



# FuelForward

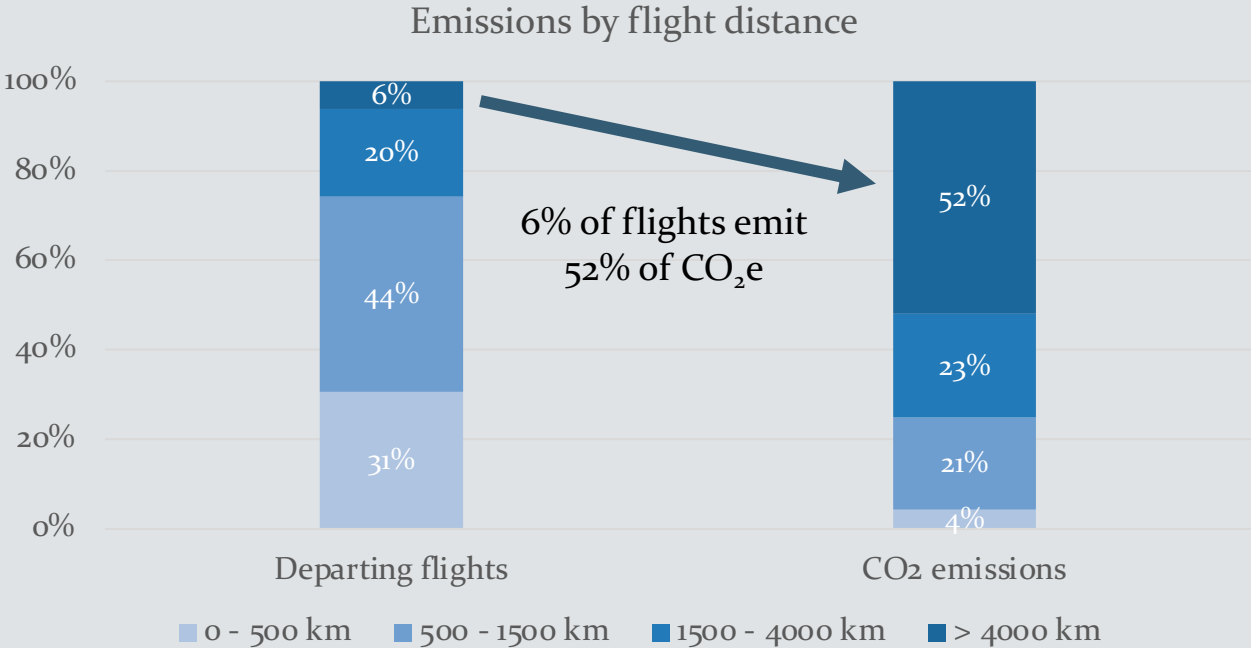
Kellogg-Morgan Stanley Sustainable Investing Challenge

*IESE Business School*

# Aviation needs to change

The aviation industry alone accounts for **2.5%** of global CO<sub>2</sub> emissions<sup>1</sup>.  
A return flight **London to New York** creates **more carbon emissions** than the average person does per year in **56 countries**<sup>2</sup>.

**Global passenger** numbers are forecasted to **double** from 2019 baseline by 2037<sup>3</sup> and continue to grow further, potentially increasing aviation's **share of global CO<sub>2</sub> emissions to 22% by 2050**<sup>4</sup>.

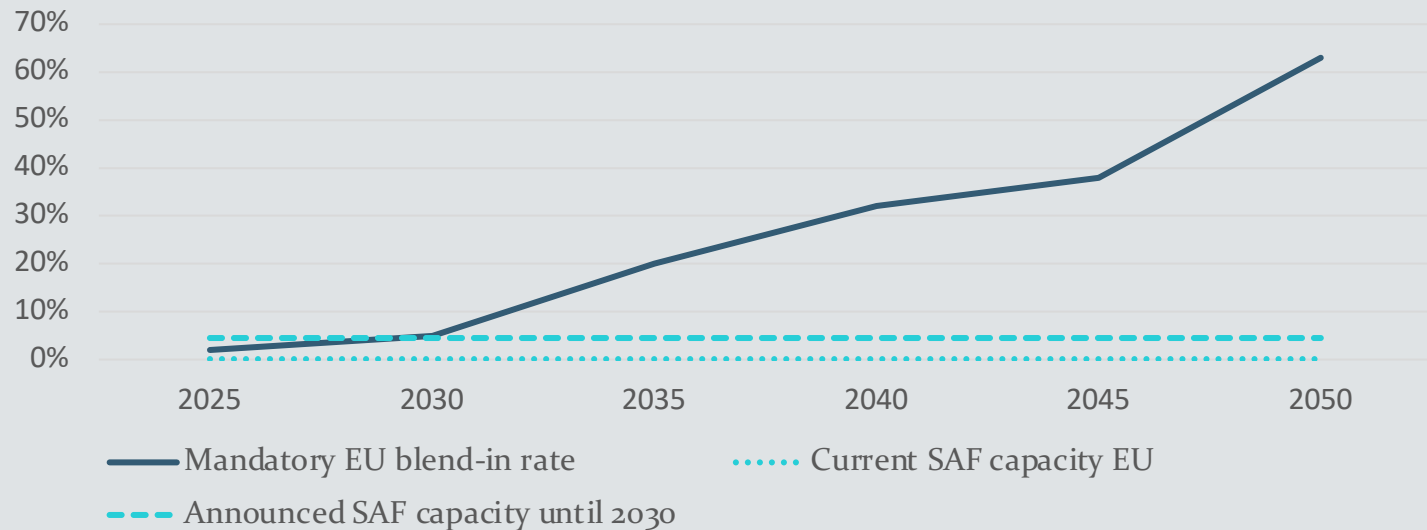


# SAF is a key player in the transition

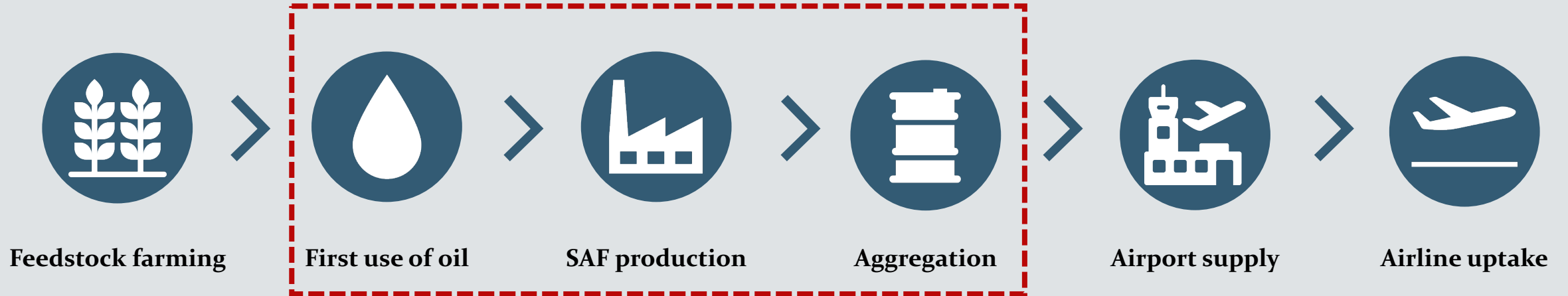
**Sustainable Aviation Fuel (SAF)** is the **only currently available solution** for long-haul flights<sup>6</sup>, but only accounts for **0.1% of global fuel consumption**<sup>7</sup>. It can achieve emission reductions of up to 100%, depending on the production technology.

Established players are **not willing to adequately invest** in production capacity due to **challenging economics**, ongoing **technological development**, and **low up-take** by airlines as-of-today.

EU required SAF capacity rapidly increasing



# What is SAF?



## HEFA

- Oils or fats, e.g., **used cooking oil** as feedstock
- CO<sub>2</sub> emission reduction of **up to 80%**
- **Feedstock** availability **challenging**

## Alcohol-to-Jet

- Alcohol, e.g., **methanol** used as feedstock
- CO<sub>2</sub> emissions reduction of **up to 40%**
- **Feedstocks** readily available in the future

## Power-to-Liquid

- Carbon, e.g., **captured from air** used as feedstock
- CO<sub>2</sub> emissions reduction of **up to 100%**
- **Far off from commercial viability** for several decades

# How do we approach SAF production

To ensure RED-II compliance<sup>6</sup>, SAF is sourced from cooking oils ("UCO"), waste oils and animal fats rather than crop-based sources

Sale of EU oil refineries has surged due to energy transition.<sup>7</sup> Fuel Forward to acquire oil refineries that were planned to be decommissioned and convert them to SAF production facility.

SAF sold to aggregator, e.g., major energy companies such as Shell or BP under a long-term contract at sustainable margins with feedstock price adjustment mechanism.

Commercial airlines buy SAF from aggregator to meet the EU SAF mandate – Fuel Forward SAF is drop-in fuel, which does not require adaptation to existing fleet or airport infrastructure.



**Sustainable  
feedstock  
sources**



**Decommissioned  
oil refineries**



**Aggregator**



**Offtaker**

# Why this approach

Fuel Forward's approach to SAF production helps to achieve UN SDG alignment across every step of the production chain

7 AFFORDABLE AND CLEAN ENERGY



KPI: Total direct global greenhouse gas ("GHG") emissions per airline

KPI: Efficiency measured as GHG emissions per passenger-kilometer

KPI: % of HEFA prices on overall cost of fuel per flight

13 CLIMATE ACTION



KPI: Reduced indirect GHG emissions (based on life-cycle assessment) from waste feedstock

KPI: Increased SAF blend-in rate by offtakers per flight

8 DECENT WORK AND ECONOMIC GROWTH



KPI: Increased rate of employment in communities living within 100 km of Fuel Forward refinery

KPI: Increased rate of employment for high-value innovative work within 100 km of Fuel Forward refinery measured as annual growth rate of real GDP per employed person

12 RESPONSIBLE CONSUMPTION AND PRODUCTION



KPI: Compliance with RED-II Sustainability Criteria<sup>8</sup> and CORSIA Sustainability Criteria<sup>9</sup>

KPI: Reduction in CO<sub>2</sub> and toxic gas emissions as a result of state of the art retrofitting and increase in quality of surrounding water bodies



# Partners

## Feedstock sellers

Belgium and the Netherlands have well-established national UCO collection programmes and have the highest collection rates in Europe.<sup>10</sup> Major UCO collectors include Van den Berg Frett Recycling (NL), Olthius (NL) and Quatra (BE & FR)

## Oil refineries

Shell announced a partial decommissioning of its Pernis refinery.<sup>11</sup> A refinery jointly owned by Total and Lukoil in Zeeland is also announced to be step-wise decommissioned over the coming years.<sup>12</sup>

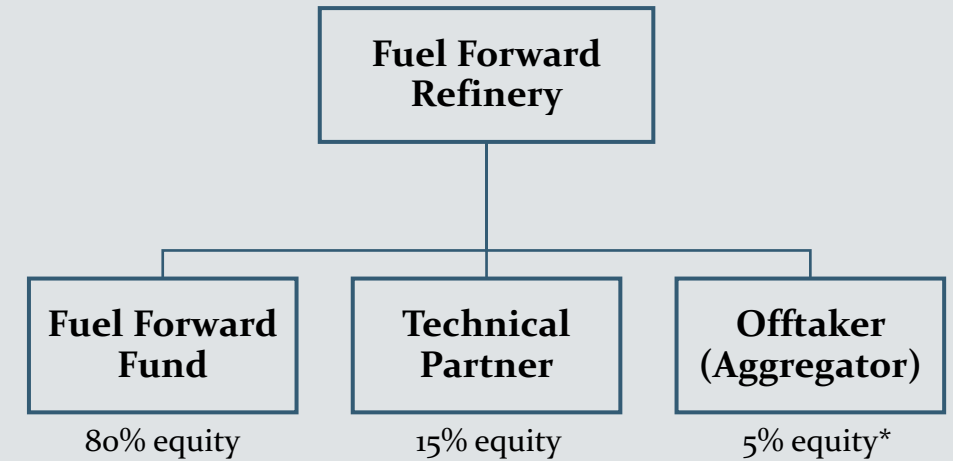
## Technical partners

Potential technical partners include SkyNRG and Topsoe which are experienced in SAF technology (crucial given that SAF yield rates are impacted by the type of technology used and this will have a knock-on effect on price).

## Offtakers

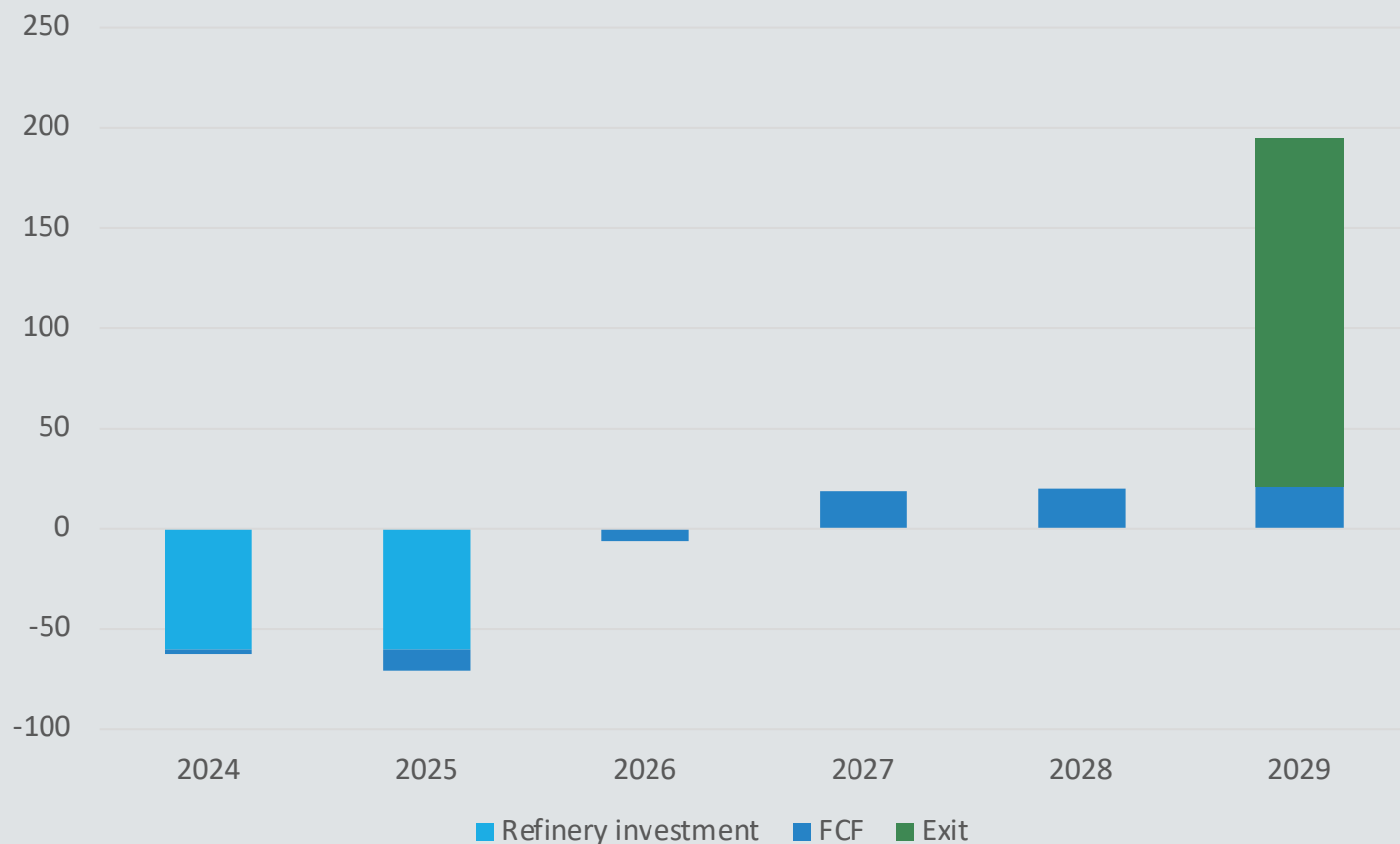
SAF producers have typically entered into a JV with commercial airlines and large energy companies. The consortium helps to support SAF production in terms of financial investment as well as industry know-how. Some examples include Shell, Repsol, Air Iberia and KLM.

## Suggested consortium structure



*\*5% equity subject to option to buy 100% of Fuel Forward refinery after 6-year period / Fuel Forward reserves right to buy Offtaker's shares*

# Returns & Fund Terms



## FuelForward Fund

Total addressable market	USD 10 Bn+
Target fund size	USD 120 Mn
Fund time horizon	6 years
Project time horizon	27 years
Target investors	Impact-oriented investors, Family Offices
Target project IRR	13.2% (gross)
Hold-to-maturity IRR	12.9% (gross)
Management fees	0.25% of AUM, 20% of returns exceeding 15% IRR
Asset class	SPV, Private Equity
Financial leverage	50% debt-equity structure



# Upside potential



## Higher SAF yield

- Production technology, while commercially established, is still in development
- Increasing relative yield of SAF from 49% to 60% would lead to 6% increase in IRR



## Legislative tailwinds

- Fees for non-compliance to mix-in rates will strengthen relative price position
- If average HBE value increases 7 to 9 Euro, subsidy per ton SAF increases by 160 EUR



## Lower hydrogen price

- Hydrogen as second biggest price driver after feedstock, price forecasted to fall
- 20% reduction in hydrogen price would reduce yearly total cost by 30 million



## “Rush” on SAF

- Positive outlook for SAF margin development would increase exit value
- 5% increase in exit value would translate into 1% IRR increase

# Risks & Mitigation

## Risk

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## Mitigation strategy

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Legal risk – EU wide legislation focuses on mandated mix-in rates more than production subsidies

Acquiring the refinery in the Netherlands allows FuelForward to make use of state-level subsidies and benefits. Experts foresee an increase in subsidies either on state or EU-level as SAF is not economically competitive otherwise, which could be leveraged if implemented soon enough before fund acquisition.



Market risk – Limited feedstock supply availability

Feedstock volumes required to cover breakeven production level would be contracted long-term with strategic supplier. Suggested Rotterdam port location will allow for easy access to both domestic feedstock which is readily available in NL due to high rates of UCO collection as well as imported feedstock where necessary (e.g., Jatropha).



Operational risk – Brownfield plant instead of greenfield approach

Building consortium with previous owner & operator plus experienced technological partner to build out SAF production line creates buy-in and de-risks it. Lower resulting investment requirements also increase project IRR significantly, making SAF output more price competitive, even at smaller scale production facility.

# Risks & Mitigation

## Risk

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## Mitigation strategy

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Environmental risk –  
Feedstock source  
contravenes Sustainability  
Criteria

As RED-II criteria is constantly being refined towards stricter standards, only waste-derived feedstock with completed life cycle assessment (LAC) will be used.<sup>13</sup> If required, additional feedstock from Jatropha, a non-food competing sustainable feedstock grown in Sub-Saharan Africa will be used. Third party auditors will be engaged to permanently ensure that production facilities and product are in line with sustainability standards.



Technology risk – Other  
SAF technologies become  
more cost competitive

Short (6-year) investment period reduces risk, since economic viability of e.g., P2L compared to HEFA is forecasted for 2050. Meeting the required SAF production capacity to reach sustainability goals around the globe will be an enormous task that requires all available capacity that could potentially be used, even if some of it at a higher price.

# Thank you!

## The Team



**Shobha  
Padmanabhan**

Former project finance lawyer in renewable energy (dual qualified in NY and Singapore). Was a Summer Associate at 8DV, a VC fund targeting wellness investments. Currently interning with a Family Office in London.



**Felix  
Kornprobst**

From Germany, experienced in the automotive sector, currently pursuing an MBA at IESE Business School, going into consulting after the MBA.

## Advisors

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**Ana Fernandez**, Chief Sustainability Officer, Vueling

**David Teeters**, Professor, IESE Business School

**Ernesto Fernandez**, Student, IESE Business School

**Gaizka Ormazabal**, Professor, IESE Business School

**Minahil Amin**, Student, Saïd Business School

**Salla Ahonen**, VP Sustainability, Neste

**Special thanks to our competition mentor:**

**Joe Davies**, Associate Director, Foresight

# References

- 1) <https://ourworldindata.org/co2-emissions-from-aviation>
- 2) <https://www.weforum.org/impact/fuelling-sustainable-aviation/>
- 3) <https://assets.kpmg.com/content/dam/kpmg/ie/pdf/2022/07/ie-aviation-2030.pdf>
- 4) <https://www.sciencefocus.com/future-technology/sustainable-air-travel/>
- 5) <https://www.eurocontrol.int/publication/eurocontrol-data-snapshot-co2-emissions-flight-distance>,  
<https://www.flightglobal.com/networks/at-6-of-flights-long-haul-services-emit-51-of-co2-eurocontrol/142445.article>
- 6) [https://joint-research-centre.ec.europa.eu/welcome-jec-website/reference-regulatory-framework/renewable-energy-recast-2030-red-ii\\_en#:~:text=The%20RED%20II%20defines%20a,financial%20support%20by%20public%20authorities.](https://joint-research-centre.ec.europa.eu/welcome-jec-website/reference-regulatory-framework/renewable-energy-recast-2030-red-ii_en#:~:text=The%20RED%20II%20defines%20a,financial%20support%20by%20public%20authorities.)
- 7) <https://www.chemanager-online.com/en/news/european-oil-refineries-sold-and-sale-2>
- 8) [https://lexpacency.org/eu/32018L2001/ANX\\_IX/](https://lexpacency.org/eu/32018L2001/ANX_IX/)
- 9) [https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA\\_Eligible\\_Fuels/ICAO%20document%2005%20-%20Sustainability%20Criteria%20-%20November%202022.pdf](https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA_Eligible_Fuels/ICAO%20document%2005%20-%20Sustainability%20Criteria%20-%20November%202022.pdf)
- 10) [https://www.transportenvironment.org/wp-content/uploads/2021/07/CE\\_Delft\\_200247\\_UCO\\_as\\_biofuel\\_feedstock\\_in\\_EU\\_FINAL%20-%20v5\\_o.pdf](https://www.transportenvironment.org/wp-content/uploads/2021/07/CE_Delft_200247_UCO_as_biofuel_feedstock_in_EU_FINAL%20-%20v5_o.pdf)
- 11) <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/oil/041421-refinery-news-roundup-more-full-or-partial-closures-in-europe>
- 12) <https://www.qcintel.com/article/zeeland-refinery-begins-3-week-maintenance-11289.html>
- 13) [https://www.icao.int/environmental-protection/pages/SAF\\_LifeCycle.aspx](https://www.icao.int/environmental-protection/pages/SAF_LifeCycle.aspx)
- 14) <https://theicct.org/wp-content/uploads/2022/09/refueu-definitions-trilogue-sep22.pdf>
- 15) [https://joint-research-centre.ec.europa.eu/welcome-jec-website/reference-regulatory-framework/renewable-energy-recast-2030-red-ii\\_en](https://joint-research-centre.ec.europa.eu/welcome-jec-website/reference-regulatory-framework/renewable-energy-recast-2030-red-ii_en)
- 16) <https://skynrg.com/a-summary-of-the-proposed-sustainable-aviation-fuel-mandate/#:~:text=Based%20on%20SkyNRG%20analysis%20C%20onon,and%20synthetic%20fuel%20mandates%20C%20respectively.>
- 17) [http://www.insightenergy.org/system/publication\\_files/files/000/000/060/original/RREB9\\_-\\_Stimulating\\_the\\_uptake\\_of\\_liquid\\_biofuels\\_\(2\).pdf?1485275774](http://www.insightenergy.org/system/publication_files/files/000/000/060/original/RREB9_-_Stimulating_the_uptake_of_liquid_biofuels_(2).pdf?1485275774)
- 18) <https://www.fastmarkets.com/insights/netherlands-to-reduce-biofuel-crediting>

# Appendix

# Input assumptions (1/2)

Inputs	Use per ton of feedstock
Hydrogen	0,045 t
Electricity	0,97 MWh
Water	384 M³
Natural Gas	5,25 GJ

Output	Yield
SAF	49%
Biodiesel	23%
Naphtha	7%
LPG	10%

Cost factor	Price (EUR)
Feedstock (UCO)	820/t
Hydrogen	5.500/t
Electricity	120/MWh
Natural Gas	26/GJ
Water	0,04/M³
Labour	2.750.000/Year
Land rent	375.000/Year
Maintenance	2% of CapEx
Insurance	0,5% of CapEx
Overhead	1.000.000/Year

# Input assumptions (2/2)

Role	# of employees per shift
Operator	6
Supervisor	1
Tech. Specialist	5

Revenue factor	Price (EUR)
SAF	1.300/t
Biodiesel	1.100/t
Naphtha	630/t
LPG	600/t
HBE	7/GJ

HBE factors	Value
SAF	44 GJ/t
Biodiesel	44 GJ/t
Naphtha	45 GJ/t
LPG	46 GJ/t
Aviation multiplier	1,2
Double counting	Yes (2)
Value captured	75%



# Excel of financial model – 2019 baseline

	2024	2025	2026	2027	2028	2029
<b>Operations</b>	0%	0%	45%	92%	92%	92%
Revenue from SAF	-	-	112.896	229.555	229.555	229.555
Revenue from HBE	-	-	104.369	212.216	212.216	212.216
Revenue from remainders	-	-	49.005	99.644	99.644	99.644
<b>Total revenues</b>	-	-	<b>266.270</b>	<b>541.415</b>	<b>541.415</b>	<b>541.415</b>
Feedstock cost	-	-	157.500	320.250	320.250	320.250
Utility cost	-	-	75.096	152.695	152.695	152.695
Labour cost	-	-	2.750	2.750	2.750	2.750
Total fixed cost	-	-	13.375	13.375	13.375	13.375
<b>Total cost</b>	-	-	<b>248.721</b>	<b>489.070</b>	<b>489.070</b>	<b>489.070</b>
<b>EBITDA</b>	-	-	<b>17.549</b>	<b>52.344</b>	<b>52.344</b>	<b>52.344</b>
Depreciation	-	-	24.000	24.000	24.000	24.000
<b>EBIT</b>	-	-	<b>6.451</b>	<b>28.344</b>	<b>28.344</b>	<b>28.344</b>
Interest	- 3.000	- 13.200	- 19.176	- 16.875	- 14.850	- 13.068
Taxes	-	-	-	- 2.351	- 2.766	- 3.132
<b>Net income</b>	- <b>3.000</b>	- <b>13.200</b>	- <b>25.627</b>	<b>9.118</b>	<b>10.728</b>	<b>12.145</b>
<b>FCF</b>	- <b>62.400</b>	- <b>70.560</b>	- <b>1.302</b>	<b>26.495</b>	<b>27.783</b>	<b>254.448</b>

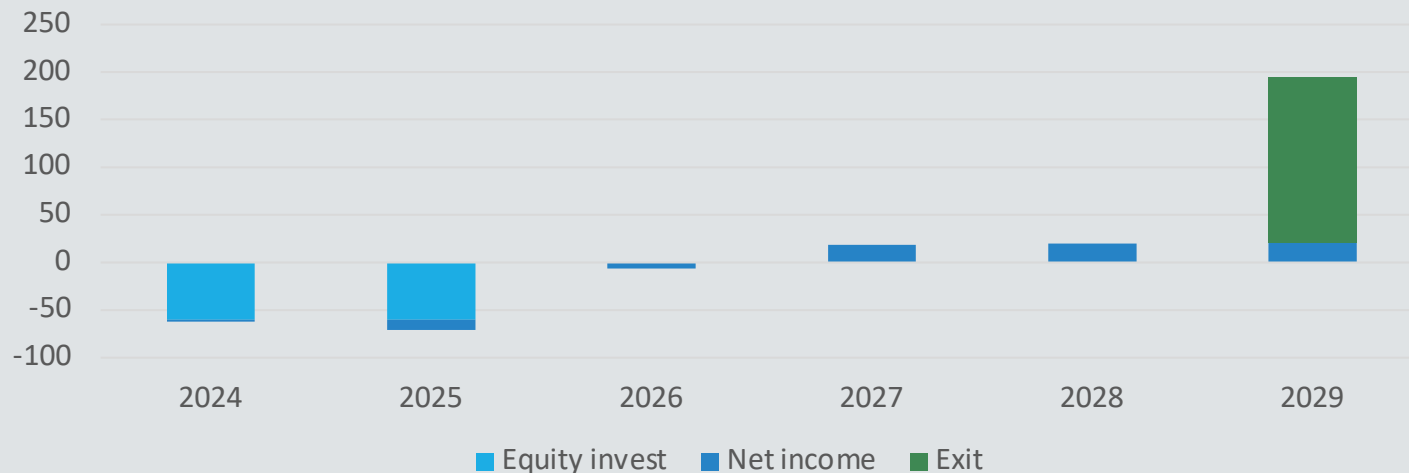
# Excel of financial model – 2023 baseline

	2024	2025	2026	2027	2028	2029
<b>Operations</b>	0%	0%	45%	92%	92%	92%
Revenue from SAF	-	-	143.325	291.428	291.428	291.428
Revenue from HBE	-	-	103.340	212.216	212.216	212.216
Revenue from remainders	-	-	80.348	163.373	163.373	163.373
<b>Total revenues</b>	-	-	<b>327.013</b>	<b>667.017</b>	<b>667.017</b>	<b>667.017</b>
Feedstock cost	-	-	184.500	375.150	375.150	375.150
Utility cost	-	-	116.046	235.960	235.960	235.960
Labour cost	-	-	2.750	2.750	2.750	2.750
Total fixed cost	-	-	13.375	13.375	13.375	13.375
<b>Total cost</b>	-	-	<b>316.671</b>	<b>627.235</b>	<b>627.235</b>	<b>627.235</b>
<b>EBITDA</b>	-	-	<b>10.342</b>	<b>39.782</b>	<b>39.782</b>	<b>39.782</b>
Depreciation	-	-	24.000	24.000	24.000	24.000
<b>EBIT</b>	-	-	<b>13.658</b>	<b>15.782</b>	<b>15.782</b>	<b>15.782</b>
Interest	- 3.000	- 13.200	- 19.176	- 16.875	- 14.850	- 13.068
Taxes	-	-	-	224	191	556
<b>Net income</b>	- <b>3.000</b>	- <b>13.200</b>	- <b>32.834</b>	- <b>869</b>	- <b>741</b>	- <b>2.157</b>
<b>FCF</b>	- <b>62.400</b>	- <b>70.560</b>	- <b>7.067</b>	<b>17.175</b>	<b>18.463</b>	<b>180.745</b>

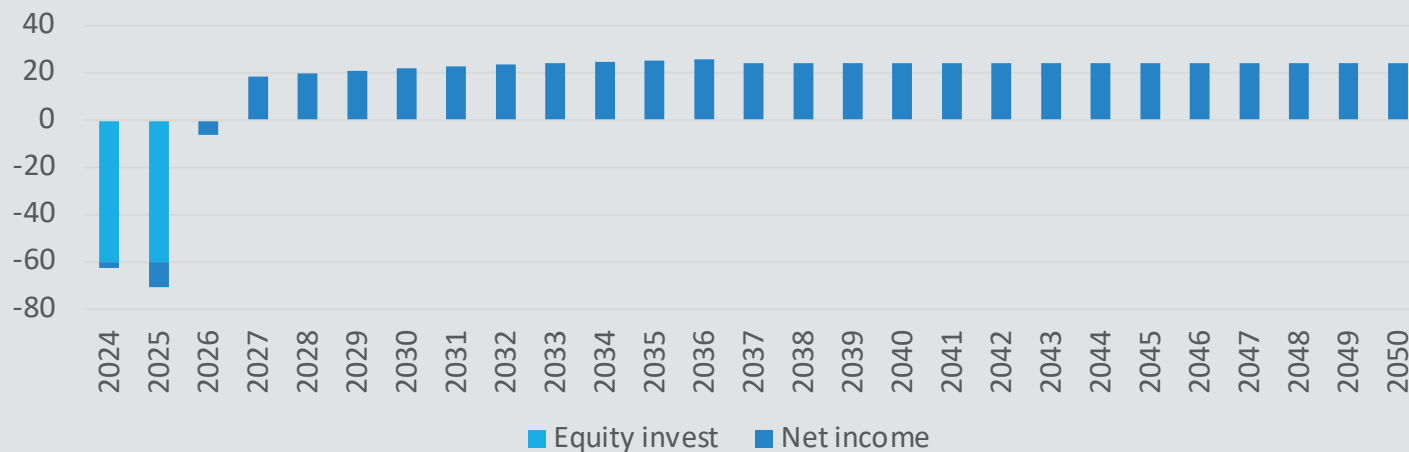


# Returns & Fund Terms

Cash flows with exit



Cash flow full asset life



## FuelForward Fund

Total addressable market	EUR 10 Bn+
Target fund size	EUR 120 Mn
Fund time horizon	6 years
Project time horizon	27 years
Target investors	Impact-oriented investors, Family Offices
Target project IRR	13.2% (gross)
Hold-to-maturity IRR	12.9%
Management fees	0.25% of AUM, 20% of returns exceeding 15% IRR
Asset class	SPV, Private Equity
Financial leverage	50% debt-equity structure

# Reference projects

## SkyNRG – DSL-01

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- Greenfield refinery
- 150.000 t yearly feedstock capacity
- EUR 250 mn investment in plant development

## Neste - Rotterdam

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- Greenfield refinery
- 1.000.000 t yearly feedstock capacity
- EUR 670 mn investment in plant development

## Total – La Mède

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- Brownfield refinery
- 600.000 t yearly feedstock capacity
- EUR 200 mn investment in plant retrofit

# EU-Level proposed legislation

"Fit for 55" Package:<sup>14</sup>

- Proposal to mandate SAF uptake (REFuel EU initiative) targeting EU-wide GHG emissions reduction of 55% by 2030
- Starting in 2025 with 2% SAF made available to airports and increasing to 5% by 2030, 32% by 2040 and 63% by 2050
- Transition period up till 2030 - aviation fuel suppliers may supply the defined minimum share of sustainable aviation fuel as an average over all the aviation fuel they supplied to EU airports in a given period (as opposed to supplying the defined minimum shares at each airport)

Renewable Energy Directive (RED-II):<sup>15</sup>

- EU Member States must ensure that 14% of their transport fuels are derived from renewable energy sources (including 1st generation biomass)
- Advanced biofuels have a specific sub-target of 0.2% in 2022, at least 1% in 2025, and increasing to at least 3.5% in 2030
- Advanced biofuels must fall within the RED-II definition which excludes palm oil, does not create additional demand for land (ILUC) and is primarily made from wastes or residues

Predicted cost of penalties:<sup>16</sup>

- Fuel suppliers: At least 2x the difference between the yearly average price of fossil jet fuel and SAF, times the amount of SAF required to meet the specified target (penalties in 2030 approximately €1,000 and €6,000 per tonne of fuel for the advanced bio and synthetic fuel mandates)
- Airlines: At least 2x as high as yearly average price of conventional jet fuel, multiplied by the quantity of SAF that has not been uplifted. Taking an average market price of €600 per ton of jet fuel, airlines could risk a penalty of €1,200 per ton of non-tanked SAF

# Domestic-level legislation (NL)

- Dutch Emissions Authority has implemented the HBE Compliance System which requires companies that deliver fuel to the transport market to annually increase the proportion of renewable energy they supply according to mandated targets<sup>17</sup>
- HBE refers to Renewable Energy Units – for each gigajoule of renewable energy that companies physically deliver to the Dutch transport sector generates one HBE, or two if a multiplier of two can be applied. Fuel suppliers can then trade to help achieve their annual obligations
- In an effort to reduce dependence on Russian oil and increase domestic renewable energy production the Dutch ministry of infrastructure and water management has proposed lowering the multiplier for biofuels produced from feedstocks listed in Annex IX Part A and B of the EU's Renewable Energy Directive (RED II) to 1.6 from 2<sup>18</sup>

# EU-Level sustainable finance proposals

- EU Commission has proposed to expand the EU taxonomy's list of investments that can be labelled as green
- The EU taxonomy green label aims to provide a gold standard for sustainable investing which will help facilitate funding towards climate-friendly projects
- However, the proposals have been controversial with stakeholders split over whether certain aviation investments being considered green is in fact "greenwashing" by the EU
- As zero-emission aircraft are currently not possible, industry players are pushing for more carbon efficient planes which use SAF to fall within the green label list
- As the aviation industry relies on competitive pricing, industry players fear that losing the green label could make it harder to secure finance for deliveries of new planes and drive up funding costs
- The EU has yet to make a final decision but when it does, it could drastically change financing for EU-wide aviation investments