Sustainable Jet Fuel from Flexible Waste Biomass

EU Horizon2020 Project
flexJET

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EUBCE

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flexJET project

Project overview

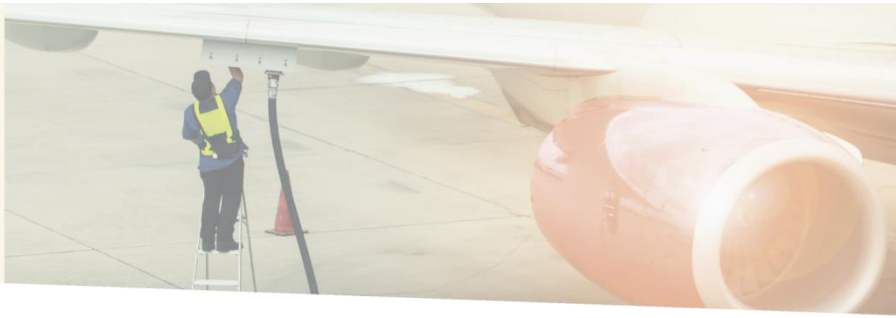
- Total costs: 15 M Euro
- EU financing: 10 M Euro
- H2020 LCE-20 Programme
- Duration: 48 Months (2018-2022)
- Consortium with 13 partners from 5 EU countries

Aim

- To build a **pre-commercial demonstration plant** for the production of **SAF** derived from **digested food waste** and **waste vegetable oil** while mapping the full economic social and environmental impact of the technology.

EU sustainable aviation vision

- Vision for a climate neutral economy by 2050
- Bound Paris agreement to keep global temperature rise to below 1.5 deg C
- RED amended in 2015 to include a voluntary opt in for aviation taken up by UK
- EU has invested approx. Euro 5 Billion over last 10 Years to support these commitments
- In 2016 aviation accounted for 3.6% of all EU28 GHG emissions (13.4% from transport sector)
- Aviation emissions more than doubled since 1990 (will continue to become more significant as other sectors decarbonise)



Partners

Fraunhofer UMSICHT

green fuels

UNIVERSITY OF BIRMINGHAM

susteen sustainable resources from waste

HYGEAR

BIGA

The University Of Sheffield.

LEITAT managing technologies PPT R&D 2017

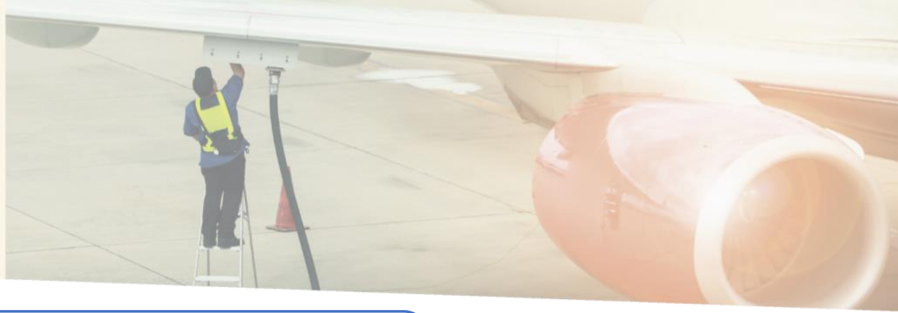
ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

SkyNRG

WRG Europe Ltd Engaging with Research

etaflorence renewableenergies

- Management
- Technology (SABR-TCR / PSA)
- Feedstock
- Products Tests
- Supply Chain
- Social and Environmental Sustainability Analysis
- Dissemination



- From feedstock diversification assessment
- Through environmental and social sustainability evaluation of the process
- To commercial uptake facilitation of cost-competitive aviation fuel

By contributing to the Renewable Energy Directive targets for renewable energy and to the fulfillment of the CORSIA targets

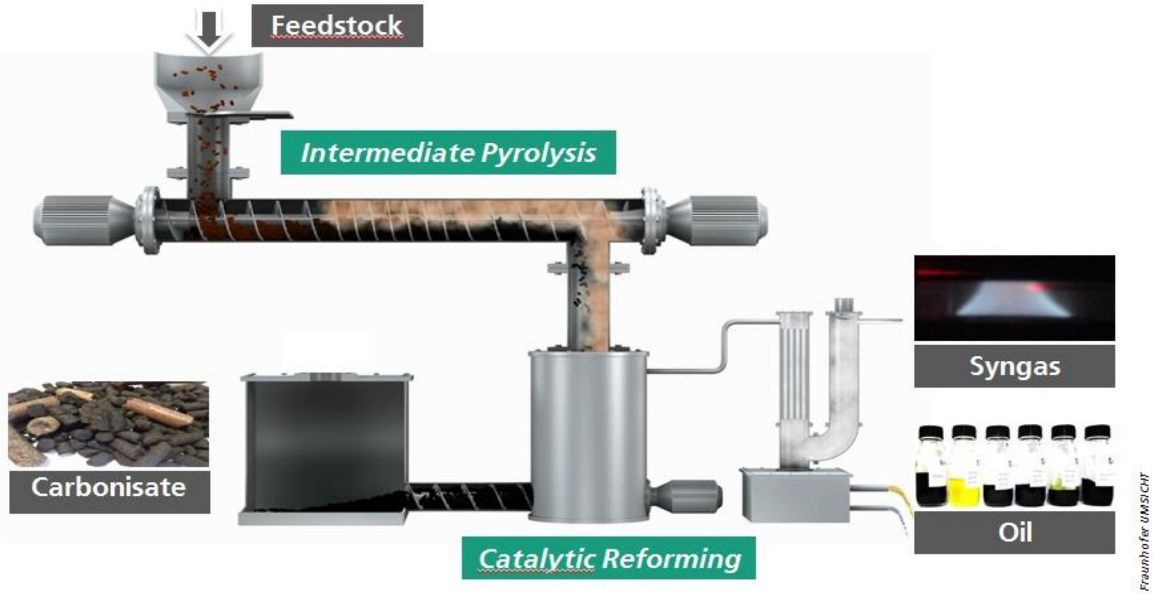
Kick –off	**Plant Design**	**Demo Plant**	**SAF Delivery**	**End of Project**
April 2018	Mid 2019	Mid 2020	End 2021	Mid 2022

Objectives

- Demonstrate the technical viability of aviation fuel production from waste biomass compliant under ASTM D7566
- Evaluate the environmental and social sustainability of the process
- Contribute to the Renewable Energy Directive targets for renewable energy
- Facilitate towards commercial uptake of the technology

Combination of Two Innovative Technologies

TCR® (Thermo-Catalytic Reforming)



Source:

susteen
sustainable resources from waste

SABR (Transesterification)

green fuels gfr

- TCR (Thermo-Catalytic Reforming)
- 500 Kg/h Biomass Plant

- TCR (Thermo-Catalytic Reforming)
- 30 Kg/h Biomass Plant

TCR Feedstock

TCR Crude Products

BIO-OIL

C	76.6 wt.%
H	7.7 wt.%
N	2.2 wt.%
S	0.6 wt.%
O (diff.)	11.2 wt.%
H_2O	1.7 wt.%
Ash	< 0.05 wt.%
TAN	4.9 mg KOH/g
HHV	33.9 MJ/kg

- miscible with fossil/bio fuels
- low tar content and acidity
- low fraction of non-volatiles

SYNGAS

H_2	35 ± 3 v/v%
CO	15 ± 2 v/v%
CO_2	25 ± 1 v/v%
CH_4	7 ± 2 v/v%
C_xH_y	2 ± 1 v/v%
N_2 (diff.)	16 ± 2 v/v%
HHV	11 MJ/m³

- tar and dust free gas
- H_2 over 30 v/v%

CHAR

C	65.0 wt.%
H	1.2 wt.%
N	1.5 wt.%
S	0.3 wt.%
O (diff.)	2.2 wt.%
H_2O	0.7 wt.%
Ash	29.1 wt.%
HHV	23.9 MJ/kg

- high mechanical stability
- transportable and storable
- low-odour

TCR Oil After Upgrading

TCR® BIO-OIL

C	77.6 wt.%
H	8.0 wt.%
N	4.6 wt.%
S	0.6 wt.%
O (diff.)	7.0 wt.%
H_2O	2.2 wt.%
Ash	< 0.005 wt.%

LHV	34.0 MJ/kg
TAN	2.1 mg KOH/g
Viscosity	4,428 mm^2/s
Density	1014.4 kg/m^3

- miscible with fossil/bio fuels
- low tar content and acidity
- low fraction of non-volatiles

TCR® BIO-OIL, HDO

C	86.2 wt.%
H	13.0 wt.%
N	< 0.5 wt.%
S	0.01 wt.%
O (diff.)	< 0.7 wt.%
H_2O	0.003 wt.%
Ash	< 0.005 wt.%

LHV	42.25 MJ/kg
TAN	0.0 mg KOH/g
Viscosity	0,97 mm^2/s
Density	815.7 kg/m^3

- Outstanding fuel quality

- SABR Plant Green Fuels
- Transesterification (50,000 Litres Per Day FAME Production)

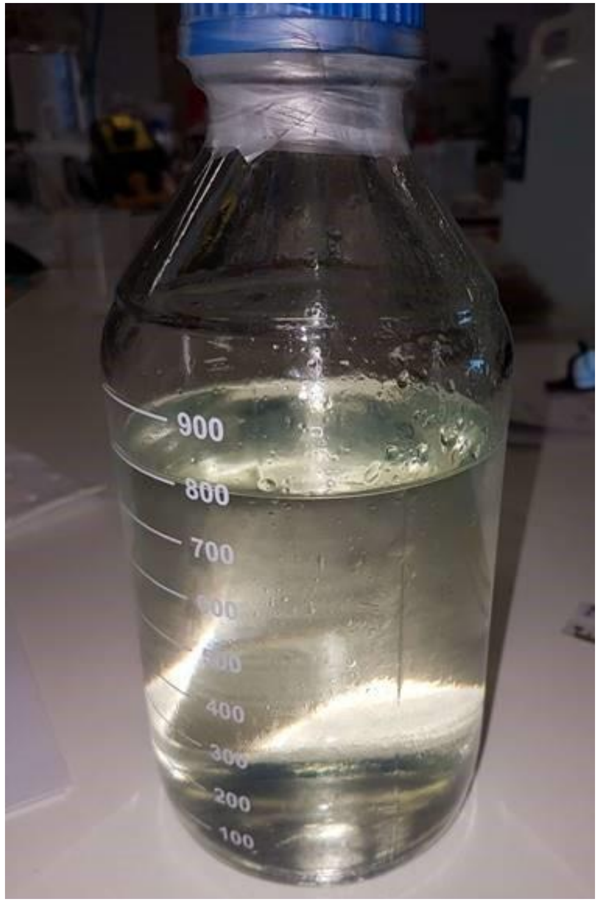
HEFA Production

- *Optimisation:*
  - *HDO reaction temperature*
  - *HC reaction temperature*
  - *H2 pressure*

Fractional distillation results:

- **Up to 55 vol.% at Jet Fuel fraction**
- **45 vol.% Others**

(including green diesel and gasoline)

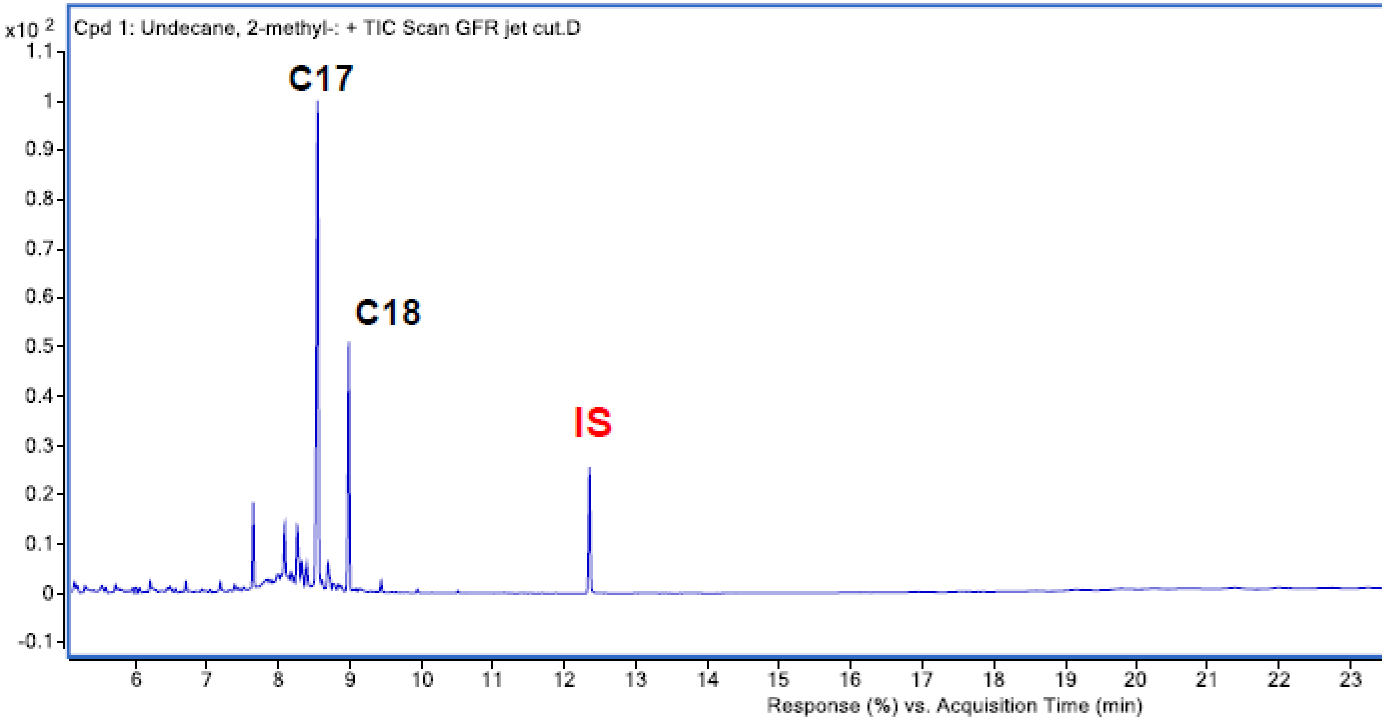


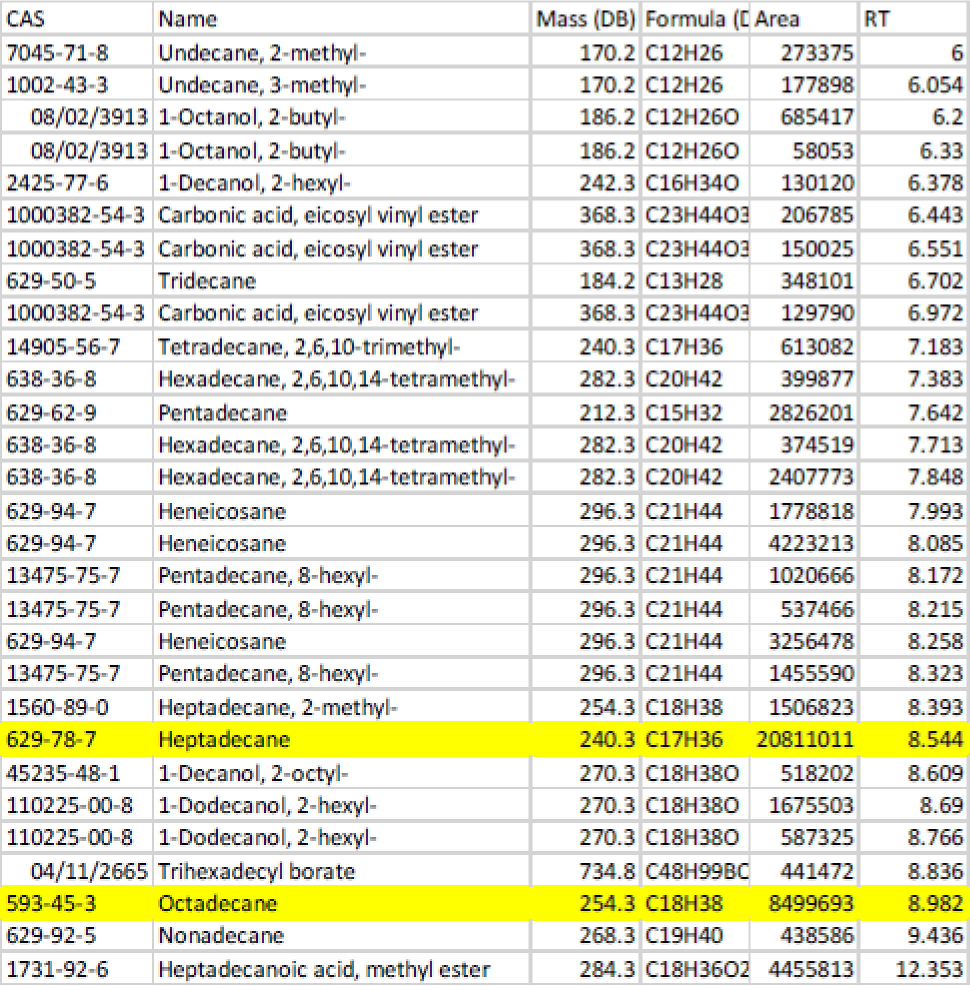
Sample after HDO + HC

Source: green fuels gfr

Results

HEFA Production – GC-MS Jet Fuel Cut

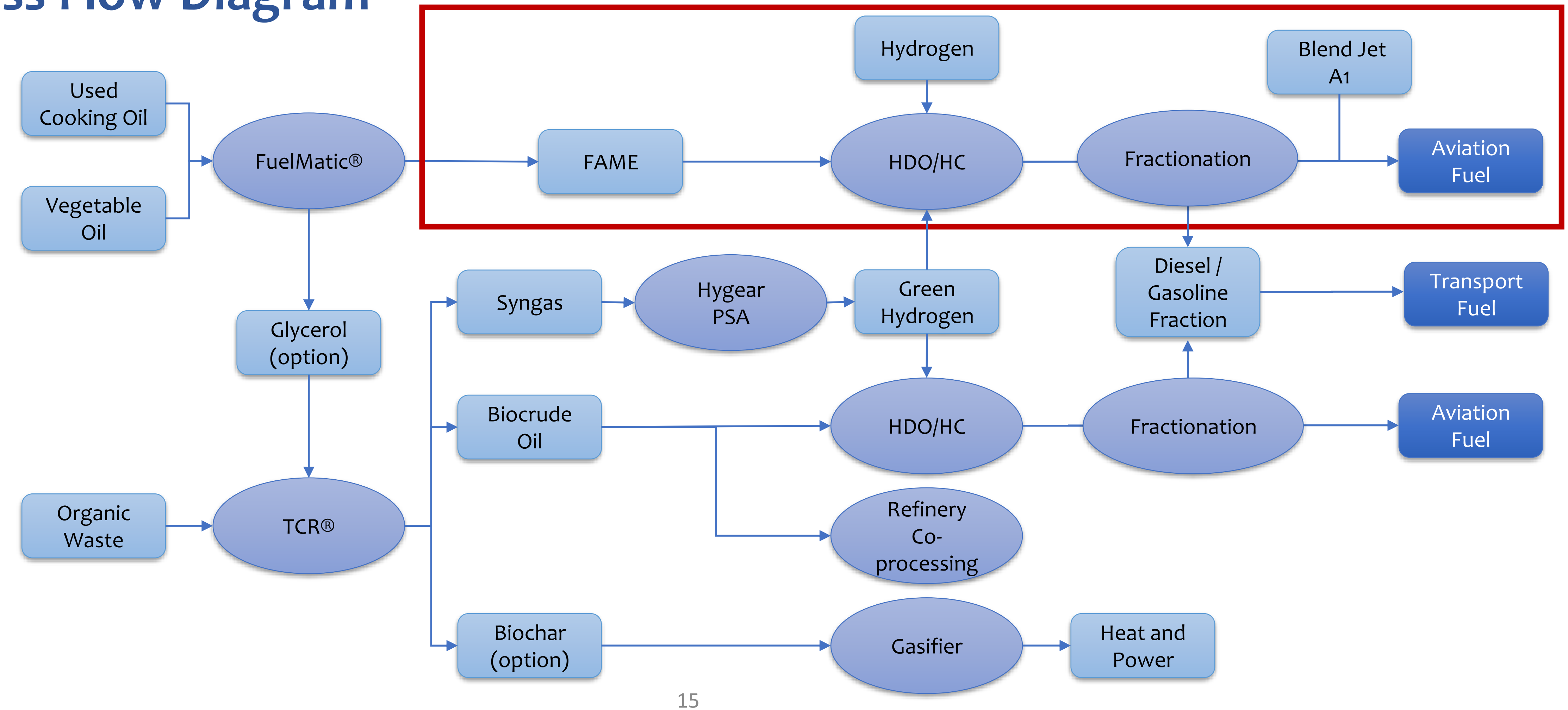




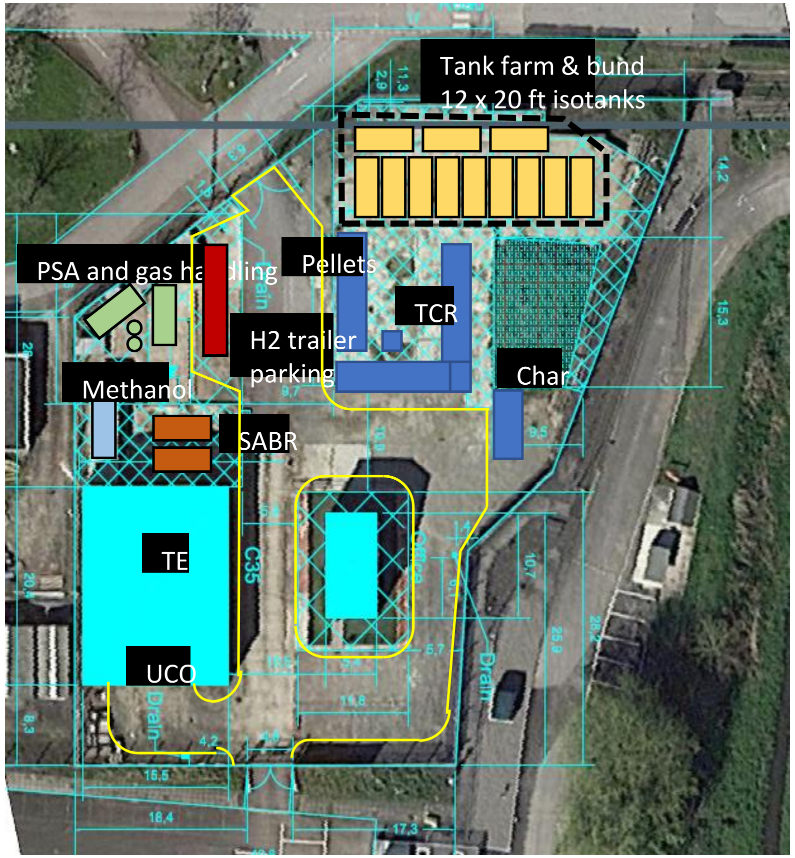
CAS	Name	Mass (DB)	Formula (D	Area	RT
7045-71-8	Undecane, 2-methyl-	170.2	$C_{12}H_{26}$	273375	6
1002-43-3	Undecane, 3-methyl-	170.2	$C_{12}H_{26}$	177898	6.054
08/02/3913	1-Octanol, 2-butyl-	186.2	$C_{12}H_{26}O$	685417	6.2
08/02/3913	1-Octanol, 2-butyl-	186.2	$C_{12}H_{26}O$	58053	6.33
2425-77-6	1-Decanol, 2-hexyl-	242.3	$C_{16}H_{34}O$	130120	6.378
1000382-54-3	Carbonic acid, eicosyl vinyl ester	368.3	$C_{23}H_{44}O_3$	206785	6.443
1000382-54-3	Carbonic acid, eicosyl vinyl ester	368.3	$C_{23}H_{44}O_3$	150025	6.551
629-50-5	Tridecane	184.2	$C_{13}H_{28}$	348101	6.702
1000382-54-3	Carbonic acid, eicosyl vinyl ester	368.3	$C_{23}H_{44}O_3$	129790	6.972
14905-56-7	Tetradecane, 2,6,10-trimethyl-	240.3	$C_{17}H_{36}$	613082	7.183
638-36-8	Hexadecane, 2,6,10,14-tetramethyl-	282.3	$C_{20}H_{42}$	399877	7.383
629-62-9	Pentadecane	212.3	$C_{15}H_{32}$	2826201	7.642
638-36-8	Hexadecane, 2,6,10,14-tetramethyl-	282.3	$C_{20}H_{42}$	374519	7.713
638-36-8	Hexadecane, 2,6,10,14-tetramethyl-	282.3	$C_{20}H_{42}$	2407773	7.848
629-94-7	Heneicosane	296.3	$C_{21}H_{44}$	1778818	7.993
629-94-7	Heneicosane	296.3	$C_{21}H_{44}$	4223213	8.085
13475-75-7	Pentadecane, 8-hexyl-	296.3	$C_{21}H_{44}$	1020666	8.172
13475-75-7	Pentadecane, 8-hexyl-	296.3	$C_{21}H_{44}$	537466	8.215
629-94-7	Heneicosane	296.3	$C_{21}H_{44}$	3256478	8.258
13475-75-7	Pentadecane, 8-hexyl-	296.3	$C_{21}H_{44}$	1455590	8.323
1560-89-0	Heptadecane, 2-methyl-	254.3	$C_{18}H_{38}$	1506823	8.393
629-78-7	Heptadecane	240.3	$C_{17}H_{36}$	20811011	8.544
45235-48-1	1-Decanol, 2-octyl-	270.3	$C_{18}H_{38}O$	518202	8.609
110225-00-8	1-Dodecanol, 2-hexyl-	270.3	$C_{18}H_{38}O$	1675503	8.69
110225-00-8	1-Dodecanol, 2-hexyl-	270.3	$C_{18}H_{38}O$	587325	8.766
04/11/2665	Trihexadecyl borate	734.8	$C_{48}H_{99}BO$	441472	8.836
593-45-3	Octadecane	254.3	$C_{18}H_{38}$	8499693	8.982
629-92-5	Nonadecane	268.3	$C_{19}H_{40}$	438586	9.436
1731-92-6	Heptadecanoic acid, methyl ester	284.3	$C_{18}H_{36}O_2$	4455813	12.353

Source: green fuels gfr

Process Flow Diagram


HEFA – ASTM D7566

Plant Site Berkeley UK



Prince Charles Site Visit

- Invitation to open plant
- Invitation to BBC for dissemination
- First UK plant delivering SAF

flexJET Advantages

- High feedstock flexibility
- Green Hydrogen
  - Hydrogen separated from TCR® Syngas by PSA to be used in HDO / HC
- Side and end products flexibility
- Highly scalable (small scale decentralised facilities can be built)
- It can be integrated into existing infrastructure

CONSORTIUM

Coordinator UNIVERSITY OF BIRMINGHAM

Partners

Fraunhofer UMSICHT

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

susteen sustainable resources from waste

WRG Europe Ltd Engaging with Research

green fuels

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SkyNRG

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The University Of Sheffield.

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project FLEXJET

Duration
April 2018 - March 2022

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