

India

Neutral (no change)**Highlighted Companies****Adani Ports & Special Economic Zone****HOLD, TP Rs868, Rs806 close**

The company has a subsidiary which has been operating a CBG plant since 2019.

Thermax**ADD, TP Rs2880, Rs2915 close**

Thermax Bioenergy, a subsidiary, has been refining its understanding of biogas technology. There are strong synergies with its flue gas treatment business.

Summary Valuation Metrics

P/E (x)	Mar22-A	Mar23-A	Mar24-F
Adani Ports & Special Economic Zone	35.31	32.41	19.74
Thermax	105.16	72.84	52.46
P/BV (x)	Mar22-A	Mar23-A	Mar24-F
Adani Ports & Special Economic Zone	4.45	3.82	3.21
Thermax	9.4	8.49	7.53
Dividend Yield	Mar22-A	Mar23-A	Mar24-F
Adani Ports & Special Economic Zone	0.76%	0.76%	0.11%
Thermax	0.24%	0.31%	0.33%

Renewable Energy

Report on Renewable Energy Expo 2023

- We attended the Renewable Energy Expo 2023 held recently. Our focus areas were biogas plants, solar energy and batteries.
- Feedstock availability & competition are key areas of concern for biogas plants, as highlighted by Reliance Bioenergy, Adani Oiltanking & Thermax Bioenergy.
- Bifacial, half-cut solar panels have a 200bp higher efficiency and require 15% less land area.

Renewable Energy Expo 2023

Renewable Energy Expo 2023 (REI) was held in Greater Noida from 4-6 Oct 2023. The expo also included a one-day conference on biogas. The biogas exhibition and conference were a part of the Bioenergy Pavilion organized by Indian Biogas Association (IBA) and Ministry of New & Renewable Energy (MNRE). A sum of Rs27.55bn in investments has been pledged over the next three years at the Bioenergy Pavilion. We have focused on biogas plants, solar energy and batteries at the REI.

Biogas plants

Feedstock availability is a major area of concern even among large corporates like Reliance Industries or RIL, Thermax, and Adani Ports & SEZ. IGX (IEX's subsidiary) has been developing a product to enable the trading of the green attribute of compressed biogas or CBG. IGX is also looking at biomass trading.

Solar energy

While there haven't been a lot of advances in solar cell technology, their packaging into solar panels has advanced. Bifacial half-cut solar panels need 15% less land area to generate the same power output. Their efficiency is 200bp higher than conventional solar panels.

Batteries

Chemicals companies like Anupam Rasayan and GFL have been venturing into the battery chemicals space. Start-ups like Godi Energy have been developing their own sodium-ion battery chemistries.

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Biogas

Biogas plants

Evonik Industries' biogas purification technology >

Biogas has a large amount of carbon dioxide, hydrogen sulphide and water in it. This must be removed before it is compressed into CBG.

Figure 1: Biogas composition

Constituent	Formula	Concentration (v/v)	
Methane	CH ₄	40–75%	Combustible
Carbon dioxide	CO ₂	15–60%	Non-combustible
Moisture	H ₂ O	1–5%	Non-combustible
Nitrogen	N ₂	0–5%	Non-combustible
Hydrogen	H ₂	Traces	Combustible
Hydrogen sulfide	H ₂ S	0–5000 ppm	Combustible
Oxygen	O ₂	< 2%	Non-combustible
Trace gases	–	< 2%	
Ammonia		0–500 ppm	

SOURCE: RENEWABLE AND SUSTAINABLE ENERGY REVIEW, INCRED RESEARCH, COMPANY REPORTS

The above table shows the range of concentrations for the different constituent molecules in biogas.

As we can see, a considerable amount of gas must be removed from raw biogas to make it suitable for use in automobile engines.

Carbon dioxide removal is the most expensive part of refining biogas. The process of carbon dioxide removal in a CBG plant is the same as the carbon capture process used in large-scale industrial plants.

Pressure swing adsorption (PSA) is the most common method of biogas purification due to its cheap acquisition cost. However, this system requires a significant number of electronic controls. In case of electronics failure, there could be considerable downtime for the CBG plant. Also, a PSA system generally has a minimum 30% gas load requirement. Thus, a PSA system has high operation cost (due to the electricity required) and low load flexibility.

According to Evonik Industries, gas membrane system (used in offshore oil and gas production) is a better fit here. These systems can also have a very long life. In some cases, they can last up to 20 years.

Skepticism on long-term operability of CBG plants on the part of Lars Enviro >

Lars Enviro has been running biogas plants for 10-15 years. The company rightly pointed out that most CBG plants in India are less than three years old. So, CBG plants haven't even had their first major service/overhaul event. Thus, we don't yet know what the actual long-term cost of running a CBG plant is going to be like.

Equipment lease agreement >

Leasing equipment for a biogas plant would greatly reduce the cost of acquisition and bring the minimum economically viable scale down. This model is commonly used by the airline industry. Older, more established equipment producers are more amenable to this model than their newer counterparts.

Offtake agreements, Lols >

- RIL has been concerned about feedstock availability.
- GAIL pointed out that many CBG plant developers have been setting up large plants without considering how much offtake can be expected.

- Out of the 5,000-plant target, only around 2,300 Letters of Intent or Lols have been signed. Of these 2,300 Lols, less than 100 plants have been operationalized.
- There are considerable concerns around the difference in gas standards for CBG and CGD, leading to low amount of offtake agreements.
- Adani Oiltanking has a large operational plant at Namakkal in Tamil Nadu. This plant has been operational since 2019 and has generated 15% of the national CBG production since then.

Feedstock availability and pricing ➤

This was a key concern voiced by all the panelists at the conference. Mr. Bashir Shirazi of RIL Bioenergy raised the concern about feedstock availability. Mr. Atul Kharate of Adani Oiltanking suggested that CBG prices should be linked to the prices of feedstock.

There's a fear in the CBG industry that due to minimum support price or MSP and other uses of the feedstock, its prices will rise. The industry feels that command zones, like the ones used by the sugar industry, need to be developed.

An IBA representative recommended that the biogas project developer should have at least part-ownership of the upstream supply chain to help ensure feedstock availability and control over the prices of raw materials.

CBG trading ➤

Mr. Rajesh Kumar Mediratta, MD & CEO of IGX (a subsidiary of IEX), described CBG as a bundle of methane and green attribute. IGX is looking at making a CBG certificate just like a Renewable Energy Certificate (REC) for electricity. It will be in terms of mmBtu (unit of energy).

IGX is also considering creating a platform to trade biomass, the feedstock for CBG.

Thermax ➤

Thermax has been focusing on making CBG from straw. However, the company wants differential pricing for such CBG as it helps to clean up waste, which would otherwise have to be burnt. Central government assistance for paddy straw procurement is essential, given the low unavailability of paddy straw in some parts of the country which have fewer crop seasons.

The company also pointed out that as CBG is sold to city gas distribution or CGD companies in a compressed form, CGD companies save on compression cost. Thermax wants these savings to also be recognized and passed on, at least in part.

Investment pledges ➤

As a result of the Bioenergy Pavilion, the IBA received investment pledges worth Rs27.55bn. IBA has signed joint ventures (JVs), MoUs (memorandums of understanding) and received Lols (Letters of Intent) at the Renewable Energy India (REI) Expo. Mr. Gaurav Kumar Kedia, chairman of IBA, said these promises are expected to bear fruit in the next three years.

Solar

Bifacial solar panels ➤

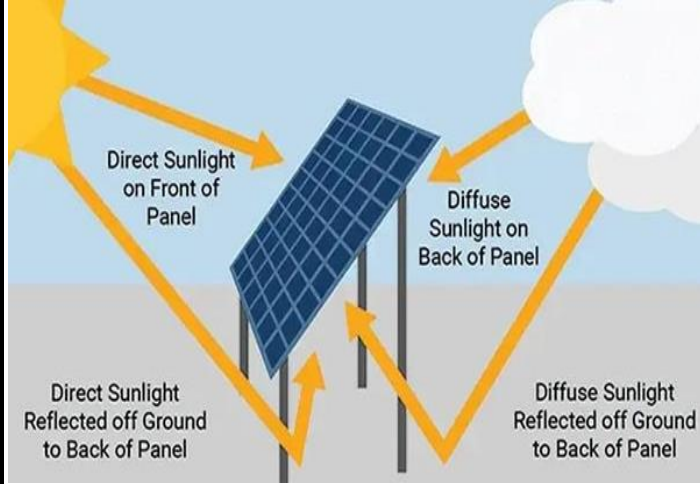
Bifacial solar panels lack a back sheet, like conventional panels, as they can absorb sunlight from both sides. So, they're installed at a higher slant, like 60 degrees vs. 30 degrees. This has the following benefits:

- They can catch more sunlight by being placed at a higher angle.
- They make optimal use of the sunlight tracking system.
- They easily manage 23% efficiency compared to 21% efficiency of monofacial panels.
- They can generate similar power output in 15% less land area.

Their drawbacks are:

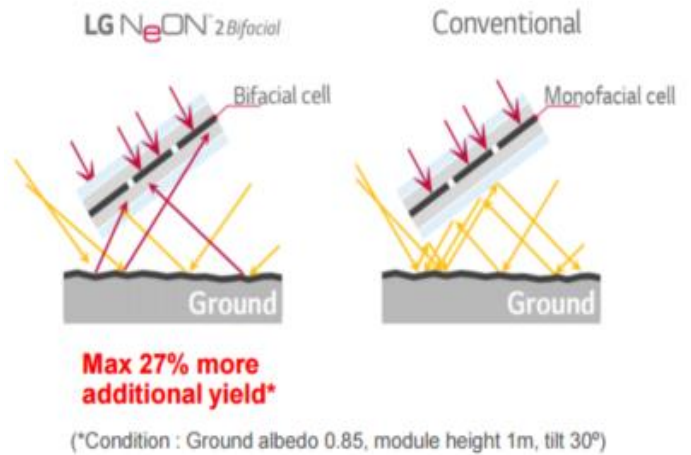
- Bifacial solar panels are slightly more expensive than conventional ones.
- They need a tracker to make the most use of them. The addition of a tracker increases maintenance costs.
- They are less suitable for use on sloping roofs.

Figure 2: Working of a bifacial solar panel



SOURCE: MBT-ENERGY.COM, INCRED RESEARCH, COMPANY REPORTS

Figure 3: Bifacial vs. monofacial solar panel

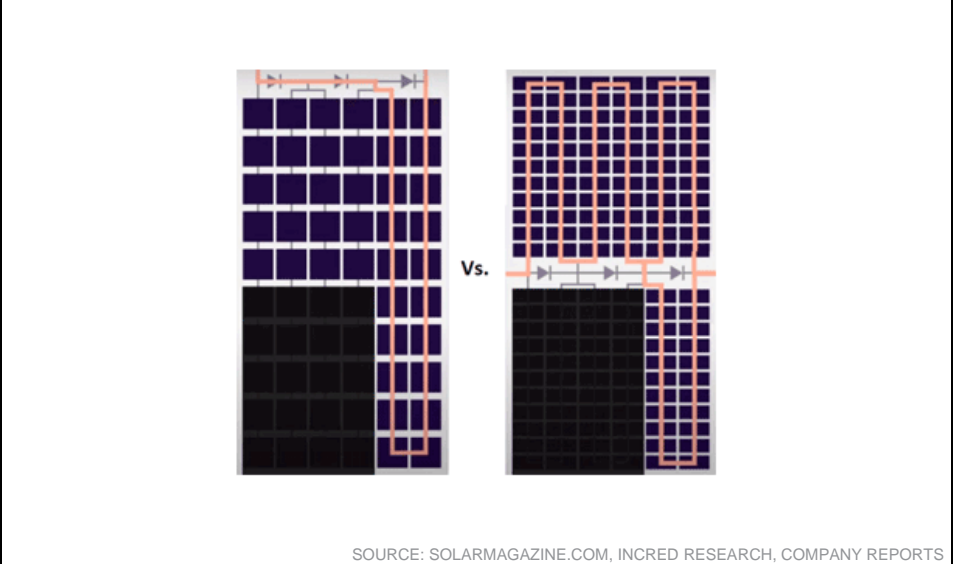


SOURCE: SOLARCHOICE.NET, INCRED RESEARCH, COMPANY REPORTS

Half-cut solar panels ➤

In the case of conventional solar panels, a partial shadow on the solar panel causes electricity generation to stop. This leads to a lower plant load factor (PLF) for conventional solar panels.

Figure 4: Working of a half-cut solar panel



SOURCE: SOLARMAGAZINE.COM, INCRED RESEARCH, COMPANY REPORTS

Half-cut solar panels allow for better power generation, as only half of the solar panel would be affected by the partial shadow. These panels operate at a similar voltage as conventional panels, but their current is lower. This leads to fewer electrical losses within the panel.

On the downside, they're more difficult to manufacture due to the greater number of components inside them. This requires their manufacturers to have more stringent quality control measures.

Visaka Industries' solar roof ➤

Generally, rooftop solar installations have a lot of space left between panels due to the structure of the installation frame & protrusions in the roof.

Visaka Industries, a roofing materials company, has created a solar roof which improves the packing efficiency of solar panels. Conventional rooftop solar installations require 100sqft of roof space for a 1KW power output. Visaka Industries' product manages 1KW power output from just 65sqft.

This product has a price of Rs40/watt whereas conventional solar panels cost up to Rs30/watt. The key benefit of this product, which offsets its higher price, is that it allows the terrace of a building to be turned into a usable floor without requiring permission from the municipal authorities.

The company has also been venturing into the two-wheeler EV space. It manufactures the battery pack by itself, but the cost of battery packs comes to US\$240/KWh. This price is higher than what is offered by the competitors.

Batteries

Battery chemicals >

Several speciality chemicals companies are venturing into the battery space.

GFL >

GFL has started developing its production of:

- NaPF6: This is the sodium-ion counterpart of LiPF6.
- LFP-CAM: This is the cathode active material in an LFP battery.
- PVDF: This serves as binder for the battery electrodes.

Anupam Rasayan >

Given its experience in fluoride chemistries, Anupam Rasayan has ventured into electronics chemicals (e.g., fluorinating agents for the semiconductor industry) and battery chemicals. In the battery space, the company is developing chemicals for both lithium-ion and sodium-ion batteries. Anupam Rasayan is making/developing the following:

- Fluorinated solvents
- Electrolytes
- Additives.

The additives stop a layer of chemicals from forming on the electrodes and thus increase the battery's life and efficiency.

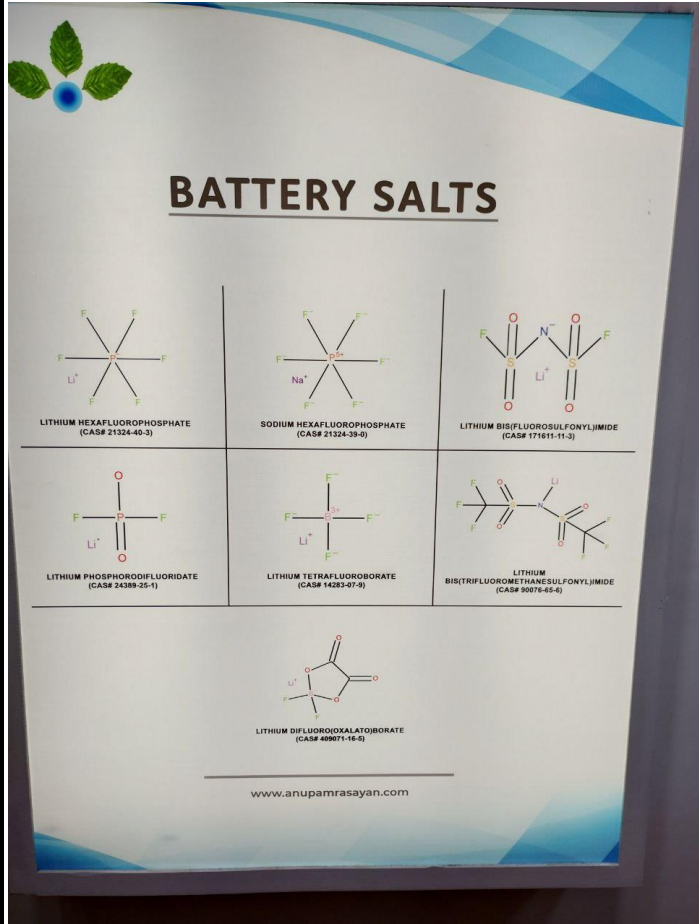
Fluoro-ethylene-carbonate is the key chemical being developed as a solvent. Due to its fluorinated nature, it is expected to act as a fire retardant, thus increasing the safety of the battery.

The list of additives includes:

- LiFSI: Lithium bis(fluorosulfonyl)imide
- LiTFSI: Lithium bis(trifluoromethanesulfonyl)imide
- LiDFOB: Lithium difluoro oxalate borate.

NaPF6 (sodium hexafluorophosphate) is the sodium counterpart of LiPF6 and would be used in sodium-ion batteries.

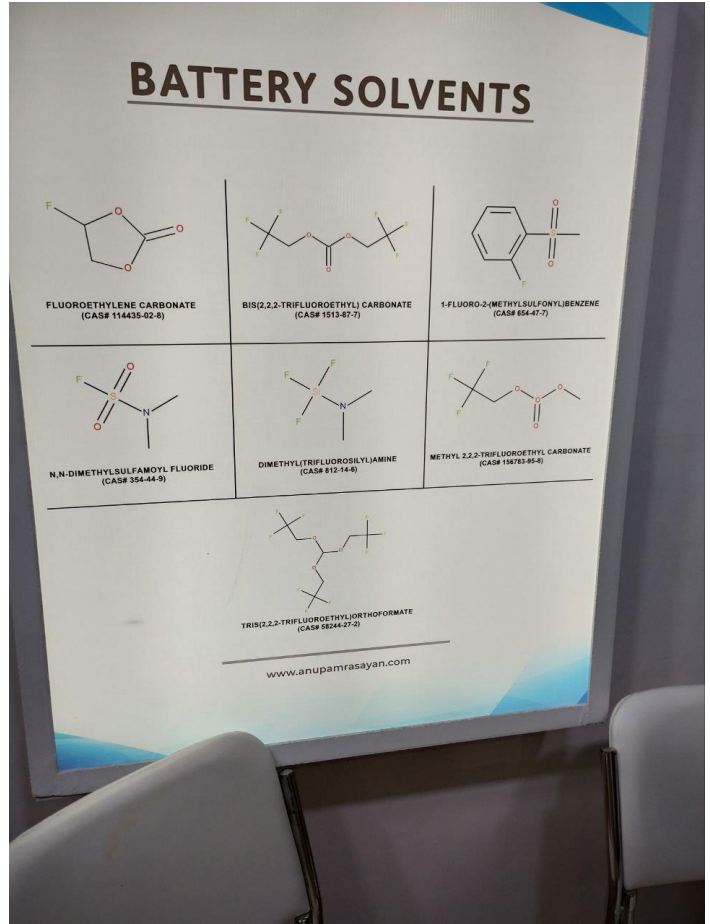
Figure 5: Anupam Rasayan's battery salts



Battery salts under development

SOURCE: REI EXPO 2023, ANUPAM RASAYAN, INCRED RESEARCH, COMPANY REPORTS

Figure 6: Anupam Rasayan's battery solvents



Battery solvents under development

SOURCE: REI EXPO 2023, ANUPAM RASAYAN, INCRED RESEARCH, COMPANY REPORTS

The above images are from Anupam Rasayan's stall at the REI Expo 2023. Currently, Anupam Rasayan has received clearances to supply its products to certain battery manufacturers in the EU, US and Japan. The company is in the process of obtaining clearance to supply its products to certain clients in South Korea as well.

Battery chemistries ➤

Godi Energy has a battery manufacturing facility in Hyderabad. The company currently sells both LFP and NMC battery packs. It is developing its own sodium-ion battery chemistries too.

For sodium-ion batteries, the company is working on a NASICON cathode, which will allow for 1-pot synthesis. The materials involved here aren't sensitive to moisture. This is a key concern we had pointed out in our earlier report: [Status update on sodium-ion batteries](#).

Godi Energy is also working on a hard carbon anode, which is the most researched anode for these batteries. These batteries are expected to be 20-25% cheaper than lithium-ion ones. At gigascale production, a further reduction of 10-15% in cost is likely.

Investment Ideas

Plant operators and EPC providers ➤

- Adani Ports & SEZ: Subsidiary Adani Oiltanking has been operating a CBG plant since 2019.
- Thermax: Subsidiary Thermax Bioenergy has been operating CBG plants and is improving its understanding of biogas technology. There are some synergies

between its flue gas treatment business and the biogas business. This company would be the preferred EPC provider.

Pump manufacturers ▶

- Roto Pumps: This company manufactures agricultural pumps and other pumps which can be used to pump slurry and digestate in a biogas plant.

Gas logistics companies ▶

- Everest Kanto Cylinders: This company manufactures compressed natural gas or CNG cylinders. These cylinders can be used to store CBG too.
- Likitha Infrastructure: This company builds cross-country gas pipelines and CGD stations. It is an indirect beneficiary of CBG popularization.

Indirect agri plays ▶

- Escorts Kubota: The company will benefit from rising agricultural incomes.

Exchanges/platforms ▶

- IEX: Subsidiary IGX is looking at enabling trading of CBG and biomass.

Automobile companies ▶

- Bajaj Auto: This company manufactures CNG three-wheelers. These can easily run on CBG too.
- Maruti Suzuki: The company unveiled a CBG vehicle at the recent Auto Expo and has a 1tpd CBG plant.

Solar energy component makers▶

- Borosil Renewables: This company is the best bet in this space. Bifacial solar panels require more glass, and this will increase the demand for the company's products.

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