



Sustainable Pathway for Drop-in Biofuel



Expert Workshop

Potential of HTL routes for biofuel production

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Reliance at a Glance

- Fortune Global 500 company. Revenue \$ 90+Billion (2018-19)
 - Energy Value Chain, Consumer Centric (Retail, Digital)
- Refinery Complex: Largest in the world.
- 120 patents granted/164 patents filed (2018-19)
- 24 state-of-the-art labs. 900+ scientists and engineers in R&D and Tech
- R&D in refining, petrochemicals, catalysts, alternate energy, novel materials, bio-fuels, synthetic biology, nanotechnology
- *Breakthrough R&D using **Algae platform technology** – Sustainable source of biofuels, bio-chemicals and nutritional products.*
- **RCAT- HTL**, *spin-off technology* from algal research. A novel process that provides sustainable solution **for Waste valorization.**



Refinery



FCC



Coker



Hydro-processing

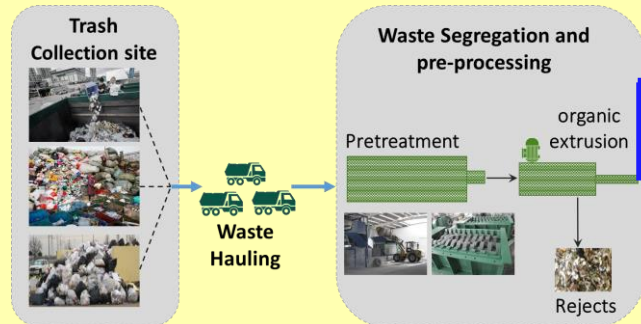


RCAT-HTL

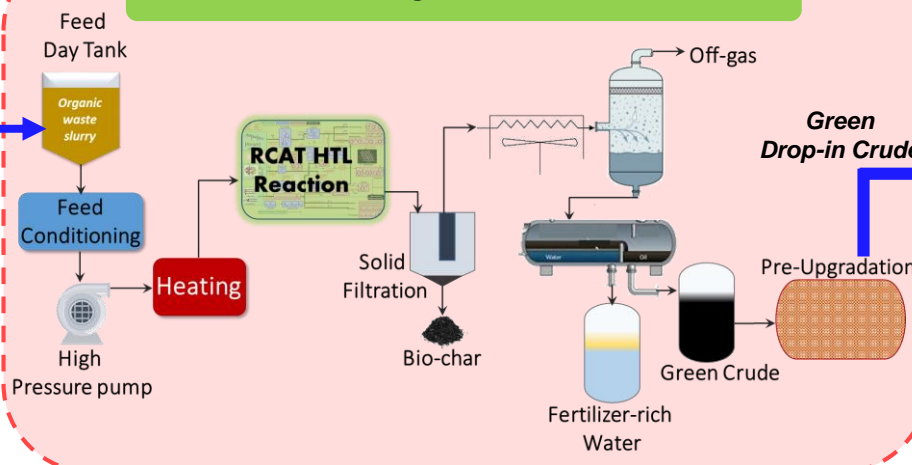
Refinery Pilot Plants

RCAT-HTL for energy-dense Drop-in biofuel

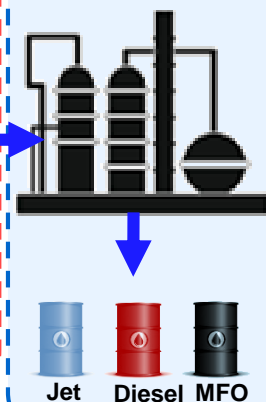
Waste collection and Processing



RCAT-HTL



Existing Refinery Infrastructure



Handles any organic waste **Feed Flexible Technology**

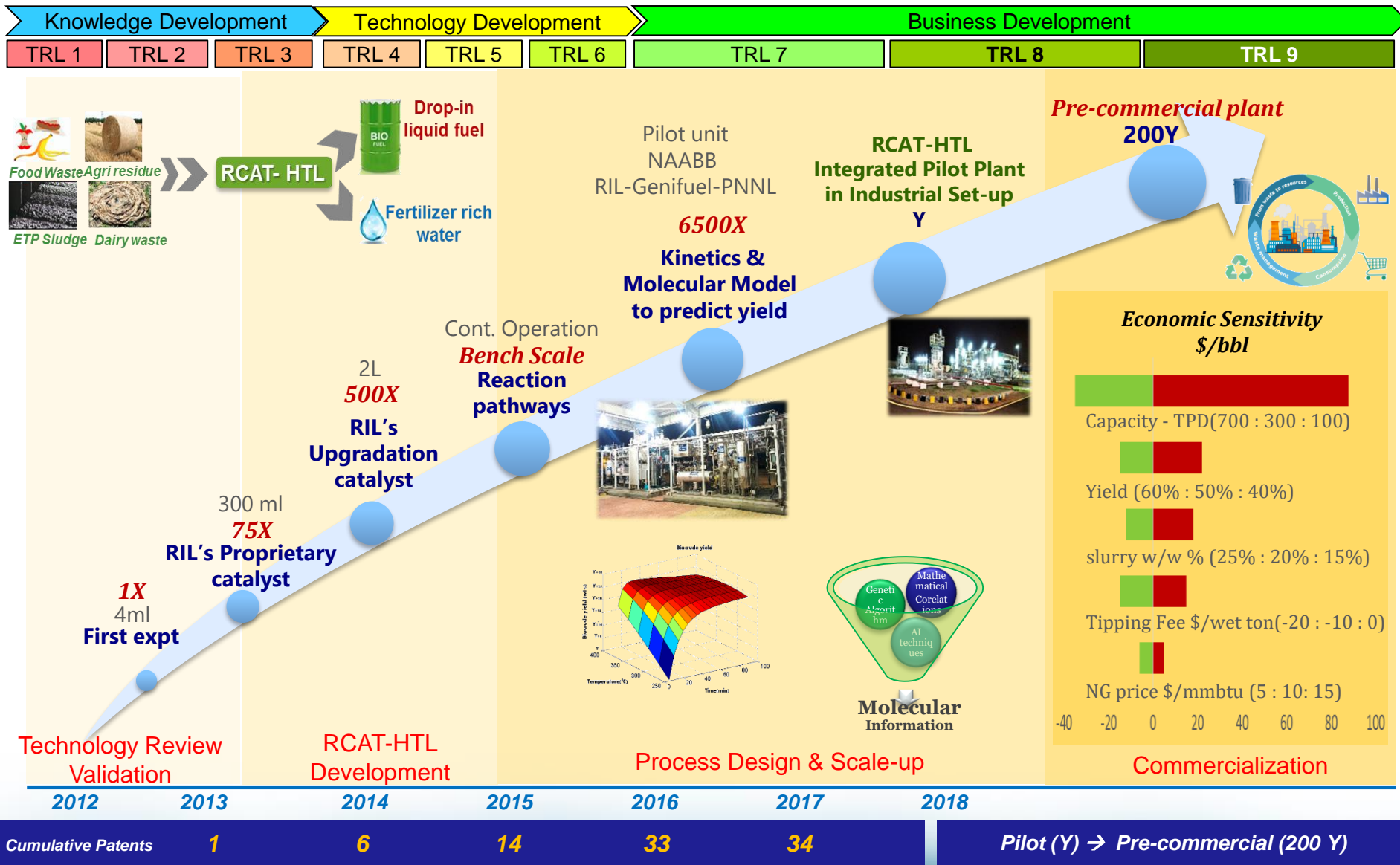
(Agro waste, MSW organics, food waste, food processing waste, manure, bio-solids, ETP sludge, industrial waste, mixed non-recyclable plastics, automobile waste tyres)

❑ **Energy efficient:** Uses water in waste as a reactant and recovers fertilizer-rich water. No need of drying wet waste

❑ **Drop-in renewable crude as product:** Can be processed in existing refining infrastructure. No change in engine technology

Replaces fossil crude and produces climate friendly transportation fuels

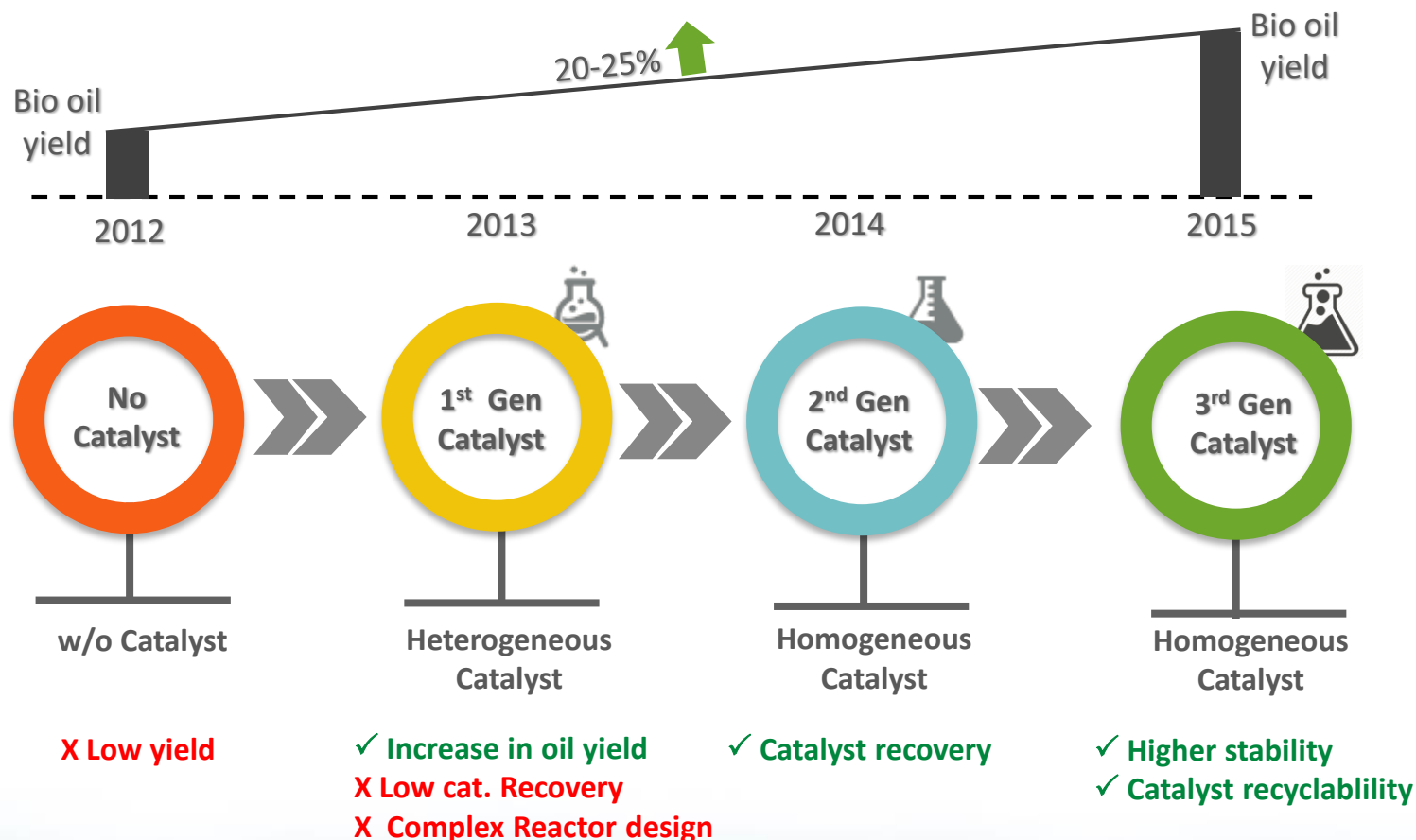
RCAT-HTL Development Journey at Reliance



Technology proven at large pilot scale. Next step : Commercialization by scaling from Y to 200Y for de-risking

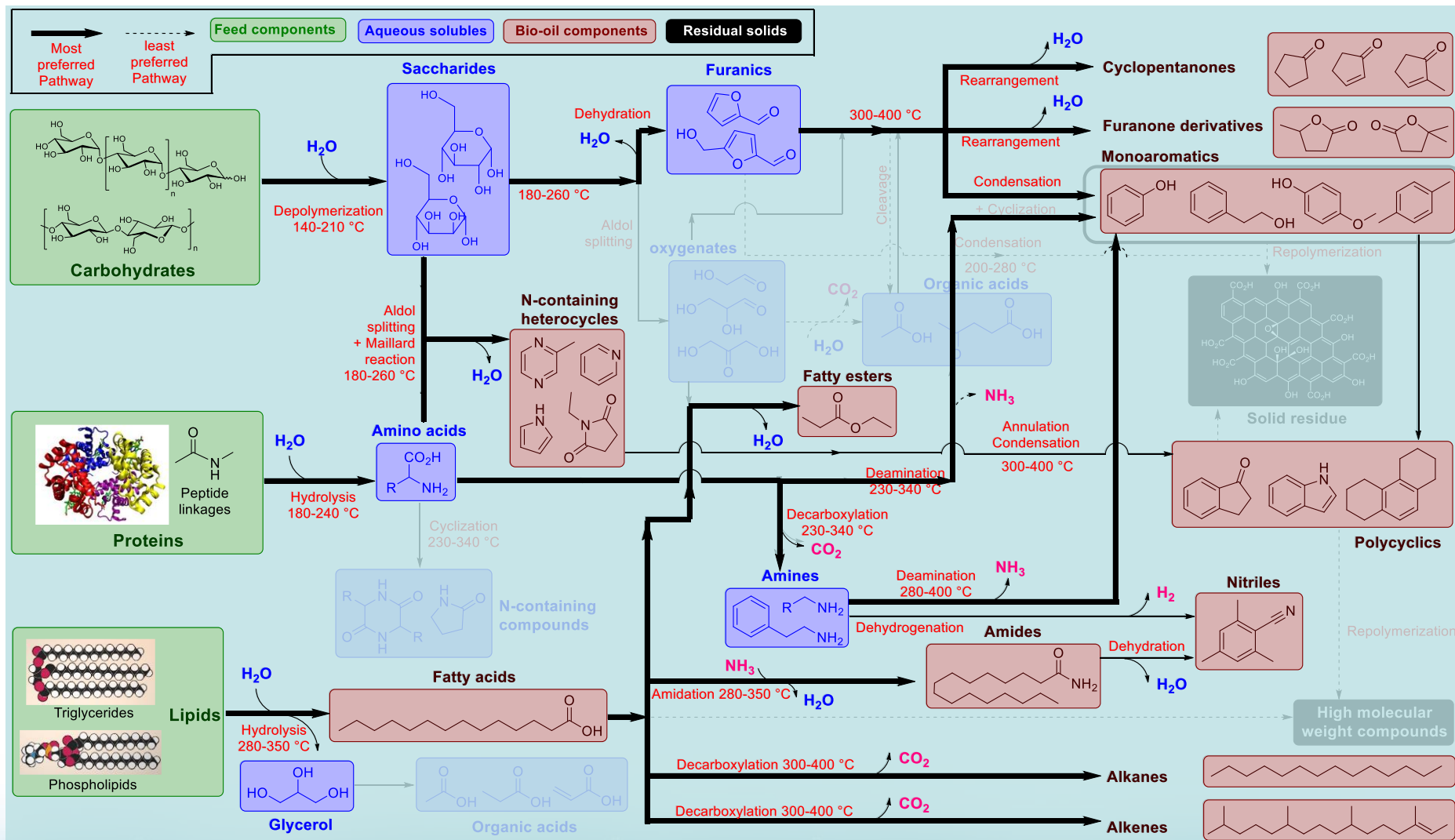
RCAT- HTL: Catalyst Development

Over 125+ Homo- & Heterogeneous catalysts evaluated



Current 3rd Gen Catalyst increased bio-oil yield by 20-25%

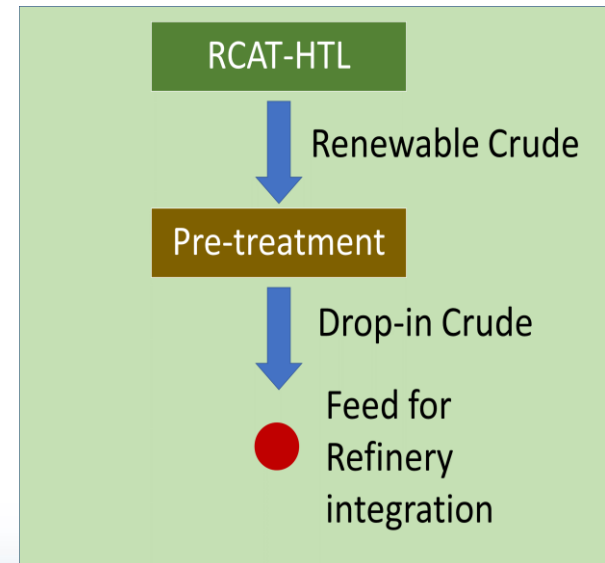
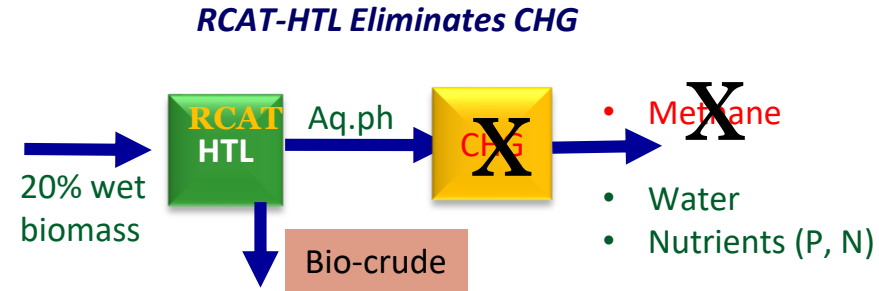
R-CAT HTL - Catalytically amplified pathways



Presence of catalyst activates Hydrolysis, Dehydration, and Millard Pathways for Bio-crude production

RCAT- HTL: Innovations

- Conventional HTL needs aq. phase treatment for reuse (e.g. CHG)
- RCAT-HTL maximizes C, H recovery to oil phase. Eliminated expensive CHG
- Aqueous phase usable as nutrient-rich water
- Molecular level understanding of HTL kinetics. Developed kinetics models to predict yield and compositions
- Technology ready for commercialization
- Drop-in bio-crude can be processed in existing refinery and engines



HTL reaction network is complex but can be tuned by operating conditions

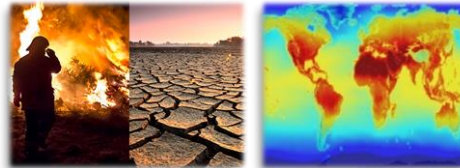
“Drop-in” renewable fuel for Sustainable Pathway



- Climate action
- Clean energy
- Sustainable cities

3 Most
Important
environmental
goals

Climate change effects



Clean/Renewable energy



Risk of Refining capacity under-utilization, with advent of EVs for road transport.

- Solar energy for **Aviation and Long haul transport** – **unlikely** due to energy storage constraints.
- **Liquid fuel** will continue to be used **for aviation**
- **“Drop-in”** liquid biofuel will help utilize refining and distribution infra-structure fully
- **Drop-in liquid fuel from Algae, Waste biomass**

Waste as valuable resource with right technology

- 2 bn tons solid waste (2016), **3.7 bn tons** (2050)!
World bank report 2018
- **>70%** of waste dumped, landfilled
- Improper waste treatment produces **Methane, 25x potent** GHG than CO2!
- **Waste has inbuilt Energy, Water and Nutrients**
All are lost, when waste is not treated

Renewable Liquid fuels – Promising solution for Climate Change and Sustainable Economy

Business Potential for Waste to Drop-in fuel

Global Scenario

Waste	million tons per annum
MSW	2000
Food Waste	1066
Agro Waste	820
STP Sludge	750

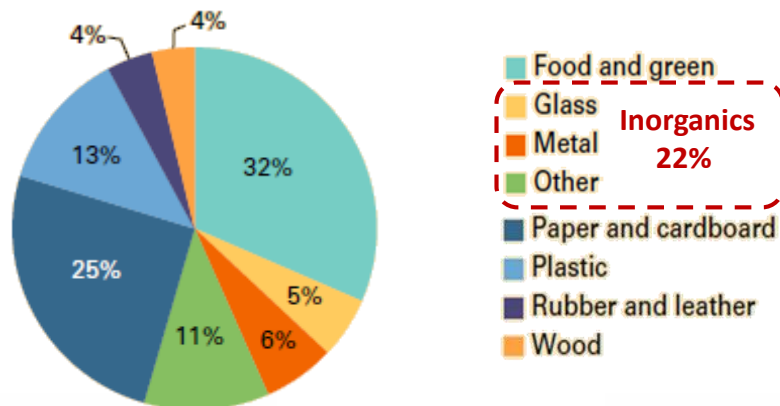


Indian Scenario

300-400* million bbl

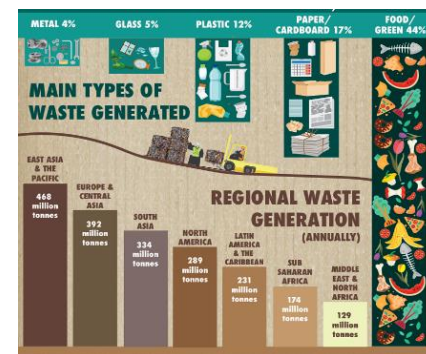
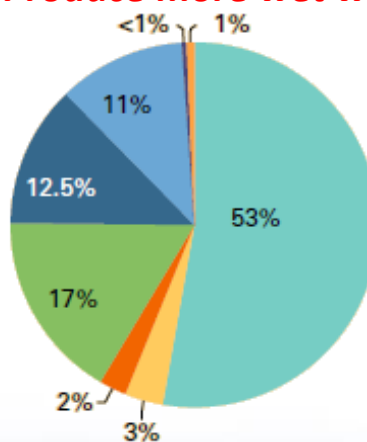
100 – 140 million bbl
More than India's ATF demand

High Income countries

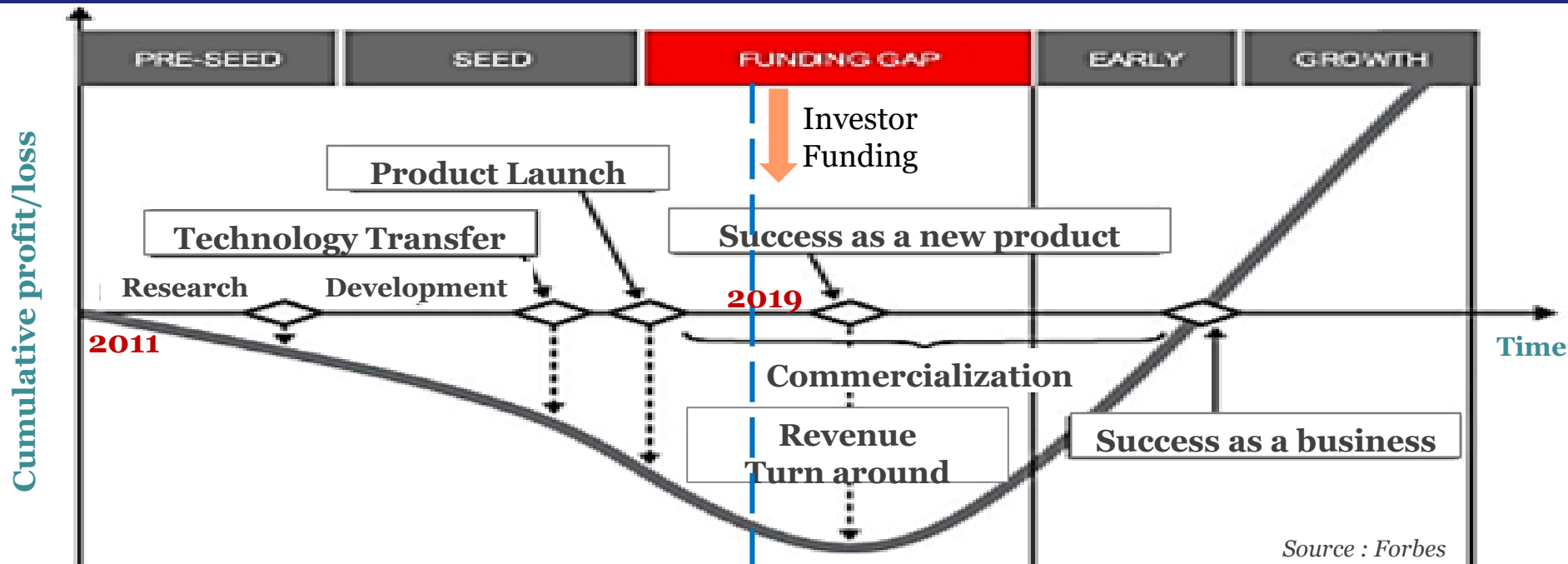


Lower middle Income countries

Produce more wet waste



RCAT-HTL Commercialization plan



Source : Forbes

Role of Reliance till date				Role of Reliance in RCAT-HTL Commercialization		
Plant Capacity	Lab Scale	Continuous Bench Scale	Largest of its kind Pilot plant	First Demo plant	First Commercial plant	n th Commercial plant
Design	Concept - to - Commissioning			End-to-End Technology support: Technology information package, Feasibility study, Process Design Package, Start-up and Commissioning Support		
Feed	Feeds tested : Algae, Food waste, Industrial sludge, Distillery effluent			MSW, Bio-sludge, Agro-waste, Animal Manure, Lignin residues		
Specialized Expertise	Kinetics & Molecular Modeling, Stochastic modeling and Techno-economic Analysis, Life cycle analysis (LCA)			Support in efficient operation of plants by providing in-house expertise, Continuous R&D to spearhead technology advancement in future		


Enormous business potential for RCAT-HTL

RCAT-HTL Summary

Successfully tested Algae, Food waste, ETP sludge. RCAT-HTL is more feed-flexible – can handle both dry as well as wet waste by co-processing or independently



- **35+ patents, concept to commissioning** experience and scale-up expertise. End-to-end solution to entrepreneurs
- **AI-based kinetic models** being developed in-house. Helps economic screening of business cases for different wastes
- **Variety of feeds being tested:** Lignin residue, Industrial sludge, Distillery spent, ETP sludge, agro waste, Used Cooking Oil
- **Due diligence and Head-to-head assessment** done with competing technologies
- **Drop-in green crude: Co-processing in existing refinery,** avoids extra capex for refining, transport and distribution
- Ready for scale-up and commercialization



Ensuring India's energy security
Operating the world's largest refinery

Thank You

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