Executive Summary

Odisha is situated in the eastern part of India, with a geographical area of 1,55,707 square km, and population of 4.2 crore. Per capita net state domestic product (at constant prices with 2011-12 base) in Odisha is Rs. 79,607 in 2021-22, which is lower than the national average (Rs. 91,481).

Though Odisha has the share of 3.47% population in India, net GHG emission from Odisha was 9.3 per cent of the country in 2018. In per capita terms, net emission from Odisha (6.15 tCO_2e per capita) is higher than that of the national average (2.24 tCO_2e per capita). The GHG Platform India 2022 report for Odisha suggests that overall emission in Odisha increased at a compound annual growth rate (CAGR) of 7.85 per cent, from 102.73 Mt CO_2e in 2005 to 274.54 Mt CO_2e in 2018. Clearly, lowering carbon footprint is essential for Odisha's development strategy.

Understanding feasible policy choices and their financial implications are a must for adopting the correct policy interventions for the transition towards a low carbon pathway. This study is a small endeavour in this direction. It differs from similar studies by incorporating price in energy modelling framework. We believe that price plays a crucial role in determining choices of the feasible technologies depending on the supply/demand situation. Only by understanding the combined forces of behavioural realities, markets and prices, and technological innovation and infrastructure together, coherent responses can be built to facilitate transition of energy systems. Further, as Odisha is a small state, its economy is impacted by macro-economic environment of the rest of India and the world. So, policies need to be developed by considering the economic framework that take these factors into account.

In this context, we have used in our analysis an integrated assessment modelling (IAM) framework that links a macro model with a bottom-up energy model. Sectoral outputs and prices are endogenously determined within the system in this model unlike usual bottom–up energy models. Many developed countries had adopted modelling tools of this kind to analyse energy transition issues. However, in India, this tool, to the best of our knowledge, has not been adopted, and that too, at a subnational level. It is also important to note that while analysing Odisha's policy dilemmas, we have the assumption that the rest of the Indian states are also moving towards energy transition, because studying Odisha's economy in isolation would not be sufficient to derive the macro-economic consequences of a policy intervention.

The integrated modelling approach involves soft linking of the macroeconomic top-down CGE model and bottom-up (MESSAGEix) energy model. The top-down macroeconomic CGE model used for integration is a multi-sectoral, multi-regional (Odisha, Rest of India and Rest of World) variant of the GTAP power model with a disaggregated power sector.

The CGE model produces forecasts of sectoral output and prices for the business-as-usual and two policy scenarios. These CGE results, further, are used as an input as exogenous input demand projection into the MESSAGEix model, which is an energy optimisation model. The projected demands are derived such a way so that those are met by supplies subjected to least cost optimisations along with environmental, resource, and capacity constraints along with other policy constraints. The model provides technology-based decisions in each of its sectors in terms of cutting down of emissions and the cost of implementing those pathways in a given period. The integrated model is a recursively dynamic model with multiple periods to simulate changes as per policy targets for the short, medium and long term for the low carbon pathway of the Government of India.

Our business-as-usual (BAU) scenario assumes that Odisha's economy will hover around 6 per cent per annum growth over the model run period, namely, 2022–2050. Per capita emissions will rise from 6.69 tons CO_2e in 2030 to 31.41 tons CO_2e in 2050. According to our estimates, US$ 467 billion investment will be required in the base run in the energy sector during the period 2025-2050. This amounts to 7.3 per cent of cumulative SDP for the period 2025-50.

The key message that is brought out by our simulation is that energy transition towards renewable energy will not take place without complementary support polices towards this sector. The government needs to play a key role in effecting the change. A market-based approach with taxes/subsidies performs better in facilitating the growth of renewable electricity in Odisha. It is also pragmatic to augment the capacity of renewable capacity as far as possible. Since Odisha has high coal deposits and the presence of other minerals, the dependence on fossil fuel, despite projected reduction to a certain extent during the study period, will continue to be high in the energy/ fuel mix. The role of carbon capture and storage is a technology that Odisha needs to invest in. The investment in green hydrogen can also be explored since the State is endowed with large number of mines geographically located within the State facilitating the growth energy-intensive industries in the state.

Our observation is that increased energy efficiency along with productivity growth is essential for energy transition, since higher energy efficiency leads to energy saving and lower emission. An energy efficiency to the tune of 1.5 per cent concomitant with productivity growth of 1 per cent per annum leads to positive growth in majority of the sectors in the State. This also leads to a lower increase in per capita emissions. With these policy interventions, the per capita emission will rise to only 11.81 ton CO_2e in 2050 versus 31.41 ton CO_2e in 2050 in the base run. With increased energy efficiency, the need for funds for investment for energy transition also falls by nearly 1 per cent of cumulative SDP for the period 2025-50.

Our results show that direct employment from operation and maintenance of power plants would be affected by the shift towards green energy in 2050, since the coal mining and coal electricity sectors are still major providers of employment in the state. A major part of output from these sectors is also exported. With green transition, direct employment is these sectors would reduce, and employment in the renewable energy sector would increase, but as a result, the net effect on direct employment generated from operation and maintenance of power plants would still be less in the policy scenario 2 vis-à-vis base run in 2050, amounting to a 83,000 less direct employment in the energy sector by the year 2050. However, this would not have that negative effect on total employment. Through the interlinkage of renewable energy with other sectors of the economy, the economy as a whole is not facing employment shrinkage as a result of the transition to green energy. Total employment from operation and maintenance of power plants, which captures the direct, indirect and induced employment generated from all sectors including the energy sector, is expected to provide 8.6 million more employment under Policy scenario 2 in 2050 compared to the baseline scenario. Manufacturing and installation of new renewable power plants would also generate some more employment.