Sustainable Aviation Fuels
Ready for take off
CAAFI Symposium
June 1st, 2021

Christophe BONELLI
SAF Business Developer at TotalEnergies
c christophe.bonelli@totalenergies.com

June 2021
May 28th: Total is transforming and becoming TotalEnergies

OUR BELIEF
Energy is life.
We all need it and it's a source of progress. So today, to contribute to the sustainable development of the planet facing the climate challenge, we are moving forward, together, towards new energies.

Our ambition is to be a world-class player in the energy transition.
Our New Climate Ambition
Get to Net Zero by 2050
#MakeThingsBetter
TotalEnergies share the ambition to get to Net Zero by 2050 together with society for its global business (Scope 1+2+3)

3 major steps to get TotalEnergies to Net Zero

<table>
<thead>
<tr>
<th></th>
<th>Net Zero on Operations by 2050 or sooner (Scope 1+2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Net Zero in Europe by 2050 or sooner (Scope 1+2+3)</td>
</tr>
<tr>
<td>3</td>
<td>60% or more Net Carbon Intensity reduction by 2050 (Scope 1+2+3)</td>
</tr>
</tbody>
</table>
TotalEnergies HISTORIC COMMITMENT TO SAF
OVER 150 SUCCESSFUL COMMERCIAL FLIGHTS SINCE 2014

Consortiums / Coalitions / Associations

FR | GER | EU | WW
---|---|---|---
Lab-Line | TotalEnergies | Normandie CoPro | Grandpuit Retrofit
Toulouse – Paris | Flightpath | Industrial test | SAF W&R based
24 flights | ARTFuels | HEFA production
From Toulouse platform | FuelsEurope | From La Mède/Oudalle


1st US Commercial Flight
Orlando – Sao Paulo
Boeing 737-800

1st EU Commercial Flight
Frankfurt – Berlin
Airbus 320

201620152014
SIP approved pathway
SAF production, Brazil

2019
Cannes Festival
Nice – Paris
24 flights

Normandie CoPro Industrial test

1st Transconti. Flight
Amsterdam – Rio de Janeiro
Airbus A350

HEFA production
From La Mède/Oudalle

Planes’ deliveries
From Toulouse platform
>50 flights\(^{(1)}\) since 2016

First SAF delivery @Paris CDG, May 2021

\(^{(1)}\) Cathay Pacific, China Airlines, Iberia, China Southern, Japan Airlines

CAAFI symposium | June 2021
BECOMING A LEADER IN RENEWABLE FUELS
CAPTURING SYNERGIES WITH EXISTING ASSETS

<table>
<thead>
<tr>
<th>Convert existing sites</th>
<th>Increase Coprocessing</th>
<th>Expand existing new complexes</th>
<th>Renewable Fuels production Mt/y</th>
</tr>
</thead>
<tbody>
<tr>
<td>La Mède</td>
<td>Europe</td>
<td>South Korea</td>
<td>5.0</td>
</tr>
<tr>
<td>HVO Capacity 500 Kt/y</td>
<td>300 Kt/y starting-up</td>
<td>Evaluating projects in Daesan. 500 Kt/y</td>
<td>2020 2025 2030</td>
</tr>
<tr>
<td>Incl. 100 Kt/y SAF</td>
<td>over 2022-24</td>
<td>SAF ~100Kt/y post 2027</td>
<td></td>
</tr>
<tr>
<td>Grandpuits</td>
<td>SAF 170 Kt/y (HVO 90)</td>
<td>SAF ~100Kt/y</td>
<td></td>
</tr>
<tr>
<td>First Zero oil platform, SAF 170 Kt/y (HVO 90)</td>
<td>Evaluating project in Port Arthur refinery</td>
<td>Exploring projects (active discussions) with partners in Japan, Middle East, and the Unites States</td>
<td>2.5</td>
</tr>
<tr>
<td>Start-up 2024</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Renewable fuels: at least 2 Mt/year by 2025 and nearly 5 Mt/year by 2030

SAF: 500 kt/year by 2025 and up to 1.5 Mt/year by 2030, depending on market interest
Paris, May 18th, 2021
TotalEnergies, Air France-KLM, Groupe ADP and Airbus have joined forces to carry out the first long-haul flight (Paris-Montreal) powered by SAF produced in France (La Mède & Oudalle) by TotalEnergies. Blend of Jet A1 and 16% of SAF made from Used Cooking Oil.
TotalEnergies APPROACH TO SAF FEEDSTOCK

ALL FEEDSTOCKS MUST FULFILL SUSTAINABILITY CRITERIA. SUPPLY WILL BE RESTRICTED BY LOGISTICS AND COMPETING DEMANDS.

SUSTAINABILITY

What type of feedstock is environmentally & socio-politically sustainable

- TOTAL does not consider 1G crop-based feedstock
- Recycling carbon (fossil-based feedstocks) as long as reductions in GHG emissions achieved
- Low carbon electricity from renewable source (solar, wind)

OPTIONALITY

Which industries are today’s and futures use of feedstock

- Multiple industries competing for feedstocks and in particular road transport
- Aviation approach:
  - No food competition
  - Limited change in competing use (legislation)

COLLECTABILITY

What is the amount of feedstock economically reasonable to collect (and transport)?

- Degree of fragmentation
- Existence of infrastructure
- Geographical conditions
TotalEnergies THREE-STAGE TECHNOLOGY DEV.

TotalEnergies VIEWS TECHNOLOGY DEVELOPMENT AS CRITICAL. WE STARTED WORKING ON ALL THREE STAGES

1. **Scale up**
   - **Technology** – Lipids hydrogenation
   - **Feedstocks** – Waste & residue lipids, Pyrolysis and Algae oils
   - Scale-up production from sustainable lipids
   - **Technology breakthrough!**
     - Upgrade pyrolysis biocrude and develop algae-based oil use

2. **Expand**
   - **Technology** – ATJ & GAS+X
   - **Feedstocks** – Ethanol, MSW, Wood and Ag residues, CO2, CO
   - Advanced and waste feedstocks provide large practical potential

3. **Develop**
   - **Technology** – PTL
   - **Feedstocks** – Renewable electricity, CO2, CO
   - Tap into a nearly unlimited resources
   - Develop e-Fuels as renewable electricity and technology costs decline
WHAT SAF NEEDS TO TAKE OFF?

**THE ASAP FACTORS**

**Availability**
- No significant SAF commercial volumes
- SAF volume today less than 0.01% of total fuel demand
- But over 3,0Mt in announced capacity by 2025

**Sustainability**
- SAF standards to meet societal and political expectations
- Supply chain transparency with certified GHG benefits
- Wastes and residues feedstocks preferred but limited in availability

**Affordability**
- SAF cost premium over conventional fossil jet
- SAF cost at least 4 times jet fuel which Jet fuel cost is the largest overhead expense for airlines
- Further technological development and improved economics are needed

**Policy**
- Limited to some SAF national initiatives
- Policy mechanisms gathering pace but limited to national initiatives
- Stable long term policy measures are crucial to scale up SAF demand
EXECUTIVE SUMMARY

Growing pressure on the aviation sector to decarbonize its activity.

Liquid fuels are hard to substitute for long haul flights. Sustainable Aviation Fuels (SAF) are alternative to Conventional Aviation Fuels (CAF). They contribute in reducing CO₂ emissions and do not require changes in existing infrastructures/aircraft.

Cost of SAF is superior to min 4 times fossil jet market price. SAF development requires a supporting regulation. First regulatory mandates are appearing in Europe. With appropriate legislation and technology development, SAF market could exceed 200Mt by 2050 (40% of the forecasted jetfuel market).

TotalEnergies aims at becoming a leader in renewable diesel / jet production while capturing synergies with existing assets. Grandpuits bio-refinery expected to produce 170kt SAF by 2024 using residual oils hydrotreatment technology (HEFA). We are exploring alternative routes to bring SAF to markets as early as 2021.

Among the 7 SAF approved pathways, lipids hydrogenation is the only commercial and the least expensive technology to produce today. However, its development could be limited by the feedstock availability (need to secure oil waste & residues feedstock).

TotalEnergies R&D concentrate efforts in developing 3 routes: (1) lipids hydrg. for assets development, (2) Other pathways including AtJ and FT, (3) E-fuels, even if currently limited by available renewable cheap power.
Thanks for your attention
christophe.bonelli@totalenergies.com