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# High power laser hybrid welding – challenges and perspectives

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**Abstract**

High power industrial lasers at power levels up to 100 kW is now available on the market. Therefore, welding of thicker materials has become of interest for the heavy metal industry e.g. shipyards and wind mill producers. Further, the power plant industry, producers of steel pipes, heavy machinery and steel producers are following this new technology with great interest.
At Lindø Welding Technology (LWT), which is a subsidiary to FORCE Technology, a 32-kwatt disc laser is installed. At this laser facility, welding procedures related to thick section steel applications are developed. Material thicknesses between 40 and 100 mm are currently of interest. This paper describes some of the challenges that are related to the development of the high power hybrid laser welding process as well as to the perspectives for the technology as a production tool for the heavy metal industry.


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*Keywords:* Laser hybrid welding; welding thick materials

## 1. Introduction

This paper describes some of the preliminary work and first experiences within laser hybrid welding carried out at Lindø Welding Technology (LWT) in Denmark based on a 32-kW disc laser installation.

For more than a decade high power laser hybrid welding has been widely utilized within the European shipbuilding industry and has become a kind of state of the art joining technology in this field. The European Ship Classification Societies issued their first unified guidelines for the approval of $CO_2$ laser welding in 1996 and the 2005 edition now contains reference to hybrid welding (Lloyds, 2005).

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Due to the ongoing technical development and the increasing power levels available on the market for industrial lasers, other heavy section steel industries are now looking for new opportunities for joining heavy metal components as an alternative to traditional welding processes.

Especially, within production of offshore windmills the industry are looking for more cost efficient joining technologies. Welding is normally carried out manually or semi-automatic, typically GMAW or submerged arc welding. Offshore windmill steel foundations include a considerably large amount of manually GMAW welded joints which constitutes for a considerably amount of the costs. The costs of an offshore windmill foundation constitutes about 30% of the entire windmill installation. It is the aim before 2020 for this industry to reduce the overall production cost by 40% in order to maintain competitiveness with competitors outside Europe. The aimed reduction of manufacturing costs will be related to the development of more efficient joining technologies as well as optimizing designs.

Now three government supported development projects in Denmark are dealing with high power laser hybrid welding within the frame of above-mentioned topic. The projects are;

- Fabrication and surveillance of green offshore structures (2013-2015)
- Cost effective mass production of Universal foundations for large offshore wind parks (2014-2016)
- Offshore wind foundation on an industrial scale (2015-2016)

The 'Green offshore' project involves laser hybrid welding related to the production of windmill towers. The 'Universal foundation' project is focusing on the production of bucket foundations. The last mentioned project deals with the fabrication of node structures related to the offshore jacket foundations.

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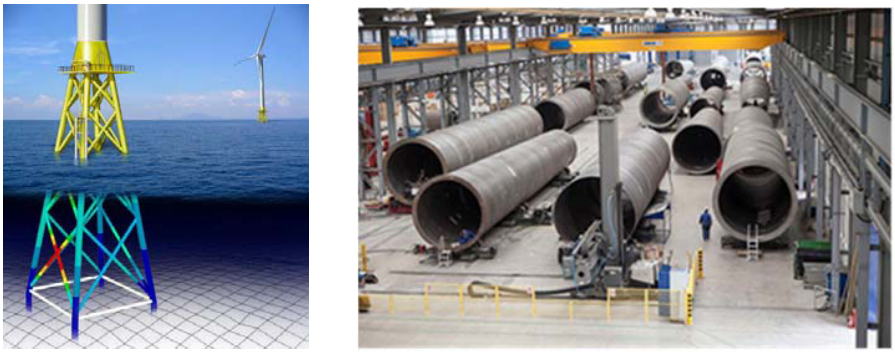

Fig.1 Offshore foundation jacket structure and windmill tower fabrication, (Mabey Bridge).

## 2. Laser Hybrid Welding - principles

Laser hybrid welding combines the benefits from a laser beam with the benefits from a traditional arc welding process and to a certain degree eliminates the drawbacks from the individual technologies. The hybrid welding technology still produces welds, which are characterized by low distortion, high reproducibility and higher productivity. The laser hybrid welding process permits greater fit-up tolerance, elimination of defects due to the addition of filler material and the ability to weld thicker materials. In general, laser hybrid welding offers higher productivity, stable and high weld quality and the possibility of implementing an automated cost reducing welding process.

The characteristic deep laser hybrid weld profile is created by combining the focused laser beam and the arc in a common melt pool. This melt pool is moving along the weld pass, see Fig.2.

A number of standards are the basis for the evaluation of the laser hybrid weld quality. The most important ones are;