

Towards advanced biofuels

Options for integrating conventional and advanced biofuel production sites
(RES-T-BIOPLANT)

Lignofuels 2016, Munich, Germany

Prepared by:

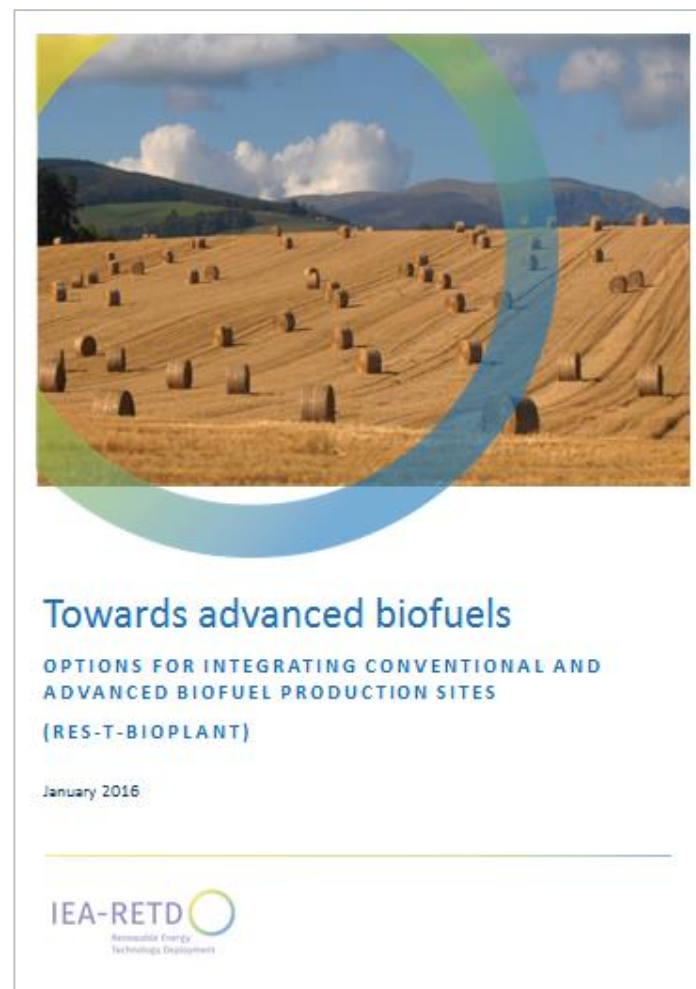
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Options for integrating conventional and advanced biofuel production sites (RES-T-BIOPLANT)

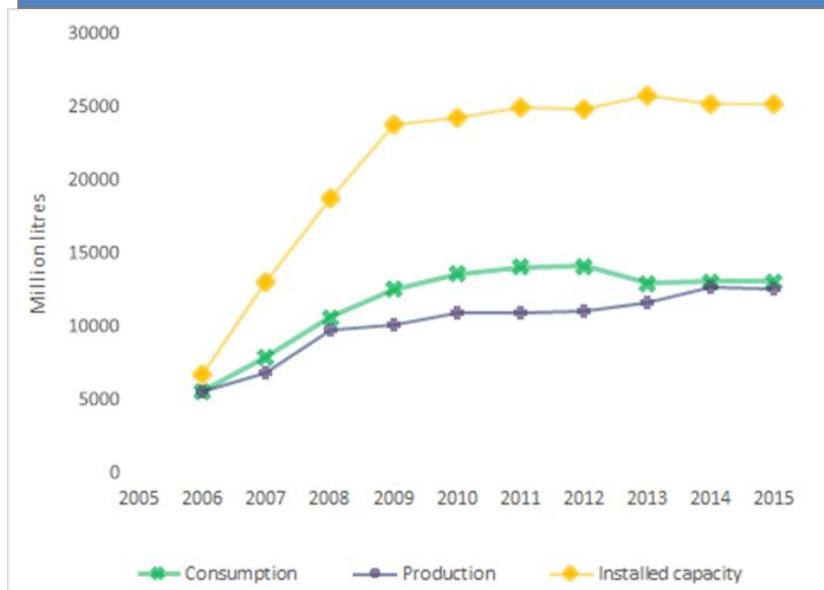
- Reasons for this study
- Objective and scope
- Feasibility of integration
- Cost savings and other benefits
- Other considerations
- Policy instruments
- Conclusions and recommendations



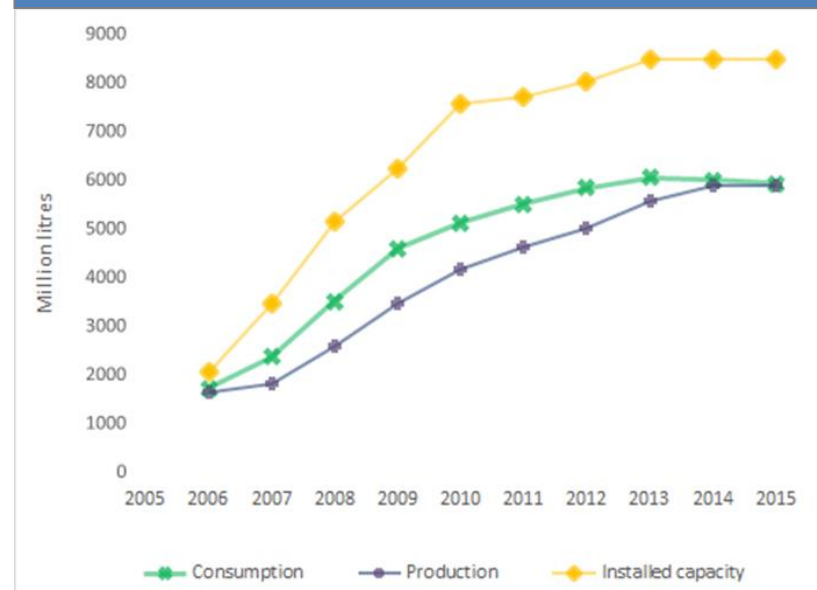
Production capacity of 1G biofuels boomed last decade in the USA, EU and some emerging countries

- But demand did not grow at same pace
- However, long-term trajectory for decarbonising transport unlikely to change (i.e. more 2G biofuels) → COP21 outcome!

Development of biodiesel in the EU



Development of bioethanol in the EU



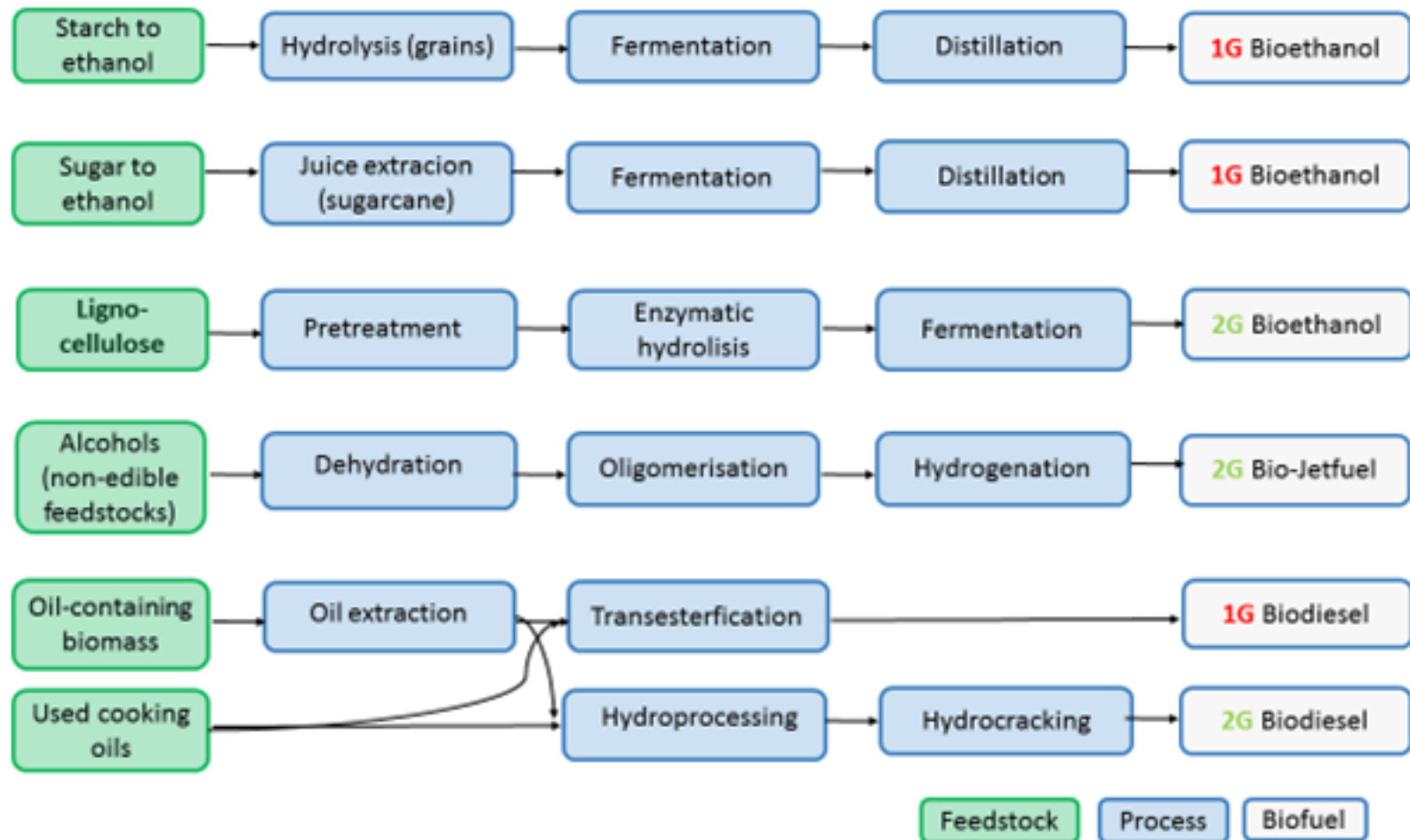
Get a better understanding of the scale of the opportunity for adapting existing sites to produce advanced biofuels

- The study analyses the potential role of government policy to incentivise integration
- Based on factual evidence from recently published work and from written and oral interviews to 21 relevant stakeholders, including representatives from producers, industry associations, government and public institutions, research and knowledge institutions, and global users and traders
- Scope of the report:
 - Identification of integration options for 1G and 2G processes
 - Technical feasibility and analysis of costs and benefits associated
 - Overview of supporting policies
 - Recommendations on next steps for sites integration
- Study supports members of IEA-RETD: Canada, Denmark, France, Germany, Ireland, Japan, Norway, UK, and the EC

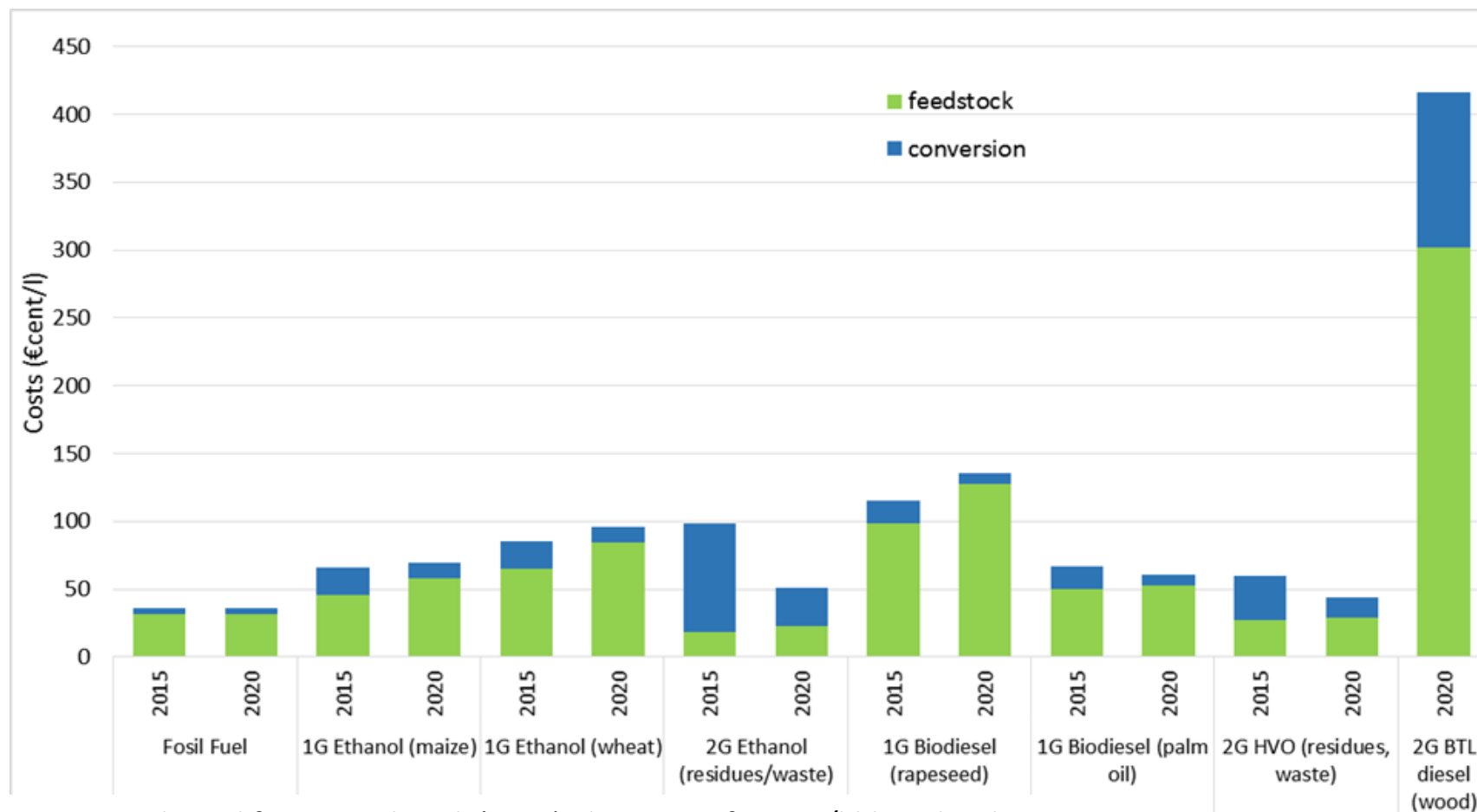
Biofuels classified on basis of the feedstock used

- Conventional (1G) biofuels are produced from food crops
 - Biodiesel (FAME) from edible vegetable oils (palm, rapeseed, soybean, and sunflower oils, etc.)
 - Bioethanol from sugars (sugarcane, sugar beets, etc.) or from cereal-based starches (corn, wheat, etc.)
- Advanced (2G) biofuels are produced from lignocellulosic feedstock, non-food crops, or industrial waste and residue streams
 - Cellulosic bioethanol produced by hydrolysis and fermentation
 - Alcohol-to-Jet Fuel (ATJ) when alcohol is produced from 2G feedstock
 - Hydrogenation processes: HVO or HEFA when produced from 2G feedstock
 - Fischer-Tropsch (FT) or Biomass-to-Liquid (BtL)

Conversion pathways linked to feedstock and 1G/2G products



Important reduction costs of conversion by 2020. Feedstock cost keeps being crucial for competitiveness

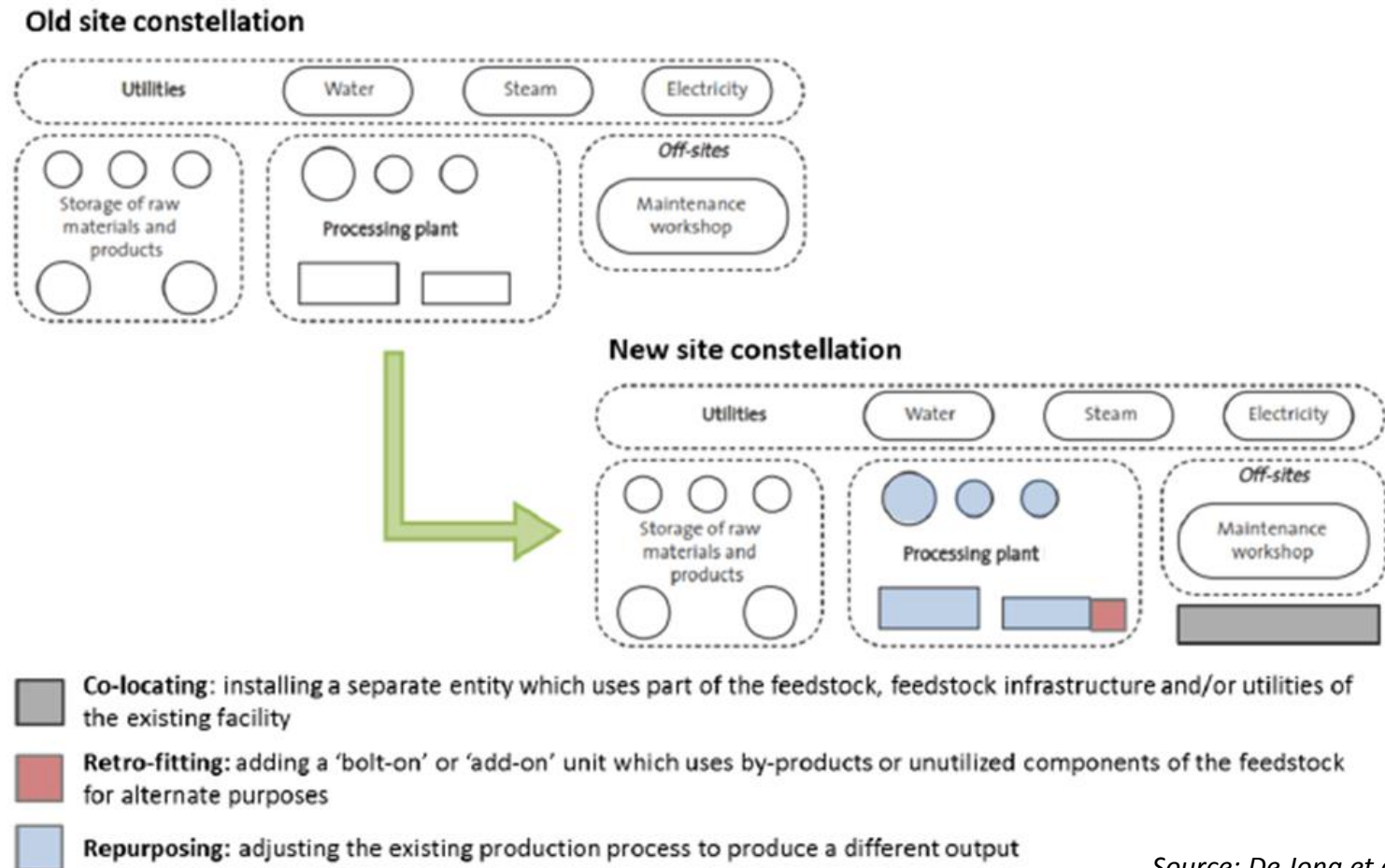


Source: Adapted from Festel et al. (2014); data given for 50 €/bbl crude oil price

2G plants can be implemented as stand-alone units or integrated with 1G plants

- Integration strategies can refer to
 - **Co-location:** Siting new separate 2G plant adjacent to existing 1G facility
 - **Retrofitting:** Altering existing 1G production line for producing 2G biofuels alongside 1G biofuels
 - **Repurposing:** Adjusting production process of existing – mothballed - facility to produce 2G biofuels
- “Energy integration” of electricity/heat is an additional key option
- Integration also possible in non-1G plants (e.g. pulp&paper mill)
- Typically, co-locating is easiest, retrofitting more challenging, repurposing seldom used

Schematic example for different degrees of sites integration. Storage, off-sites and utilities can be shared in all options



Source: De Jong et al. (2015)

Significant synergies for bioethanol sites exist, less for biodiesel

- **Bioethanol** is technically and economically more suitable for integration compared to biodiesel
- Eventually, 2G bioethanol integration will become **mainstream**, increasing resource efficiency in the production of bioethanol
- **Co-location is the most used strategy.** Retrofitting more challenging and more sensitive to economics, repurposing seldom used.
- Integration strategies are a basic approach for 2G plant implementation at pilot stage to minimize cost and investor risks
- Integration of 2G ethanol in pulp & paper industry and 2G renewable diesel into fossil refineries are interesting options

Cost-savings from co-location for all 2G conversion pathways are in the order of 5-10%

- Site-specific optimization can yield to much higher cost reductions, especially for investment costs
- Example of sugarcane ethanol in Brazil: investment of 2.9 €/l capacity for stand-alone 2G plant gets reduced to 1.4 €/l for a co-located plant.
- For corn bioethanol, production costs in co-located mills can be reduced by 34% with respect to 2G mills due to sharing electricity and steam
- Retrofitting and co-location of bioethanol plants could generate 40% CAPEX savings, which represents roughly a 20% total cost reduction

Increased resource efficiency, small land use savings, employment is positive. No extra GHG reductions

- **Improve resource efficiency with less waste.** Whole plant becomes feedstock for producing larger amount of biofuel (bagasse and sugarcane, stover and corn, etc)
- **Only few sources identified GHG emission reductions**, and those were mainly due to 2G operation, i.e. not related to integration
- **Integration can deliver (small) direct land use savings**, compared to greenfield stand-alone plants
- **Employment and regional economy impacts of sites integration are positive**, but addressed only qualitatively in literature

Decisions do not only depend on technical feasibility or costs. Business considerations are as important, even the key factor

- **“Blend wall”** restrictions limits the possibilities for larger production of drop-in bioethanol. Bioethanol for dedicated biofuel fleets (not blended) or for Jet Fuels from integrated sites are an interesting market option for the extra production capacity in the market
- **Colocation of 1G biodiesel and HVO may be interesting** because of the business value of 1G sites’ full licensing to operate, and market access (feedstock and product distribution)
- **Evolution of HVO sites (renewable diesel) into HVO sites using 2G feedstock is not considered by market players as a good business idea.** This because current HVO plants are profitable using 1G feedstock and don’t need technology changes to keep being profitable

A variety of policy instruments to support technology development, infrastructure and market introduction exist

- **Instruments for technology development**

- *Economic* Public and private funding for R&D
- *Collaborative* Agreements for R&D cooperation

- **Instruments to support new infrastructure**

- *Economic* Direct investment and incentives for the integration of 2G sites
Financing schemes, tax exemptions/low-interest loans
Emissions trading schemes

- **Instruments for market integration**

- *Command* Blending mandates, quotas, emissions obligations
- *Economic* Tax exemptions per unit of biofuel produced
Trade certificates, tariffs and duties
- *Collaborative* Own production or consumption targets, voluntary procurement

Instruments have different effectiveness to reduce price gap, but order and strategy of implementation are crucial

- 2G bioethanol needs **market introduction support** due to low fossil fuel prices, and no **GHG crediting**
- **The order of implementation** of policy instruments is crucial though. **Quotas or blending mandates** would cause more harm than benefits if applied in an immature market. They are valid only **after** learning took place –volatile revenue imposes high risk for investments
- Technological learning requires investments to “drive down” the curve , **i.e. securing pioneer markets** is needed
- RTD budget with targets are helpful, but **not enough**: e.g. 10 yr specific tax reduction and/or credits needed!
- Stakeholders agree that **stability and predictability** are most important aspects. Policy must make clear conditions and **how much money will be available**

Transition has started, but further research is required to make integration a mainstream trend

- Co-location and retrofitting is already used by the industry as strategy to integrate 1G and 2G bioethanol sites, but more analysis is needed to **unveil** full potential
 - It is recommended to **conduct analytical studies on the economic feasibility and other benefits of specific co-location and retrofitting strategies for 1G bioethanol sites, including ATJ for the aviation sector.**
- Integration of 2G bioethanol **in pulp & paper industry** sites and 2G biodiesel into existing **fossil refineries** also options already being implemented in the market
 - Include **these integration options in follow-up work**, especially in relation to their impact on current 1G biofuel sites.

Business and market options may favour the integration of biodiesel sites

- Technical feasibility of the integration of 1G and 2G biodiesel sites is rather limited. Yet, further analysis **on business- and market-oriented options** may exist that favour this transition, mainly via co-location
 - Carry-out market research for determining conditions for which 1G biodiesel sites **could be of interest to 2G biodiesel plants investors**, especially regarding **access to market niches**, product distribution strategies and feedstock supply possibilities.

Limited information in the public domain is a bottleneck for the dissemination of benefits of integration

- There is **limited information** on 2G integration in the **public domain** (conference proceedings, journal articles, PhD theses etc.)
 - It is recommended that further analytical work should include **a panel of key industry stakeholders** to discuss what approach and incentives will allow access to “in-house” data and what level of access this might be.

Policy strategies that deliver international coherence and policy parity between different sectors using biofuels is needed

- Consider an **in-depth policy study for proposing a specific mix of policy instruments for relevant countries or supranational regions**, e.g. the EU. This study should respond to questions such as:
 - How much **economic support is needed for R&D**, for what specific technology pathways, for **how long and with which indicative results** as targets?
 - What have been the **most effective economic instruments** and incentives for realising new infrastructure? **How much money should be budgeted** for those instruments and when should they be stopped?
 - What are the **right signals before volumetric or blending mandates** can be implemented safely? Do they need to be accompanied with economic incentives such as **tax credit for production, certificates or feed-in-tariffs**?
 - How policy instruments should be designed to **avoid cross-subsidies in co-location and retrofitting setups**?

The study is freely available online

- From IEA-RETD:

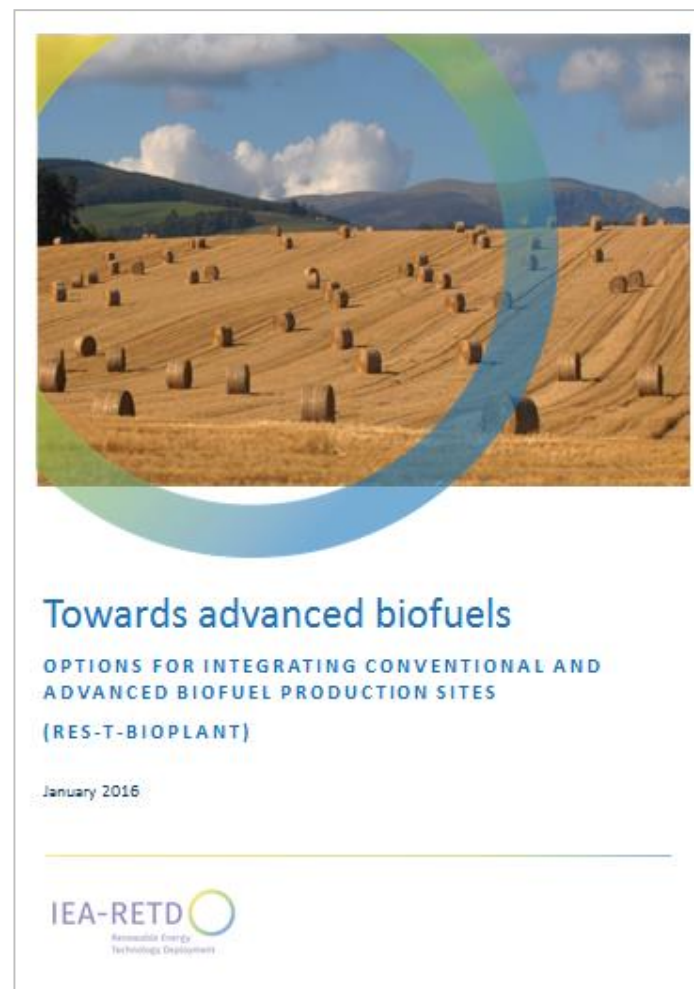
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THANK YOU!

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