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.

[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 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 8]. 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 9]. 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 10]. 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 250°C to 350°C and a pressure controlled between 25 bar to 40 bar to obtain the treated oil.

[Claim 11]. 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 12]. 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:

serially processing the treated oil through a plurality of distillation columns, each distillation column having an adsorption column corresponding thereto, and:

obtaining from an output of a first adsorption column corresponding to a first distillation column an industrial solvent comprising n-paraffin in an amount of at least 99 wt%, and a distillation range of 250°C to 270°C; and/or

obtaining from an output of a subsequent absorption column corresponding to a subsequent distillation column after the first distillation column a phase change material comprising isoparaffin in an amount of 0 to 1 wt% and n-paraffin in an amount of 99 to 100 wt%, wherein the n-paraffin is a n -paraffin having 16 carbons (n-C16), a n-paraffin 51 having 17 carbons (n-C17) or a n-paraffin having 18 carbons (n-C18), and wherein the phase change material has a heat of melting of at least 200 J/g.

[Claim 13]. 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 14]. A green diesel obtained by the method of claim 13, wherein the green diesel has a distillation range of 250°C to 330°C, a cetane number of at least 100, a flash point in the range of 100°C to 130°C, and a total glycerides content of less than 0.5wt%.

[Claim 15]. The green diesel of claim 14, wherein the green diesel has a distillation range of 260°C to 323°C.

[Claim 16]. A system for processing a renewable bio-based material by the method according to any one of claims 1 – 13, 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;

(i) a distillation unit for passing the treated oil through to form green diesel and an adsorption unit for passing the green diesel through; and/or

(ii) at least one distillation column to separate the treated oil into at least one component and an adsorption column for passing the at least one component through; and

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 17]. The system of claim 16, 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 18]. The system of claims 16 or 17, wherein the temperature in the reactor is 200ºC to 400ºC and the pressure in the reactor is 25 bar to 40 bar.

[Claim 19]. The system of any one of claims 16 to 18, further comprising a high-pressure separator and a low-pressure separator for passing the treated oil through.

[Claim 20]. The system of any one of claims 16 - 19, 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 21]. The system of any one of claims 16 – 20 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.

[Claim 22]. The system of any one of claims 16 - 21, wherein the at least one distillation column to separate the treated oil into at least one component and an adsorption column for passing the at least one component through comprises a plurality of distillation columns, and wherein the plurality of distillation columns is configured to serially process the treated oil to provide:

at an output of a first adsorption column corresponding to a first distillation column within the plurality of distillation columns an industrial solvent comprising n-paraffin in an amount of at least 99 wt%, and a distillation range of 250°C to 270°C; and/or

at an output of a second or subsequent absorption column corresponding to a second or subsequent distillation column within the plurality of distillation columns after the first distillation column a phase change material comprising isoparaffin in an amount of 0 to 1 wt% and n-paraffin in an amount of 99 to 100 wt%, wherein the n-paraffin is a n -paraffin having 16 carbons (n-C16), a n-paraffin 51 having 17 carbons (n-C17) or a n-paraffin having 18 carbons (n-C18), and wherein the phase change material has a heat of melting of at least 200 J/g.