CLAIMS:

Claim 1. A method of processing a renewable bio-based material comprising the step of:

reacting the bio-based material, comprising triglycerides and free fatty acids, with hydrogen in the presence of a catalyst on a support in a reactor to form a treated oil;

(i) passing the treated oil through a distillation unit and an adsorption unit to form green diesel; and/or (ii) passing the treated oil through at least one distillation column to separate the treated oil into at least one component and passing the at least one component through an adsorption column;

wherein the reactor comprises a cooling function for controlling the temperature of the reactor; wherein the cooling function is an internal cooling function comprising adding a cooling substance into the reactor.; and wherein the cooling substance is selected from the group consisting of a fresh amount of the bio-based material, a fresh amount of hydrogen, a portion of the treated oil and a combination thereof.

Claim 2. The method of claim 1, wherein the support is alumina (Al_2O_3), silica (SiO_2) or alumina-silica (Al_2O_3-SiO_2) preferably, wherein the support is Al_2O_3 and the catalyst on Al_2O_3 is selected from the group consisting of $NiMo/Al_2O_3$ and NiW/Al_2O_3 or the support is Al_2O_3 and the catalyst on Al_2O_3 is selected from the group consisting of $NiCoMo/Al_2O_3$, $NiMoP/Al_2O_3$ and $CoMo/Al_2O_3$.

Claim 3. The method of claim 1, wherein the temperature in the reactor is 200ºC to 400ºC and the pressure in the reactor is 25 bar to 40 bar.

Claim 4. The method of claim 1, wherein the space velocity is 0.5 h^{-1} to 2 h^{-1}.

Claim 5. The method of any one of the preceding claims, wherein a ratio of hydrogen to the bio-based material is 0.03g hydrogen/g bio-based material to 0.10g hydrogen/g bio-based material, preferably wherein the ratio of hydrogen to the bio-based material is 0.05g hydrogen/g bio-based material to 0.07g hydrogen/g bio-based material.

Claim 6. The method of any one of the proceeding claims, further comprising the step of purifying the treated oil, preferably wherein the step of purifying the treated oil comprises the step of passing the treated oil through a high-pressure separator followed by the step of passing through a low-pressure separator wherein the high-pressure separator separates a gaseous component from the treated oil.

Claim 7. The method of any one of the preceding claims,

wherein the adsorption unit comprises at least one adsorbent selected from the group consisting of activated carbon, ion exchange resin, molecular sieve and chemical adsorbent,

and/or, wherein the adsorption column comprises at least one adsorbent selected from the group consisting of activated carbon, ion exchange resin, molecular sieve and chemical adsorbent.

Claim 8. The method of any one of the preceding claims, wherein the at least one component is selected from the group consisting of n-paraffin having less than 16 carbon atoms, n-hexadecane, n-heptadecane, n-octadecane and n-paraffin having more than 18 carbon atoms.

Claim 9. The method of any one of the preceding claims, wherein reacting the bio-based material with hydrogen in the presence of the catalyst on the support in the reactor comprises:

flowing into the reactor as a co-current of reactants (a) the bio-based material as a stream comprising a plant oil and/or an animal oil, and (b) a fresh stream of hydrogen; and

performing one-step hydrotreating of the reactants in the reactor at a temperature controlled between 250ºC to 350ºC and a pressure controlled between 25 bar to 40 bar to obtain the treated oil.

Claim 10. The method of any one of the preceding claims, wherein adding the cooling substance into the reactor comprises introducing the cooling substance into the reactor by way of a nozzle at an angle between perpendicular to and co-current with the flow of reactants, and not against the flow of reactants.

Claim 11. The method of any one of the preceding claims, wherein passing the treated oil through at least one distillation column to separate the treated oil into at least one component and passing the at least one component through an adsorption column comprises at least one of:

(a) producing an industrial solvent stream from the further purified treated oil stream by:

passing the further purified treated oil stream through a first distillation column and producing a first stream of n-paraffin having less than 16 carbons, then passing the first stream of n-paraffin having less than 16 carbons through a first adsorption unit and outputting from the first adsorption unit the industrial solvent stream

and

(b) producing a first phase change material stream from the further purified treated oil stream by:

(i) passing the further purified treated oil stream through a first distillation column and outputting from the first distillation column a n-paraffin stream containing n-paraffin having less than 16 carbons, and a first additional stream;

passing the first additional stream through a second distillation column and outputting from the second distillation column a n-hexadecane stream containing at least 99% by mass n-hexadecane, and

passing the n-hexadecane stream through an adsorption column and outputting therefrom the first phase change material stream; or

(ii) passing the further purified treated oil stream through a distillation unit and outputting therefrom each of a low boiling point hydrocarbon stream and a distillation unit product stream; and

passing the distillation unit product stream through the first distillation column and outputting from the first distillation column a n-paraffin stream containing n-paraffin having less than 16 carbons, and the first additional stream;

passing the first additional stream through a second distillation column and outputting from the second distillation column a n-hexadecane stream containing at least 99% by mass n-hexadecane, and

passing the n-hexadecane stream through an adsorption column and outputting therefrom the first phase change material stream.

Claim 12. The method of any one of the preceding claims, wherein the bio-based material is one of Bleached Palm Oil (BPO), palm olein, and Palm Fatty Acid Distillate (PFAD), and wherein the treated oil is formed of hydrocarbons maintaining a carbon number in the range from C_{14} to C_{18}.

Claim 13. A system for processing a renewable bio-based material by the method according to any one of claims 1 – 12, the system comprising:

a reactor for reacting the bio-based material, comprising triglycerides and free fatty acids, with hydrogen in the presence of a catalyst on a support to form a treated oil stream;

(i) a distillation unit for passing the treated oil stream through to form each of a low boiling point hydrocarbon stream and a distillation unit product stream and an adsorption unit for passing the distillation unit product stream through to form green diesel; and/or

(ii) a plurality of distillation columns and corresponding adsorption columns by way of which the treated oil stream is subjected to further processing, the plurality distillation columns and and corresponding adsorption columns including a first distillation column, a first adsorption column corresponding to the first distillation column, a second distillation column, and a

second adsorption column corresponding to the second distillation column, wherein the plurality of distillation columns and corresponding adsorption columns is configured such that:

the first distillation column receives one of (a) the treated oil stream and (b) the distillation unit product stream, and produces each of a first stream containing n-paraffin having less than 16 carbons and a first additional stream;

the first adsorption column receives the first stream containing n-paraffin having less than 16 carbons and produces an industrial solvent stream; and

the second distillation column receives the first additional stream and produces a n-hexadecane stream containing at least 99% by mass n-hexadecane and a second additional stream; and

the second adsorption column receives the n-hexadecane stream and produces a first phase change material stream,

wherein the reactor comprises a cooling function for controlling the temperature of the reactor; wherein the cooling function is an internal cooling function comprising a cooling substance.

Claim 14. The system of claim 13, wherein the cooling substance is selected from the group consisting of a fresh amount of the bio-based material, a fresh amount of hydrogen, a portion of the treated oil and a combination thereof.

Claim 15. The system of claims 13 or 14, wherein the temperature in the reactor is 200ºC to 400ºC and the pressure in the reactor is 25 bar to 40 bar.

Claim 16. The system of any one of claims 13 to 15, further comprising a high-pressure separator and a low-pressure separator for passing the treated oil stream through.

Claim 17. The system of any one of claims 13 - 16, wherein the reactor comprises an input configured to receive as a co-current of reactants (a) the bio-based material as a stream comprising a plant oil and/or an animal oil, and (b) a fresh stream of hydrogen, and wherein the reactor is configured for performing one-step hydrotreating of the reactants at a temperature controlled between 250ºC to 350ºC and a pressure controlled between 25 bar to 40 bar to obtain the treated oil.

Claim 18. The system of any one of claims 13 – 17 wherein the reactor comprises a nozzle configured for introducing the cooling substance into the reactor at an angle between perpendicular to and co-current with the flow of reactants, and not against the flow of reactants.