Intermediate pyrolysis describes a process of converting feedstock by heating it up in the absence of oxygen under moderate, “intermediate” conditions. Typical conditions are a residence time for solids between 5 to 30 minutes, low heating rates and temperatures between 350 °C - 450 °C. Due to these conditions intermediate pyrolysis has remarkable advantages regarding the feedstock, compared to other processes based on flash pyrolysis. Large particles, like pellets or chips can be used. Dry matter content can be below 50% from a technical point of view. For economic reasons the dry matter should be more than 70 % to avoid using energy mainly for drying. However, this dry matter is still very low compared to the requirements of most flash pyrolysis reactors. Another advantage is the use of variable and heterogeneous feedstock, preferably residue and waste biomass. The feedstock can vary from agricultural residues, biogas digestate, municipal and industrial biowaste to sewage sludge. The latest development of the intermediate pyrolysis technology is Fraunhofer UMSICHT’s Thermo-Catalytic Reforming process (TCR®). It is a novel process for the production of char, gas, and bio-oils with improved properties.

One significant innovation of TCR® is the integrated downstream catalytic reforming step. This multi-patented technology enables the high quality of the final products carbonisate, syngas, and oil. The robustness of the process permits the utilization of various biogenic feedstocks. The yield of the products depends on the chemical properties of the feedstocks, whereas the quality and characteristics of the products are due the robustness of the process, largely independent of the feedstocks. With the focus on the TCR® oil there is one unique selling point: The oil is thermally stable and therefore distillable. This is the basis for other thermal upgrading processes like e.g. hydro-treatment. Furthermore, the thermal stability of the TCR® oil is a basic prerequisite for usage in the fossil petrol processing industry. This includes, among other applications, combined heat and power (CHP) plants. Additional unique properties are the low water content, the low total acid number, and the high heating value. The high quality of the crude TCR®-oil can be further improved to EN fuel quality by distillation and hydrodeoxygenation (HDO). For hydrodeoxygenation sulfonated NiMo catalyst at temperatures of around 370 °C and a pressures in the range of 140 bar and with LHSV of 0.3 per hour were applied. The resulting products showed full properties of standard hydrocarbon fuels. A separation into diesel and petrol fraction by rectification demonstrated, that both fractions met the fossil fuel standards (EN 228 and EN 590). Through hydrotreating the hydrogen content was increased and the oxygen, sulphur and nitrogen content was significant lowered or respectively removed in an efficient way with a yield over 85 %.

The fuel has been tested by a Volkswagen XL 1 car under real road condition for several hundred kilometres with an average diesel consumption of 1.3 litres per 100 km.

The TCR technology has been tested and applied in laboratory scale (2kg/h throughput) and pilot scale (30 kg/h throughput). In the frame of a Horizon 2020 demonstration project a TCR 500 (500kg/h throughput) integrated with a hydrogenation unit is now being constructed and will be in commissioning beginning of 2020.