DASTUR ENERGY

Inflexion-DE

Dastur Energy quarterly publication on Energy Transition

From the **CEOs Desk**

Welcome to Inflexion-DE. It is my pleasure to introduce this inaugural issue of a quarterly newsletter from Dastur Energy, designed to provide you with a holistic overview of the challenges, strategies, and solutions for industrial decarbonization and clean energy transition.

Our goal, through this newsletter, is to share insights and analyses that you, as an enterprise leader, policymaker, or an invested stakeholder, can use to make informed clean energy transition decisions.

The field is continually evolving and as strategies, pathways and technologies continue to emerge and evolve, we will attempt to bring you some of the interesting and relevant insights.

We encourage your feedback and input. It will help us ensure that we include areas of interest and relevance through this ongoing communication platform.

Atanu Mukherjee
CEO Dastur Energy

The Gigaton **Challenge**

It has been correctly said that we may be the first generation to see some of the most drastic effects of climate change, but the last one that can take timely action on it.

As we confront the climate crisis, it is important to pause, rise above the panic and realize that all is not lost, as many would want to believe. While our dependence on fossil fuels for energy (be it wood, coal, oil or natural gas) must be addressed urgently, we should also consider the fact that we have an unprecedented opportunity. After centuries of near complete fossil fuel dominance, we may be on the brink of a developing new energy system, a transformation no less momentous than the end of WWII, or the emergence of new nations.

That's not to say that fossil fuels can be wished away and replaced overnight with clean new energy systems. Rather, we must aim to make the transition to a clean energy system without risking significant societal and economic upheaval. For that, we need to take a pragmatic view of both the challenges and the solutions that can be achieved.

It's worth remembering, that starting with the use of fire and wood, to the contribution of coal in the industrial revolution and the discovery of vast oil reserves and natural gas in the 20th century, we have been able to survive and flourish by harnessing these resources for our energy needs. Cheap and widely available energy from fossil fuels and the advent of electricity brought about unprecedented developments in our lives, societies, and economies in the last two centuries. It enabled massive scale production, transportation, and consumption, ushered in globalization, and brought us to our current global GDP of more than 100 trillion dollars -- the world as we know it. All this came at a price of course, the climate crisis.

A Challenge of **Scale**

Today, nearly every CEO and industry leader is seeking a way to tackle this unprecedented challenge -- not just to survive but transform their enterprise for the future. Unfortunately, presented with a rapidly growing array of technological innovations and potential solutions, it is easy to get confused when attempting to choose an efficient and sustainable pathway for clean energy transition.

The enormity and the scale of technological innovation and associated deployment required is certainly daunting. 10 gigatons of CO_2 need to be removed every year from the atmosphere by 2050, to achieve our goal of Net Zero. For this, McKinsey has estimated that an investment of USD 275 trillion would be needed over the next 27 - 30 years – approximately 10 % of global GDP per year. That's about 10 trillion dollars of investment every year over the next three decades. Not just scale, we need accelerated deployment across multiple fronts to address this gigaton challenge.

Further, Net Zero – the catchall term for our collective target of decarbonization, seems to be a slippery slope when it comes to stated policy targets. Already, we are in danger of missing a crucial milestone – to contain the global temperature rise to within 1. 5 degrees - the climate safety threshold. This, along with wars and other global emergencies, that constantly demand resources and exigent action, threaten to push the Net Zero horizon further. To arrest this, we must act soon, looking at both challenges and solutions through a holistic and pragmatic approach, and scale up solutions accordingly.

Can Renewables **lead us out?**

Right now, renewables seem to be the silver bullet that everyone's pinning their hopes on. But can they do the job? While renewable energy sources can eventually substitute fossil fuel-based energy to a large degree, there are two large problems associated with them.

First, close to 60% of the global emissions in the world are due to industrial processes (21%), transportation fuels (14%), agriculture, land use & forestry (24%). Currently, we do not have CO_2 free chemical transformation mechanisms (to be deployed at scale in each context) to produce steel, ammonia (required in industry and agriculture), petrochemicals and cement – core industries that power our economies. Neither do we have substitutes for carbon emitting aviation or marine transportation fuels that enable our global commerce. Further, despite the growth in EVs, we have yet to develop the high energy density battery technology that can provide enough capacity to economically transition our global stock of 1.5 billion internal combustion engines to EVs.

Second, our renewable electric supply system needs to be built up to match industry and transportation needs. Currently, renewables can only partially supplement our existing energy supply system. The electricity storage infrastructure simply does not exist. Which is also why research in new battery technologies is needed, to create utility scale storage that can transition us to an affordable and reliable all renewable electric supply system in the future. Further, with renewables like solar and wind, there is also the problem of reliability, and geographical limitations for installation and deployment, while clean energy options like hydroelectric and nuclear bring their own attendant issues, including serious environmental and societal concerns. Thus, a phased switch to renewables seems to be our most viable option.

Carbon Management and Renewable Hydrogen – **Complex Solutions**

In all the urgency and panic, most of us seem to be missing a key point: It is not fossil fuels – coal or oil, per se, that is the real problem, rather the carbon emissions, that have led to the climate crisis. Therefore, solutions must be considered through the lens of carbon management, whether it is our energy system, our industrial processes, our transportation, or our consumption of products and services.

Getting back to industrial decarbonization, particularly in the hard to abate sectors like steel, cement, ammonia and petrochemicals, carbon capture can provide an important and viable transition. In fact, carbon management is essential to industrial carbon management. However, here too, the economics of transition pose a problem, due to high operating energy and capital costs.

Scalable carbon capture will require low-cost solvents that can capture CO_2 at gigaton scale at less than $15-20/ton, which is still a few years, if not decades away. However, it is important to understand that the challenge and solution is not just limited to carbon capture. There is a need to develop appropriate pathways for carbon sequestration and EOR and other applications.
Conversion of captured carbon into value added chemical products is an option, but insufficient to address the scale of the problem. Just a small portion of captured carbon is sufficient to meet industrial demand. Large scale conversion of captured CO_2 will require significant research and understanding of CO_2 reduction, electrocatalysts and other processes for the 'CO_2-to-product' approach to be economically viable and scalable.

Sequestration offers a more scalable option, but for this to happen, a massive undertaking of geological characterization of pore space for CO_2 storage is required, across the globe. A few countries like the USA have begun to make some headway in geological mapping and in creating a carbon distribution and transportation infrastructure, and we are perhaps seeing the start of a carbon grid. This could be a compelling proposition, provided we can reconceptualize carbon from being a burden to economies and societies, to a valuable, tradable commodity, building out a carbon market beyond taxes and credits.

Hydrogen is another popular proposition, which has been growing in public imagination and in policy focus, as an alternative fuel and reducing agent for industrial processes. Cheap green or blue hydrogen in large volumes can potentially become a substitute reducing agent for steel production and to produce captured CO_2 based fuels and petrochemicals. But for this to be practical, a sufficient renewable base load for electricity supply needs to be available at less than 4c/kwh. This is far from current cost structures. Our production of hydrogen through electrolysis, or green hydrogen, is at $4-5/kg. This needs to come down to below $1/kg at millions-of-ton scale, to be deployed effectively. Bottomline, we need research, innovation and deployment in a myriad of technologies that can lead to higher efficiencies of hydrogen production. We need to create a hydrogen ecosystem for it to become an economically viable option.

No silver bullet, but **a silver lining**

Considering all these challenges, if one were to look at addressing carbon dioxide emissions at a site level, the only approach today is to seek out a local site level optimal solution. This would ideally combine carbon capture, sequestration, conversion and the use of the hydrogen produced from the carbon capture process, to minimize overall energy impact. Additionally, these solutions need to be designed to maximize leverage from governmental policy incentives such as carbon capture and hydrogen production tax credits to be financially feasible.

So, the fact remains, there is no silver bullet to fix this crisis. The only way out is to have a portfolio approach -- of energy efficiency, renewables, CO_2 based fuels and products, energy storage and batteries, green hydrogen, blue hydrogen and ammonia from gas and coal through efficient carbon management, and other alternative fuels. Only new carbon paradigm thinking can help us turn this gigaton challenge into a gigaton opportunity.

Time is of the essence. Speed and scale of transformation are the keys to success. This can only happen through a community of dedicated technologists, industry captains, investors, and sensitized policymakers, who are able and willing to grasp the criticality of agile and exigent decision making. We need forward thinkers who can balance ROI concerns against the larger consequences of delayed action and understand the need to look for the silver lining. Rather than drown in a deluge of grim prognostications; this is probably one of the greatest chances we have at evolving and transforming not only the way we use energy, but our economies, our societies, our future.

About **Dastur Energy**

Dastur Energy Inc., is an Austin, Texas, based energy technology company that specializes in the conceptualization, design, and development of clean energy transition and carbon management solutions, for the power, industrial and government sectors.

The company's expertise lies in market analysis, technology options analysis, policy design, concept & feasibility studies, techno-economic analysis, integrated process design & engineering, technology licensing, and project management related to clean energy transition. Combined with its 65+ years of experience working with the heavy process industries, uniquely positions it to deliver pragmatic, competitive and commercially feasible energy solutions tailored for maximum business impact.

Dastur Energy's expertise and commitment to sustainable energy solutions has won the company several projects in design, engineering, techno-economic assessments, and technology & policy roadmap development from global enterprises, as well as respected funding agencies like the US Department of Energy, the US Trade and Development Agency, the Government of India, and the G20 Presidency.

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