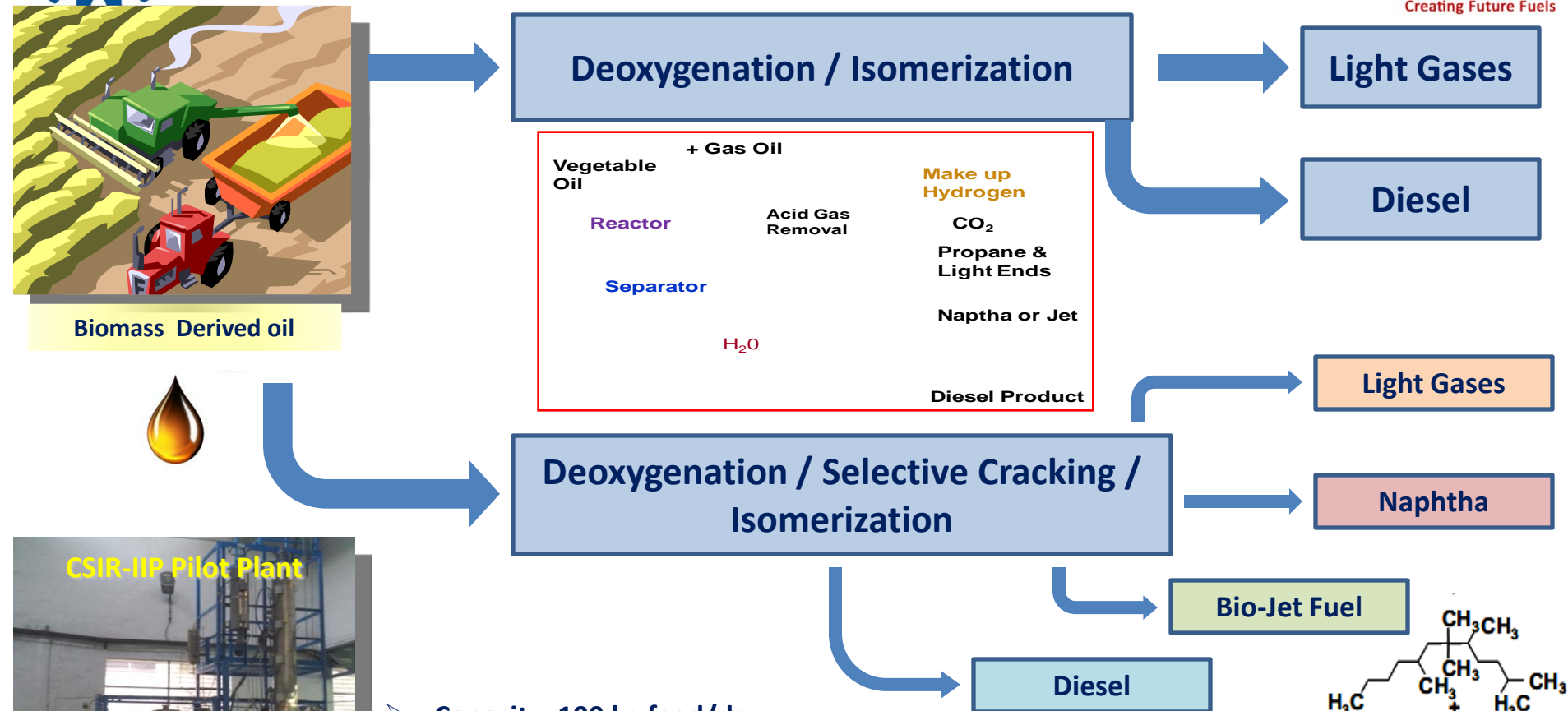
**More profit, cleaner environment, better quality of jaggery**





# Prominent Technologies Developed & Ready for Commercialization

# Process for Bio-Jet Fuel



CSIR-IIP Pilot Plant

- Capacity: 100 kg feed/day.
- 15 Liters of Bio-Jet Fuel supplied to Industrial Partners HPCL & IOCL
- The Bio-Jet Fuel Meets all the Major Specifications for Aviation Fuel as per ASTM D1655, and all parameters of IS:1571 except "petroleum origin" clause

## Scenario in India

### Waste Plastics

- ❖ As part of MSW in 60 major cities: **~ 15, 500 TPD (i.e ~ 56 Lakhs TPA)**
- ❖ Added everyday which lie littered (assuming 60 % recycling) : **~6137 TPD**

Source CPCB

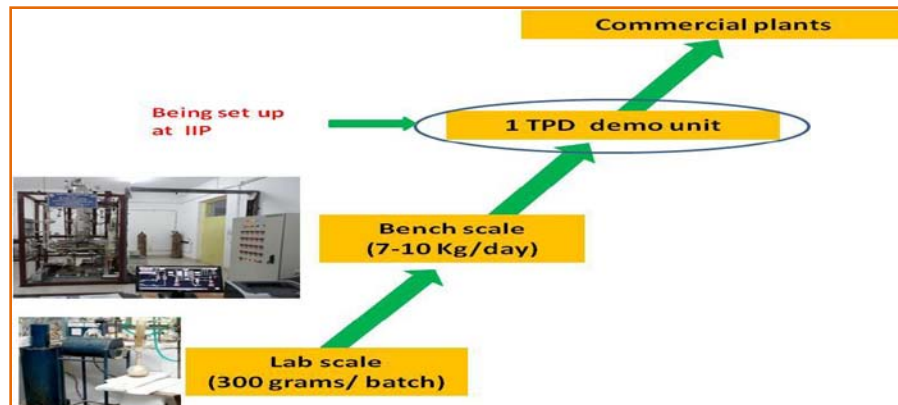


### Socio-economic impact

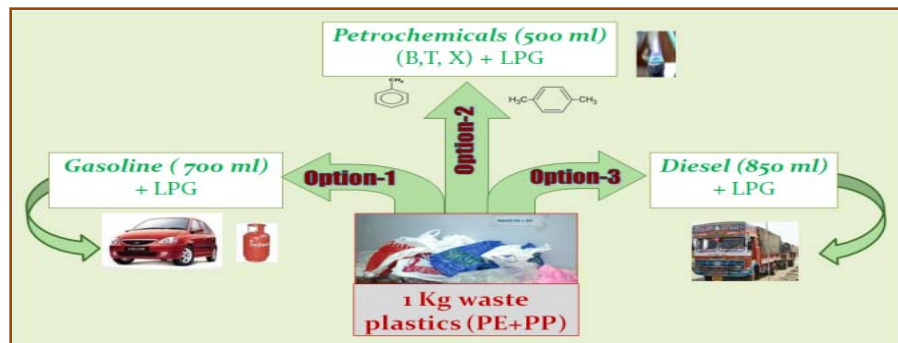


- Clean and economical automotive grade fuel from alternative source
- Impetus to waste plastics collection
- Economic benefits to rag pickers
- Green solution to waste plastics disposal

## Technology Development



## CSIR IIP & GAIL Technology



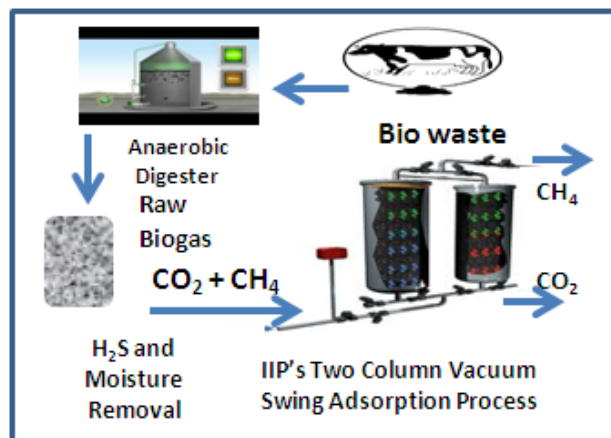
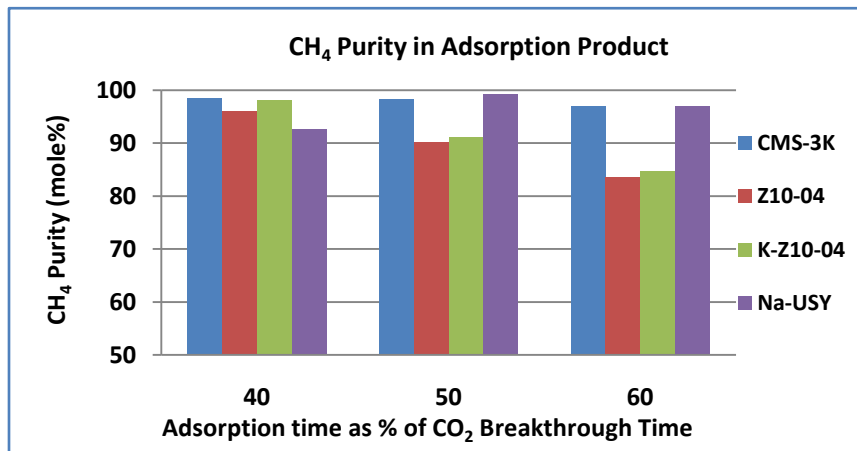
**National Award for Technology Innovation in 2012**

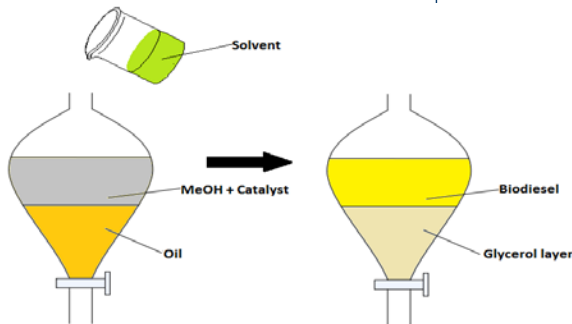
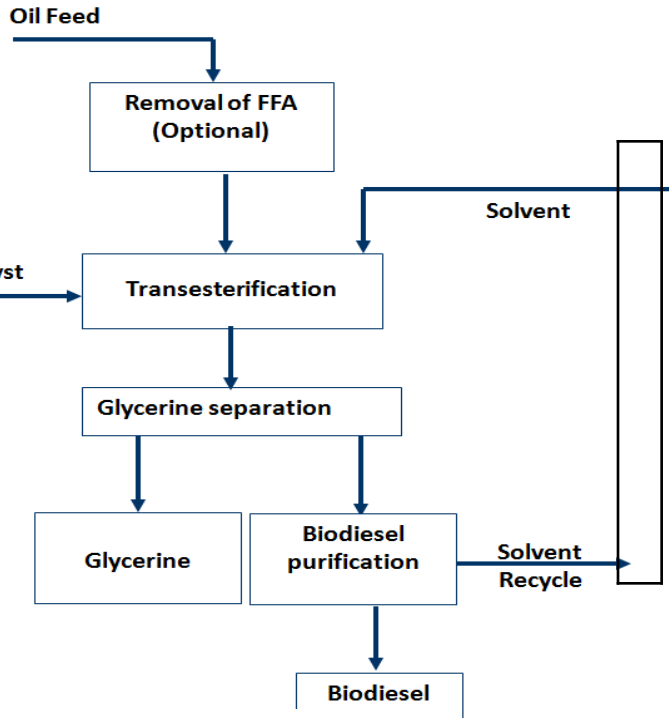
# Pressure/Vacuum Swing Adsorption (PVSA) Process for Biogas Up gradation

## Highlights

- ❖ Production of high purity CH<sub>4</sub> with purity and recovery >90 mol%
- ❖ Simpler VSA cycle based on low cost commercial adsorbent
- ❖ Low energy required, high productivity
- ❖ Product biogas suitable for
  - ❖ Combined heat and power generation
  - ❖ Transportation fuel
  - ❖ Industrial and domestic usage
- ❖ Technology suitable for rural application
- ❖ Alignment to National Missions

A Demonstration Plant Based on this Process with a Raw Biogas Throughput of 10 m<sup>3</sup>/Day is being Set-up at CSIR-IIP





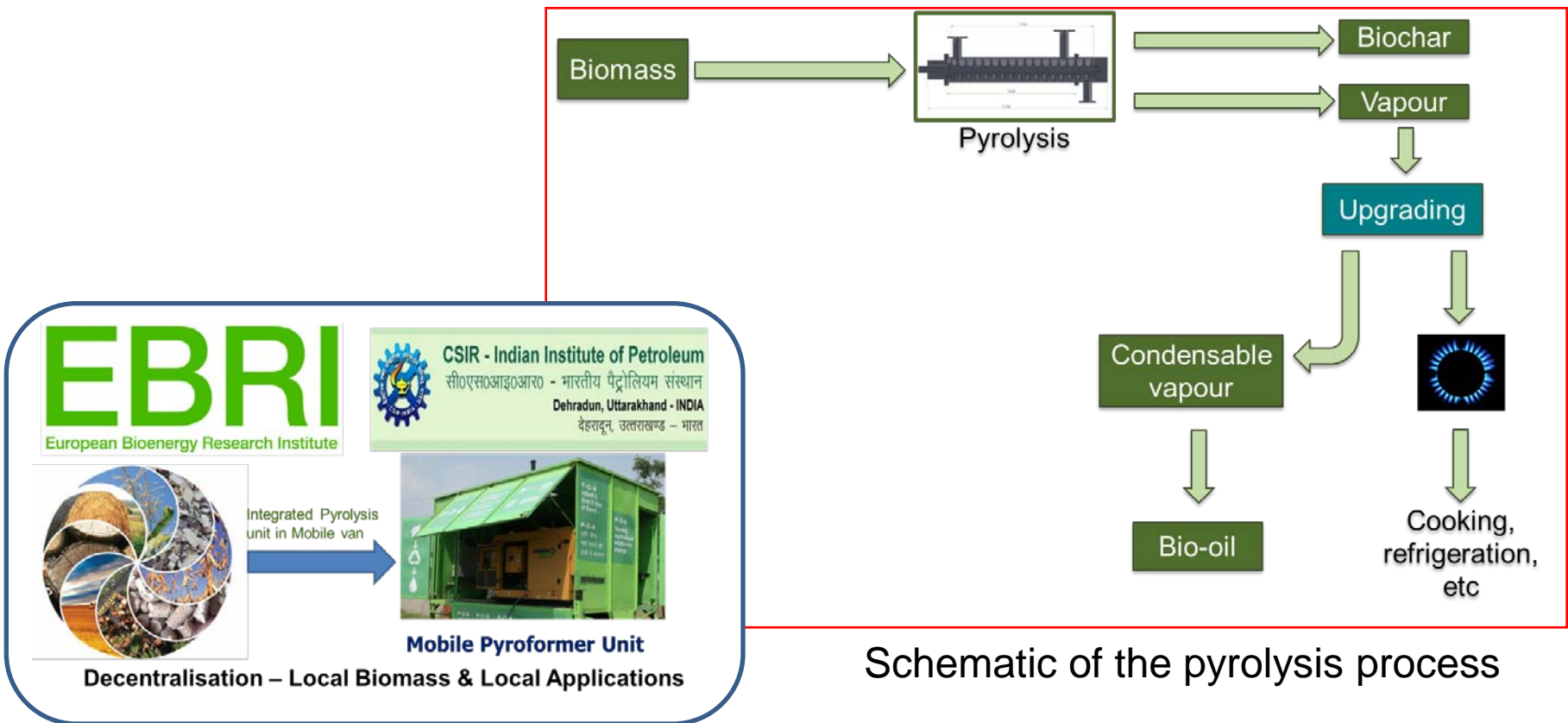
## *Salient Features*

- ✓ Suitable for feed stocks (non-edible oils) having FFA up to 10%.
- ✓ Reaction at ambient conditions in without any heating or any mechanical stirring. After separation of glycerine, biodiesel is purified by water washing/distillation.
- ✓ Especially suitable for small scale operations in rural economies

**Patent Filed: 1 Indian Patent filed**

**Active collaboration with Chhattisgarh Biofuel Development Authority**

- Pyrolysis of agriculture waste for production of bio oil for stationary applications
- *Aston University, UK sponsored Joint project between EBRI & CSIR-IIP*



Schematic of the pyrolysis process

**Farmers need never burn crop residues again**



# Field Study to Determine Benzene Emission at Petrol Stations in India



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## Objectives

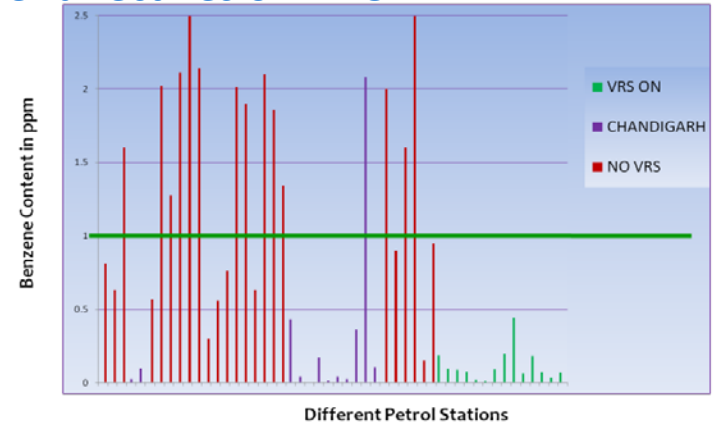
- To carry out a Field Study to determine Benzene Emission at Petrol Stations in India and different measures taken-up by OMCs on the same - **as per directives of PMO**

## Field Study

- IIP carried out a field study at **126 petrol stations in 13 cities w.r.t. installation of Vapor Recovery System (VRS) Stage-II, sale of petrol, type of ownership (ROs & COCOs) & OMCs (PSU and Private), petrol sell 50-300 KL/month, Benzene Emission.**

## Key Findings

- In general, **Benzene Content in forecourt of petrol stations having no VRS Stage - II** was in the range of **0.56 (min.) to 2.89 ppm (max).**
- Lower Benzene Content (0.01 to 0.44 ppm) was found, where VRS Stage - II has been installed -** which was **below the safe limit of 1.00 ppm of NIOSH's Short-Term Exposure Limit (STEL).** VRS Stage-II is useful to reduce Bz Emission.
- Current status of VRS Stage – II implementation** : In Delhi, out of 388 petrol stations, the Stage – II VRS has been installed at **130 petrol stations**; In the rest of the country, Stage – II VRS has been installed at **188 petrol stations.** **IIP recommended VRS Stage –II implementation at all petrol stations in the country.**



**Focus on health of petrol pump attendants and motorists**



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# Societal Impact



## Development of Biomass Chullha & its wide dissemination in rural areas

- Developed improved biomass stoves.
- Data on indoor air pollution by biomass *Chullhas* generated.
- Field trials & practical demonstration conducted at Champawat, Uttarakhand.
- For popularization of Chullhas, one day workshop attended at Champawat organized by UREDA.

Conventional <i>Chullha</i>		Improved <i>Chullha</i>	
Thermal Efficiency (%)	Total Suspended Particulates ( $\mu\text{g}/\text{m}^3$ )	Thermal Efficiency (%)	Total Suspended Particulates ( $\mu\text{g}/\text{m}^3$ )
15.12	1000	26	900



Improved Biomass *Chullha*



Improved *chullha* field trials



Popularization of *chullha*

Less fuel, reduced smoke, low cost



# Jigyasa Programme



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Council of Scientific and Industrial Research (CSIR) has joined hands with Kendriya Vidyalaya Sangathan (KVS) in form of Jigyasa, a student- scientist connect programme which was launched on 06 July 2017. The aim is to extend student's classroom education with that of a very well planned research laboratory based experimental learning.

## Jigyasa Activities

**Oil & Gas Conservation Awareness Week, "Saksham 2018"** The Oil & Gas Conservation Awareness Week, "Saksham 2018" was inaugurated on January 19, 2018. Main objective of awareness week is to bring awareness about Oil & Gas Conservation among students.

**Lecture by Scientist, IIP to Students of KV school:** A lecture on "Hydrocarbons: From Refinery to Day to Day Life" was delivered to students of KV school.

**Tarunotsav Program for XIth Students:** The "Tarunotsav" programme was organized on April 26, 2018 for students of XI<sup>th</sup> class

**Student Residential Program:** A three-day Summer Residential Programme in Science was organized at CSIR-I.I.P. for students of KV. during May 14-16, 2018

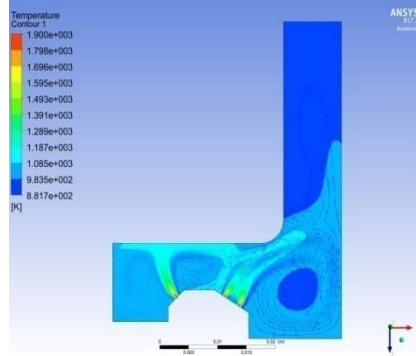
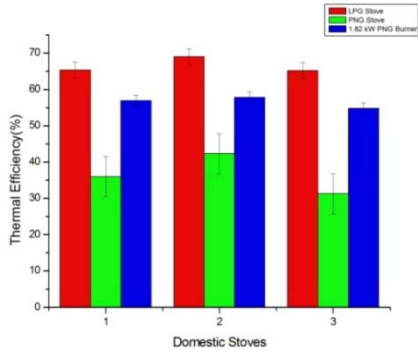




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# CSIR-IIP Road Map For New India Vision → Goals → For Future

(Sponsored by PCRA)



- Modifying LPG burner by increasing supply gas injector holes reduces the thermal efficiency of the burner
- Interchangeability between LPG and PNG is poor as “Flame Lift” phenomena is observed
- Changing supply pressure affects the flame characteristics in self aerated burners



PNG Burner

## Project Outcome:

- Improved PNG burners of four different output capacity designed
- Prototype PNG burners fabricated and experimentally evaluated
- Overall 15% improvement in thermal efficiency observed
- A standard facility for the evaluation of PNG burners established
- Evaluation procedure designed to help BIS to formulate Indian standard on PNG burners



PNG Burner Evaluation Facility



# INDIGENOUS REFORMING CATALYST



CSIR-Indian Institute of Petroleum has made efforts to make a remarkable break through in the development of indigenous Reforming catalysts. Extensive research carried out at IIP has resulted in successful design of a novel catalyst creating optimum acid sites and metal sites led to the development of a balanced Pt-Re/ $\text{Al}_2\text{O}_3$  catalyst called IPR-2001. The catalyst exhibits improved product quality in terms of  $\text{C}_5+$ , Octane, BTX and  $\text{H}_2$  yields along with improved catalyst life.



## Commercial Success : At CPCL and IPCL in 1990



## Feedback from User Industry (CPCL)

“  
*The performance of catalyst is quite satisfactory with good quality product especially with respect to reformate and  $\text{H}_2$  yields*  
*In fact the reformate RON was achievable at 5 °C temperature lower than what it was guaranteed*  
 ”

*The catalyst was in operation successfully for about 21 months of single*

**Recognition : CSIR-IIP Bagged CSIR Technology Award in 1992**