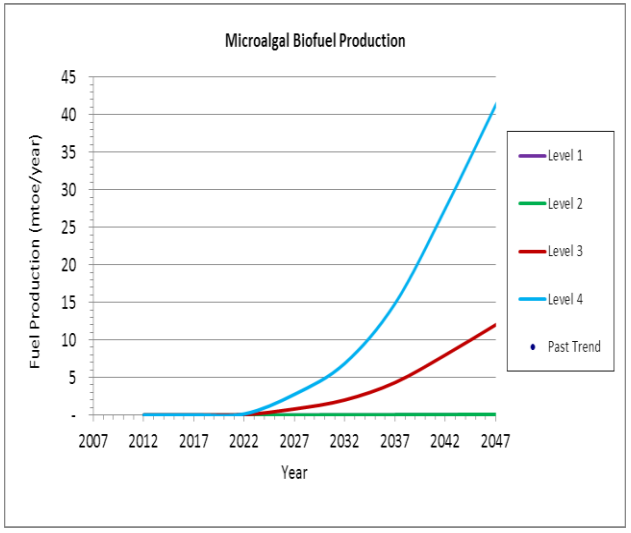
BIOENERGY: ADVANCED BIOFUELS

Advanced biofuels (beyond first and second generation) have been considered as they present a large scope for use as transportation fuel. Microalgal biofuels and macroalgal (seaweed) fuels (offshore) have been considered under this scenario. They qualify theoretically by resource assessment to cater to the magnitude of India's transportation fuel needs. These are still in the R&D stage and are considered to be in a relatively earlier stage of development compared to lignocellulosic biofuels. Sea water has been considered to be the appropriate water source. One technology (microalgae) has been considered to illustrate the extensive production, while the other (macroalgae) has been projected for representative purpose with lower numbers. The numbers may be used interchangeably depending on whichever technology (or combination thereof) matures better. This analysis captures future scenarios of this emerging technology.



LEVEL 1

The microalgal technology sees barely any development with commercial production reaching only 5,000 tons/year by 2047. An area productivity of 25 g/m2/day and lipid content of 18% has been considered. The cultivation land area extends to a mere 500 ha by 2047. Offshore macroalgae also sees only negligible development with fuel production reaching just 2,000 tons/year by 2047.

LEVEL 2

The microalgal fuel development is still slow with commercial production starting at a lowly 1,000 tons/year by 2027. An area productivity of 35 g/m^2/day has been considered. Lipid content is taken to be 23%. The cultivation land area extends to 5,000 ha by 2047. This relates to microalgal biofuel production of 0.09 mtoe/year by 2047. Offshore macroalgae is modeled to reach a productivity of 35 g/m^2/day by 2047 and result in a modest 0.05 mtoe/year liquid fuel production by 2047.

LEVEL 3

The microalgal fuel development is assumed to be promising with commercial production starting from 2022 at 40,000 tons/year. An area productivity of 55 g/m^2/day has been considered and Lipid content envisaged at 28%. Microalgae cultivation extends to a land area of 0.35 Mha (2047). This relates to microalgal biofuel production of 12 mtoe/year by 2047. Offshore macroalgae also picks up with commercial production starting from 2022. 55 g/m^2/day productivity has been considered with energy yield of fuel conversion process increase to 52% by 2047 from the present 20% as in lignocellulosic liquid fuels. Liquid fuel production from macroalgae reaches 0.7 mtoe/year by 2047.

LEVEL 4

In Level 4, a highly optimistic scenario is assumed, wherein microalgal fuel is envisioned to become commercially viable starting from 2020. Areal productivity is considered to be 75 g/m^2/day with lipid content of 38%. Microalgae cultivation extends to an area of 0.65 Mha by 2047 and biofuel production progresses appreciably to 41.3 mtoe/year by 2047. Offshore macroalgae becomes commercially viable by 2022. An area productivity of 75 g/m^2/day has been considered. The energy yield of fuel conversion process is projected to increase to 60% by 2047. This relates to a macroalgal fuel production of 2.2 mtoe/year by 2047.