Availability of Resources for Biofuels Some Harsh Realities, Wild Guesses and Suggested Ways Forward

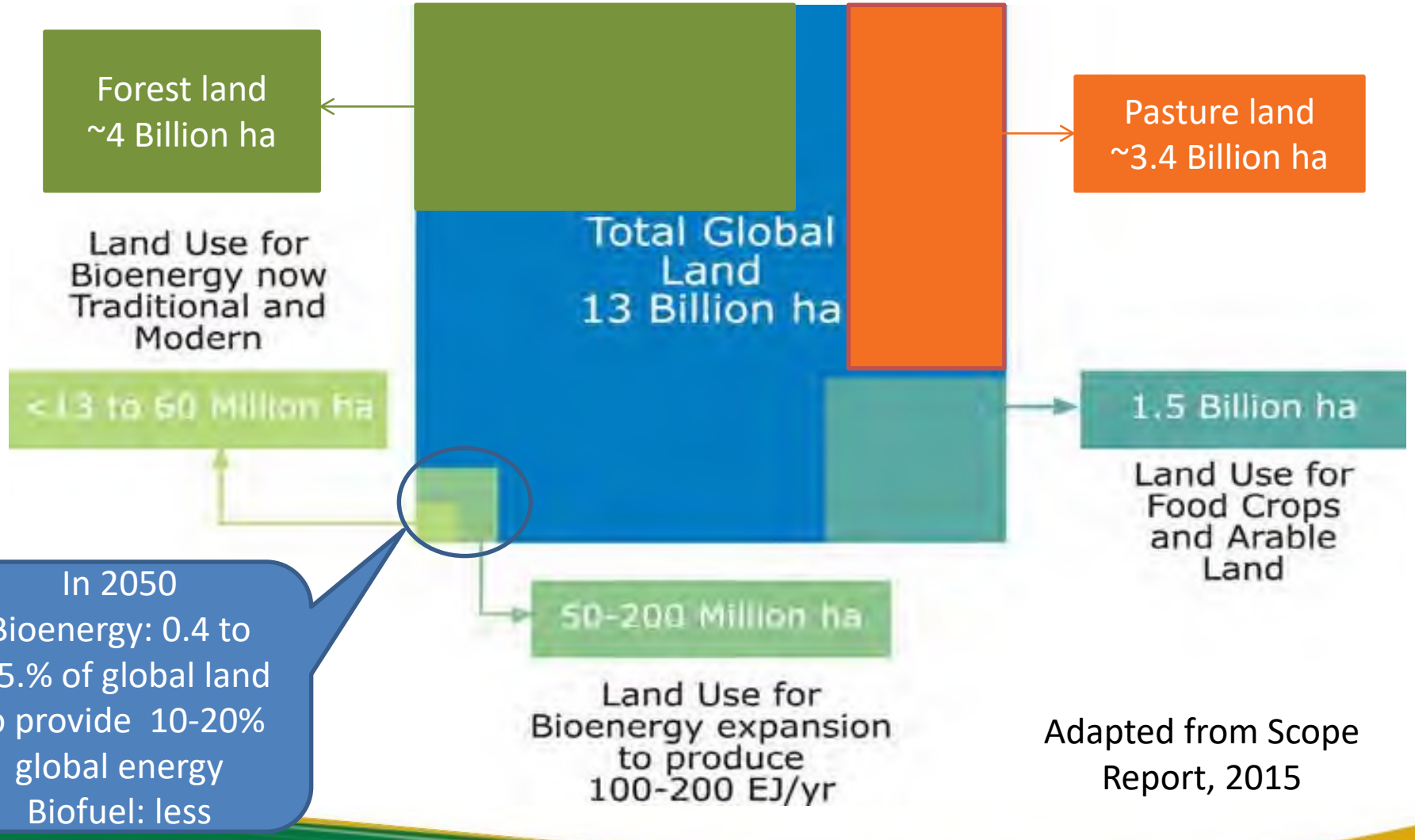
Olivier Dubois, FAO

ARTS Fuel Forum Workshop, EUBCE, Copenhagen 14-17 April, 2018

1. Some Harsh Realities

Best we can do is wild guessing on available resources for bioenergy/biofuels

Wild guess #1: How Much Land for Bioenergy? Enough



Adapted from Scope Report, 2015

Issue is more about WHOSE land

Source: Dubois, 2008

Land belongs to	Size of bionergy production unit	
	Large	Small/community type
Company (private or public)	A	C
Small producer or community	B	D

Outgrower schemes

And more about WHAT land

- **'No go areas'** (high carbon, high biodiversity) **– Relatively easy to define; more difficult to enforce – This is land governance issue, and not only for bioenergy**

- **'Best bet areas'** Often so-called degraded/marginal/abandoned land: But this is a controversial/dynamic concepts (condition changes over time + rehabilitated land can also be again used for food as well as for bioenergy, etc)- So the **use of 'best bet areas' should be *locally* defined and decided**

+

What is more Interesting for investors !?

Wild guess #2: Sustainable Bioenergy Potential?

- Ranges go **from 0 to 300 EJ !**
- Reasonable consensus that (IEA Bioenergy Roadmap 2017)
  - **At least 100 EJ** potentially available for 20150/2060
  - Potentials within the **100 – 300 EJ range still reasonable** but that the risks of delivery increases as the estimate rises.
  - **Around 145 EJ needed** to achieve the 2DS or B2DS climate change targets

Global Realities – Very difficult to soundly determine the availability of resources for biofuels beyond wild guesses

Because:

- It pretty much **depends on local conditions** and **how biofuels are managed**

- **Availability of feedstock is often reduced** by the fact that, in some important decision making places, **rules and policies are not based on science but rather on over-simplifications linked to modelling, and emotions**

- **Models do not capture such realities –** Some examples

First example: Second-hand versus brand new tractors for small-scale farmers in one South-Asian country

- **A few years ago, step wise learning process possible:** Start with cheap and energy inefficient second-hand diesel tractors, then go for new, more expensive but energy efficiency tractors, and finally biodiesel ones

- **Not possible anymore** because diesel is bad as fossil fuel, and biodiesel is bad because of alleged high-ILUC risk.

- **So what to do**: Only options are (i) do nothing or (ii) wait for quite a while before 2G biofuel, electric or hydrogen tractors reach the country. In the meantime farmers produce less and do not learn about mechanisation

Second example: Transforming an oil refinery into a biofuel refinery in a Eastern-European country

- Possibility to start with excess beetroot feedstock, a crop local farmers know well, **refused** by the financing institution **simply because 1G**
- **2G solution** - based on wheat straw and Miscanthus **– much more complicated** and **risky** because of:
  - Logistics (collect wheat straw from many farms)
  - Lack of experience on new crop (Miscanthus); and
  - Sensitivity of financial feasibility to small changes in energy costs

  As a result the **availability of biofuels has been significantly delayed** and **biofuel production is more at risk**

Third example: Sustainable smallholder palm oil intensification for food and/or biodiesel + biogas from residues

- Concerned **thousands of smallholders** in one Asian and two African countries
- **No ILUC risk** because no land use change – these would concern existing plantations
- **Funding refused simply because** the project was about **palm oil**

2. Suggestions on Ways Forward

Let's come down to earth and to some common sense!

We should

- **Move Away** from **Myths** and **Sweeping Statements**
- **Not base policy** or **funding decisions** only on modelling results and/or over-simplifications

Instead:

- **Embrace the complexities** of biofuel development **rather than oversimplifying things by relying only on modelling and global studies**
- **Be constructive** and **rigorous** by **using available tools** and proven **good practices to get things right** through an **integrated, contextualized** and **evidence-based approach**

Maybe consider FAO's Key Messages on Biofuels

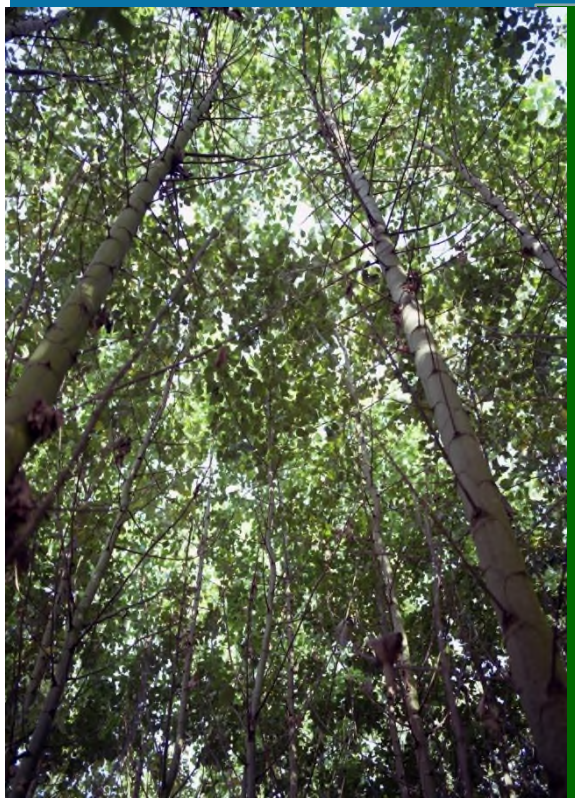
- **Sustainability of biofuels is context specific.** Therefore its assessment must be based on reality not models and global studies
- **Tools and knowledge are now available** to help governments and operators reduce risks and enhance opportunities of biofuels development
- *Per se* **biofuels are neither good nor bad.** What matters is the way they are managed
- **Biofuels** should be seen as another **opportunity for responsible investment in sustainable agriculture, rural development and bioeconomy**.

Thank you for your attention!

Contact: Olivier.Dubois@fao.org

www.fao.org/themes/energy/bioenergy

Biofuel Needs for Decarbonising Energy: Meeting the Challenge of Low Oil Prices



Workshop on EU Policy and Industry Perspectives on Biofuels in a Global Context

EUBCE Copenhagen 14 May 2018

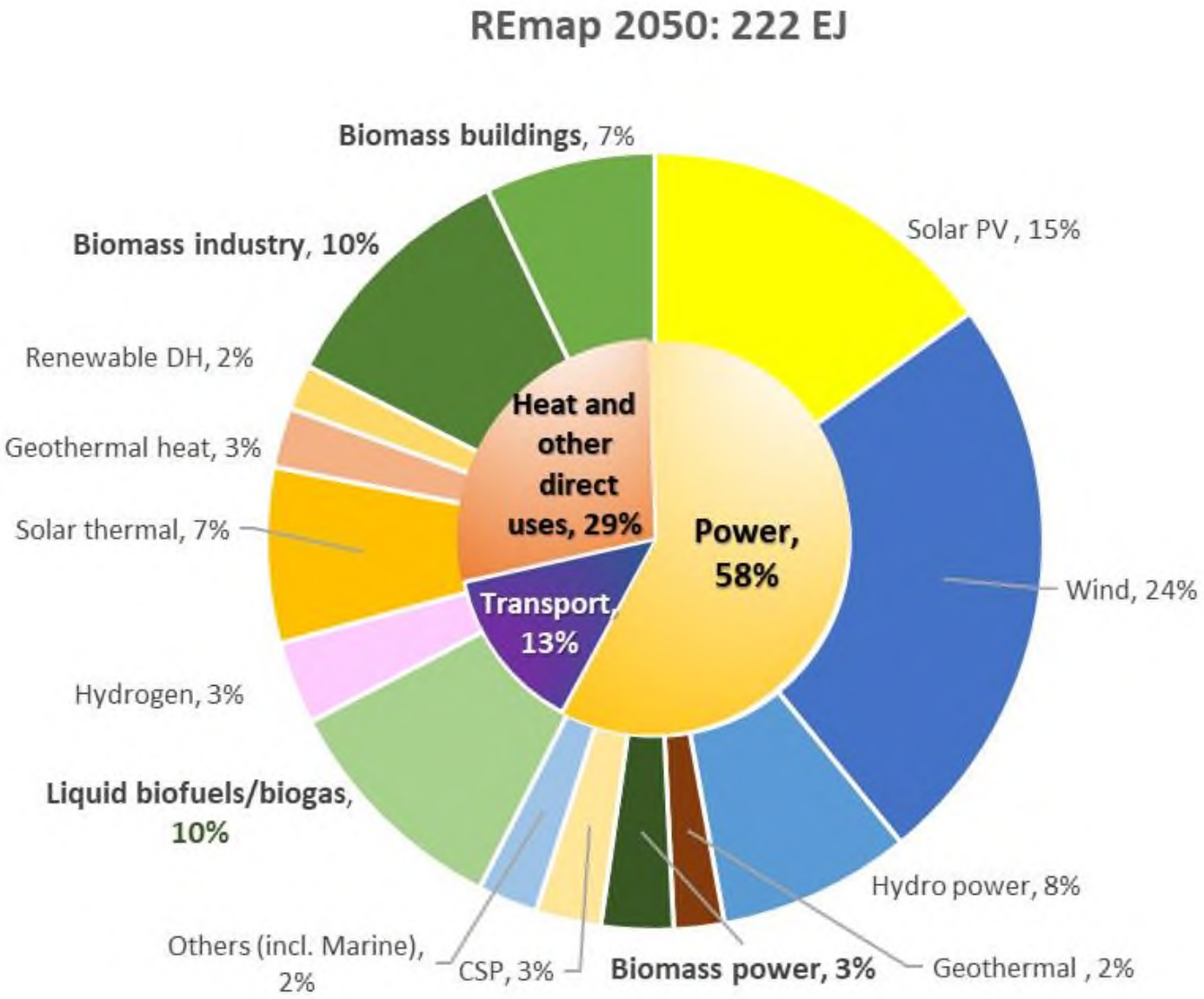
Jeff Skeer IRENA

Key points about biomass

- Most important RE form today and in future.
- Critical for meeting climate and other SDGs.
- Sustainable resource potential is ample.
- Essential for decarbonising transport
- Policy support required to mobilise effectively.

Most important RE source globally: 1/3 of cost-effective potential in 2050

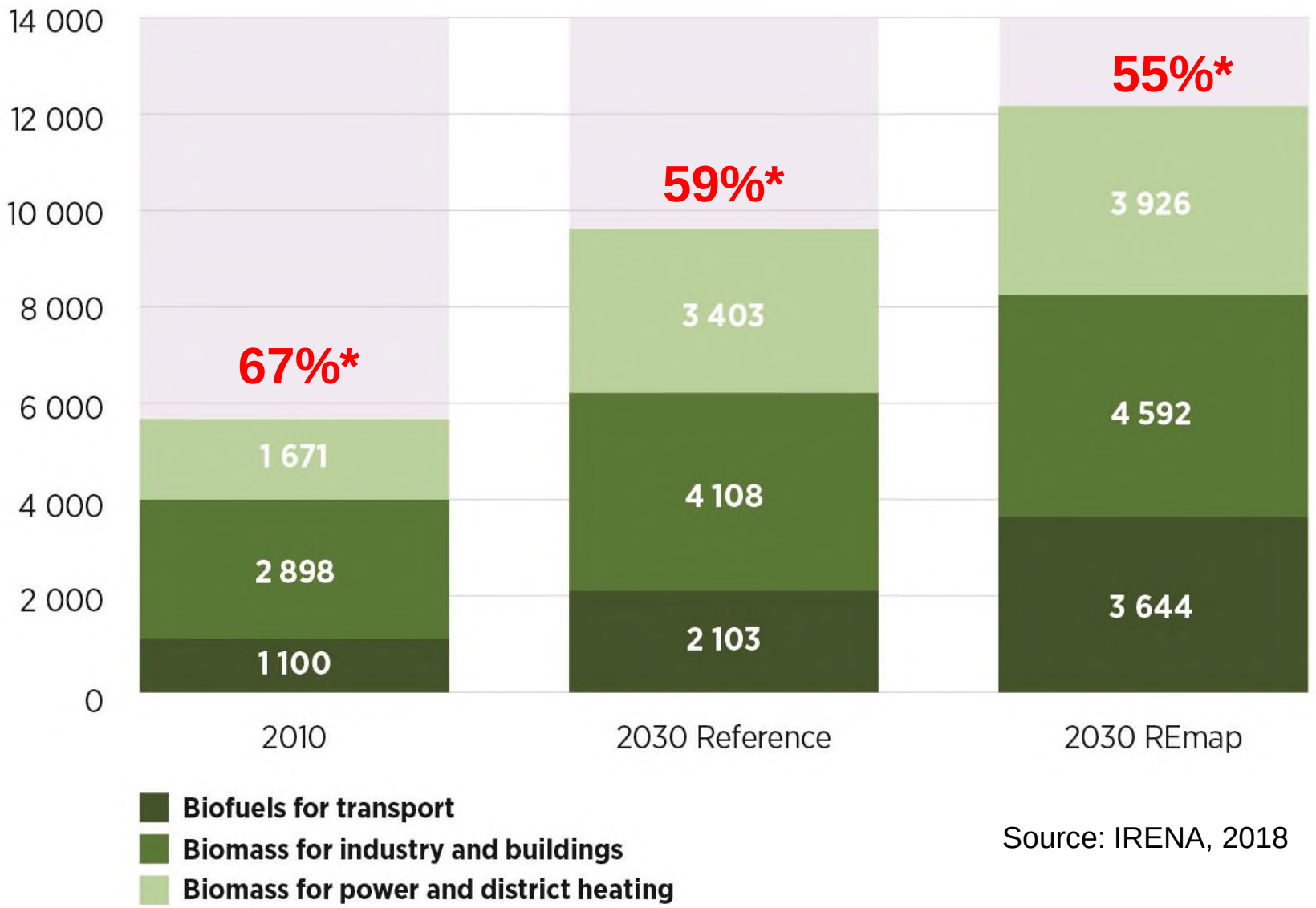
IRENA
International Renewable Energy Agency



Most important RE source in EU: 2/3 in 2010, still over 1/2 in 2030

IRENA
International Renewable Energy Agency

*biomass share of total RE deployment



Source: IRENA, 2018

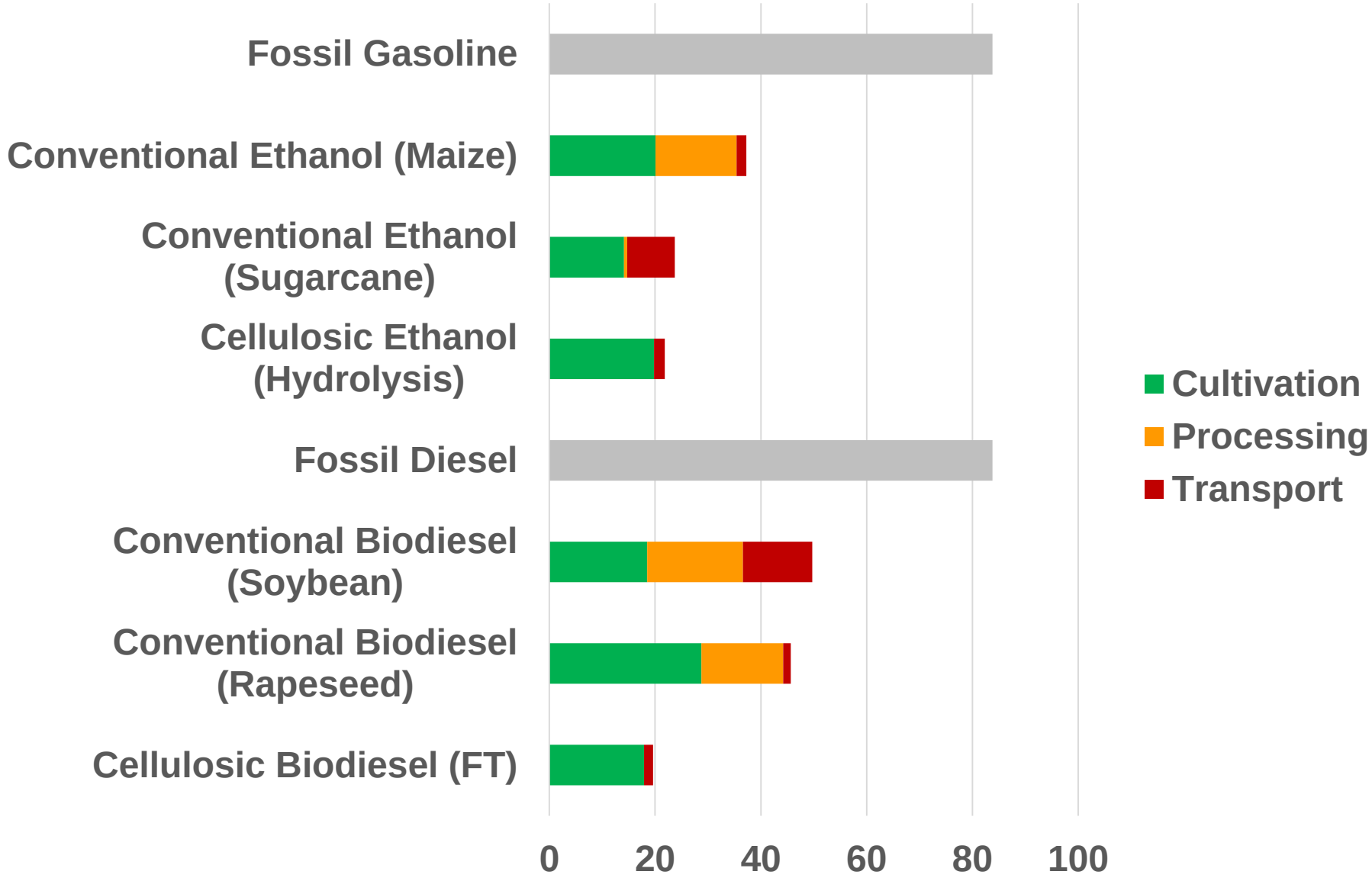
Decarbonising Transport: EVs Accelerate, Biofuels Essential for Freight and Aviation

- ***Renewable Power to Electrify Passenger Vehicles***,
  - better batteries bringing greater EV range
  - mass production lowering EV purchase costs,
  - operating costs lower for EVs than oil-fueled vehicles
  - GHG emissions lower for EVs even with fossil-fueled power, decline sharply as RE generating share grows
- ***Biofuels for Aviation, Freight and Marine Shipping***
  - High power needs require fuel with high energy density
  - Biofuels can be produced from many feedstocks

Sustainable Biomass Resources

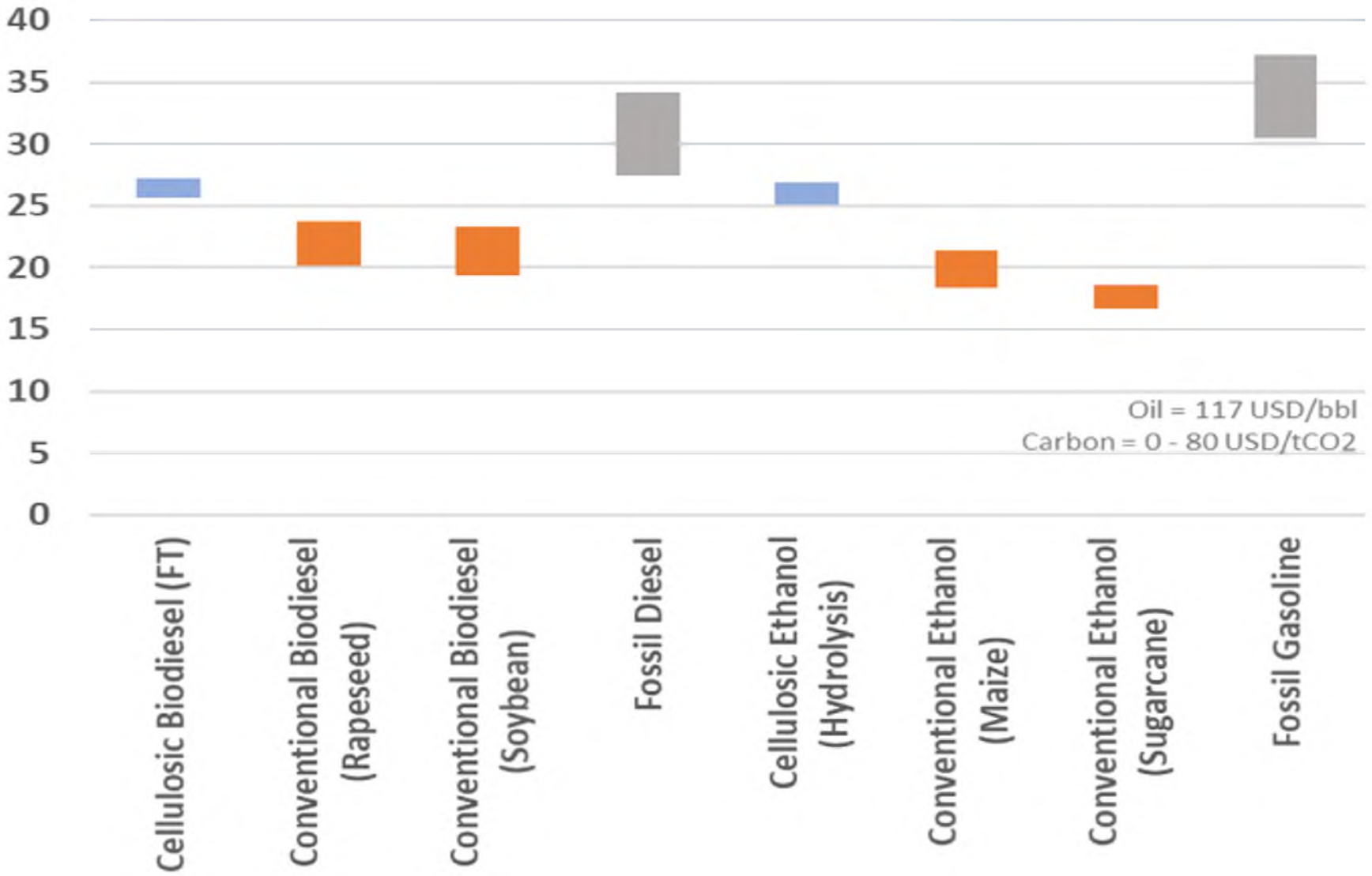
- Agriculture
  - Residues associated with growing food production
  - Higher yields on cropland (sustainable intensification)
  - Efficient livestock husbandry, freeing up pasture land
  - Reduced food losses and waste, freeing up farmland
- Forestry
  - Residues (complementary fellings on timberland)
  - Higher yields in planted forests (better management)
  - Afforestation of degraded forest and marginal lands

Carbon Benefits of Biofuels (gCO2/MJ)



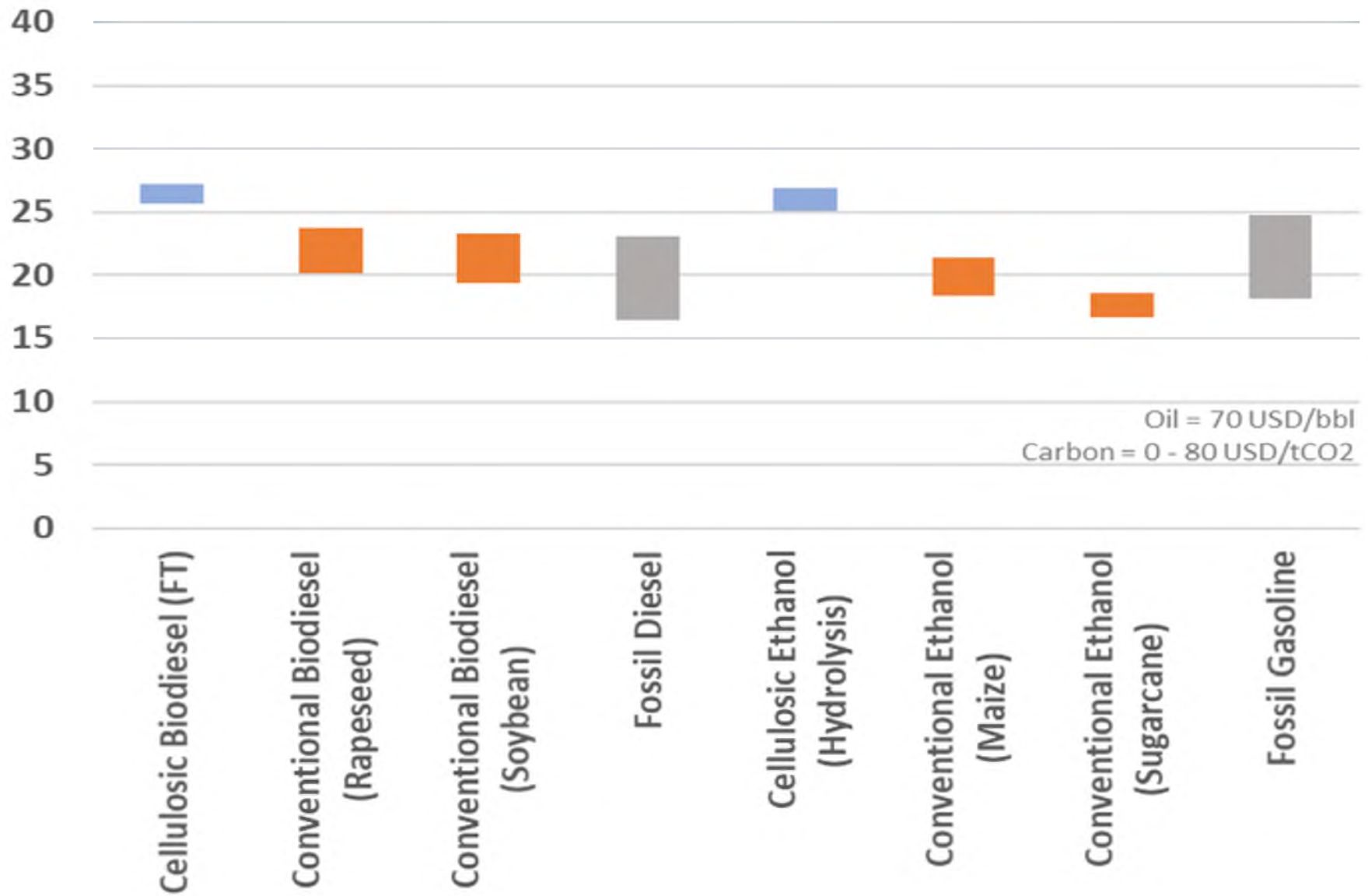
Future Fuel Costs in 2050 ($/GJ) with $117/bbl Oil and $0-80/tCO2-eq

IRENA
International Renewable Energy Agency



Future Fuel Costs in 2050 ($/GJ) with $70/bbl Oil and $0-80/tCO2-eq

IRENA
International Renewable Energy Agency



Where will we get our biojet?,

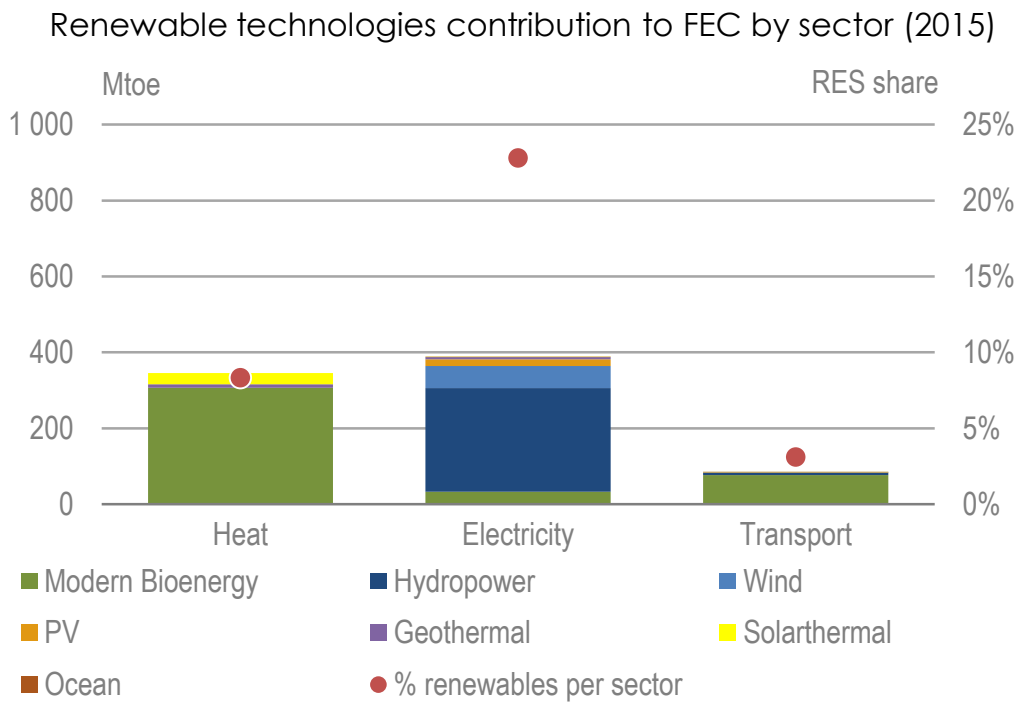
- ***Feedstocks and technologies to consider:***
  - Oilseed crops on restored land (upgrade biodiesel)
    - Europe (rapeseed), China, Americas.
  - Wood residues (Fischer-Tropsch thermochemical route)
    - Unrealised potential in SE Europe
  - Sugar/Energy cane (1G+2G ethanol plus conversion)
    - Brazil, Southern Africa, Caribbean
- ***Policy supports to consider:***
  - RD&D support for pilot plants w lignocellulosic feedstock
  - Significant market value for carbon and methane
  - Volumetric renewable fuel mandates
  - Limits on jetfuel carbon per person-km, tonne-km

IEA Technology Roadmap: The need to scale up sustainable bioenergy

Paolo Frankl, Head Renewable Energy Division

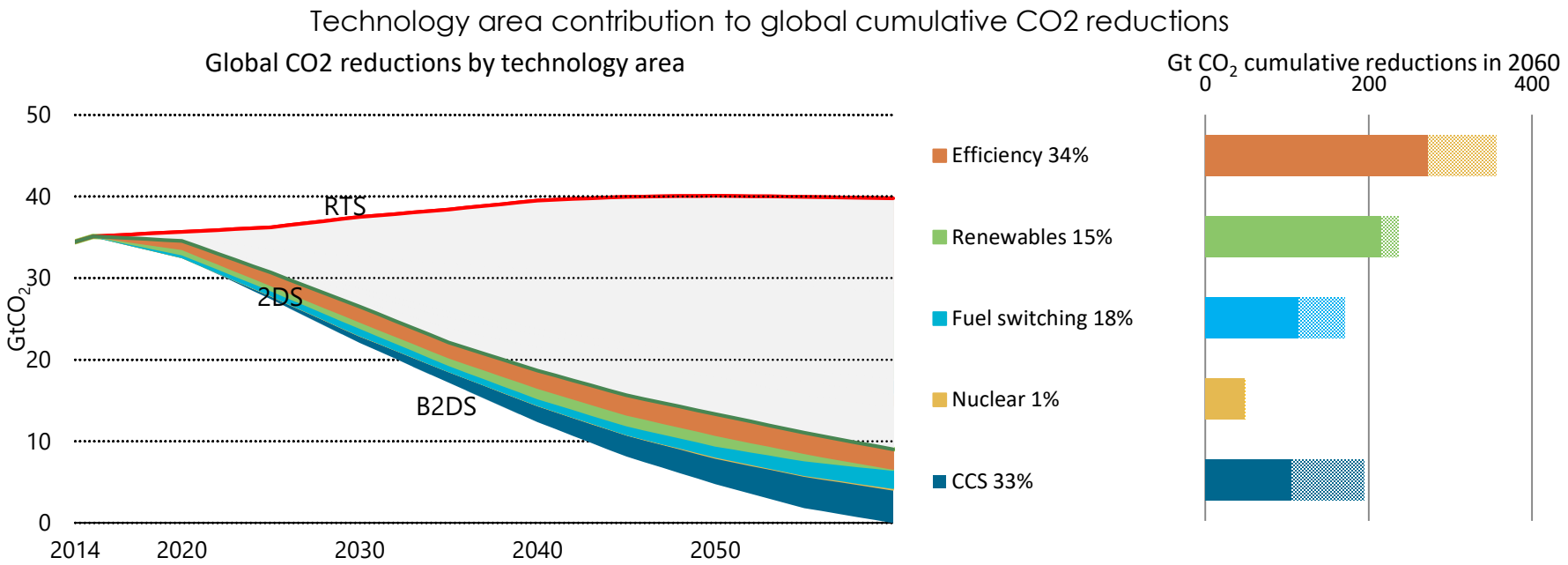
Copenhagen , 14 May 2018

Sustainable bioenergy contributes to heat & transport decarbonisation today



Modern bioenergy is currently the largest renewable energy source, with a share in final energy consumption five times greater than wind and solar PV combined.

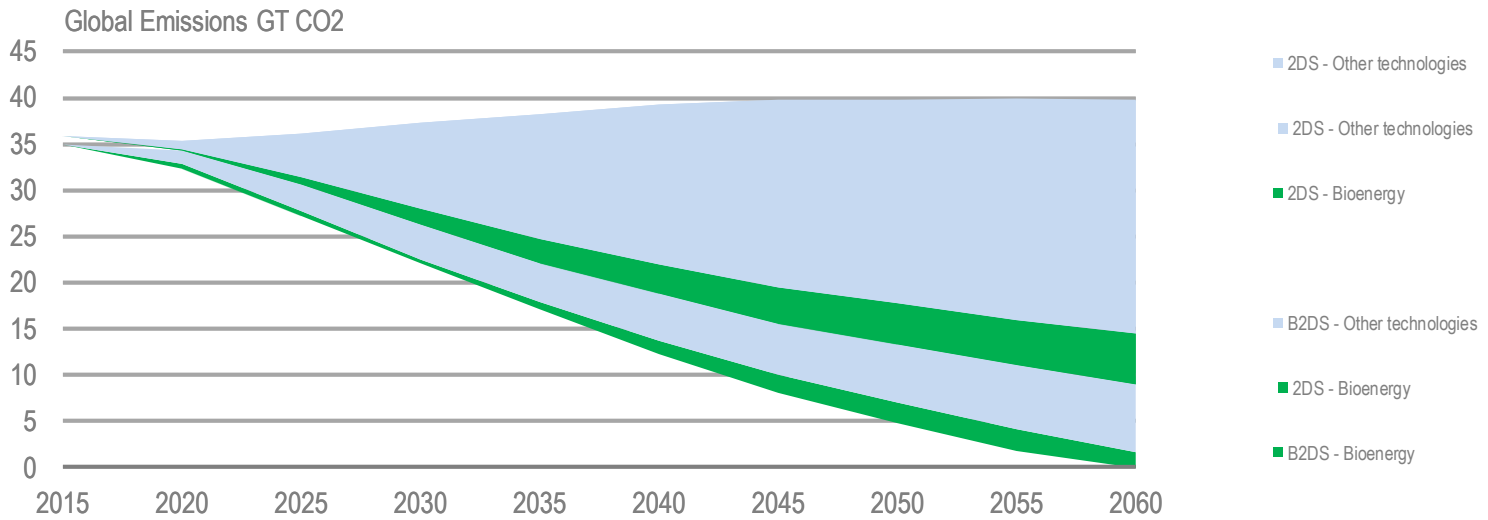
The full portfolio of technologies is needed for decarbonisation



Delivering deep carbon emission reductions will require an unprecedented effort in technology innovation and diversification worldwide

Bioenergy an essential component of IEA Low Carbon Scenarios

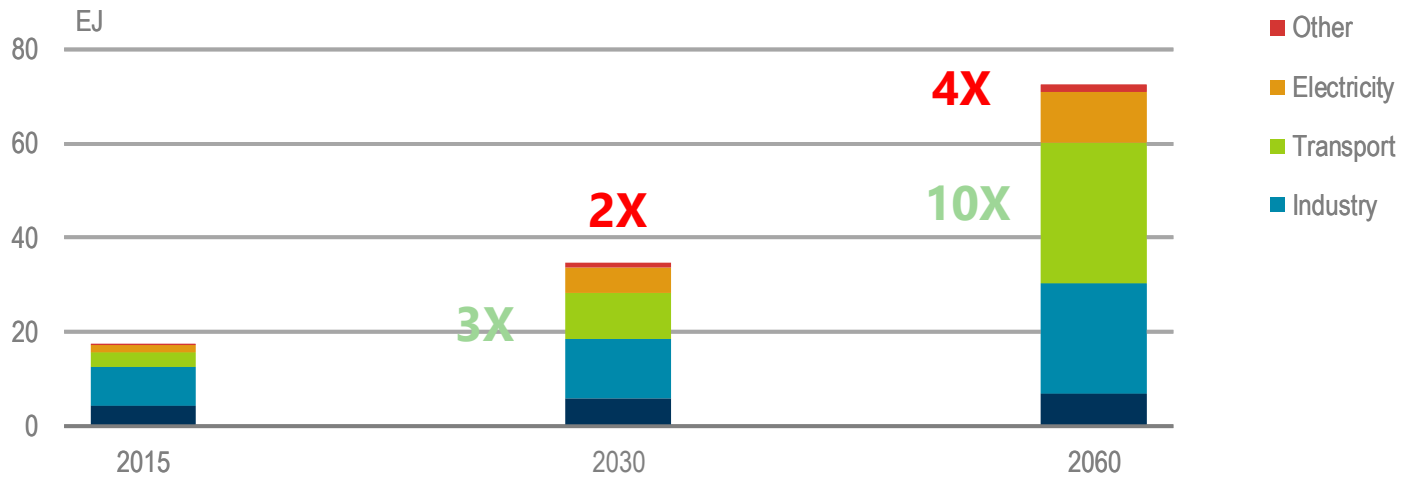
Role of Bioenergy



Bioenergy to provide some 17% of cumulative carbon savings to 2060 in the 2DS and around 22% of additional cumulative reductions in the B2DS, including an important contribution from BECCS

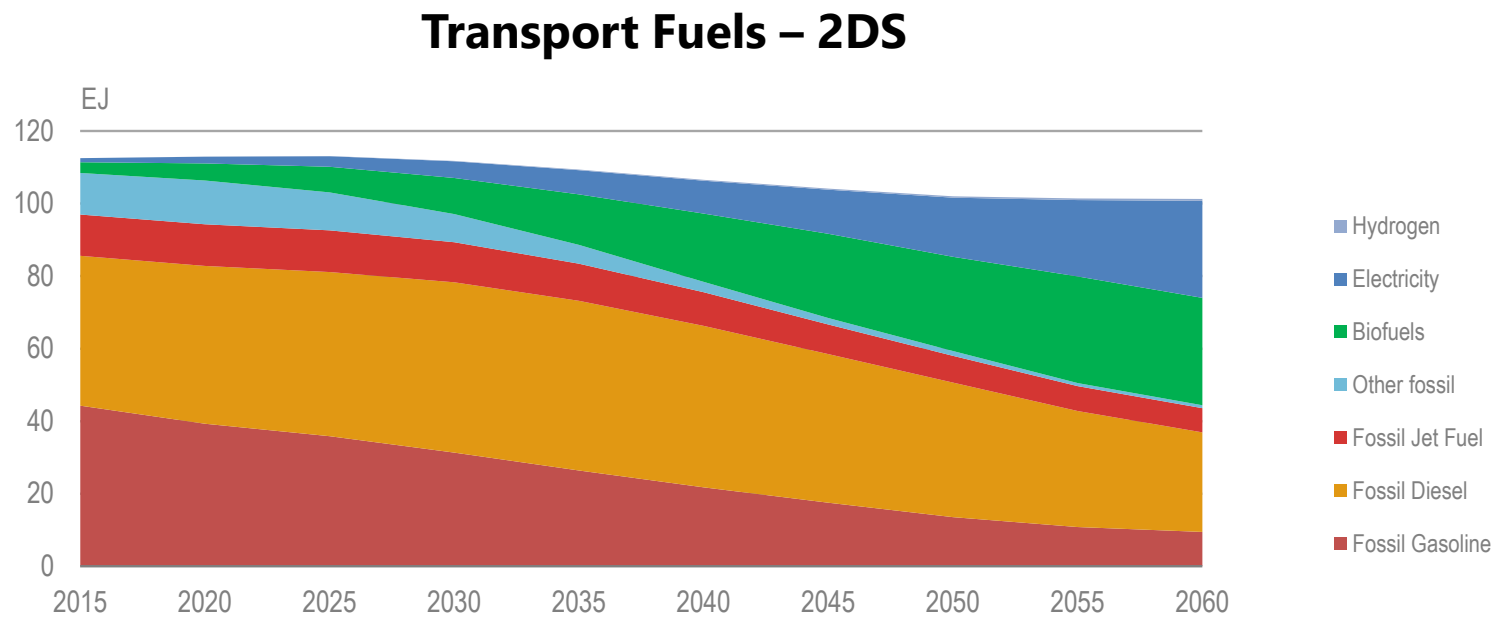
Strong acceleration needed between now and 2030

Modern bioenergy in final energy consumption in 2DS



Bioenergy in final energy consumption needs to double by 2030, and biofuels in transport treble. Advanced biofuels will need a massive scale up

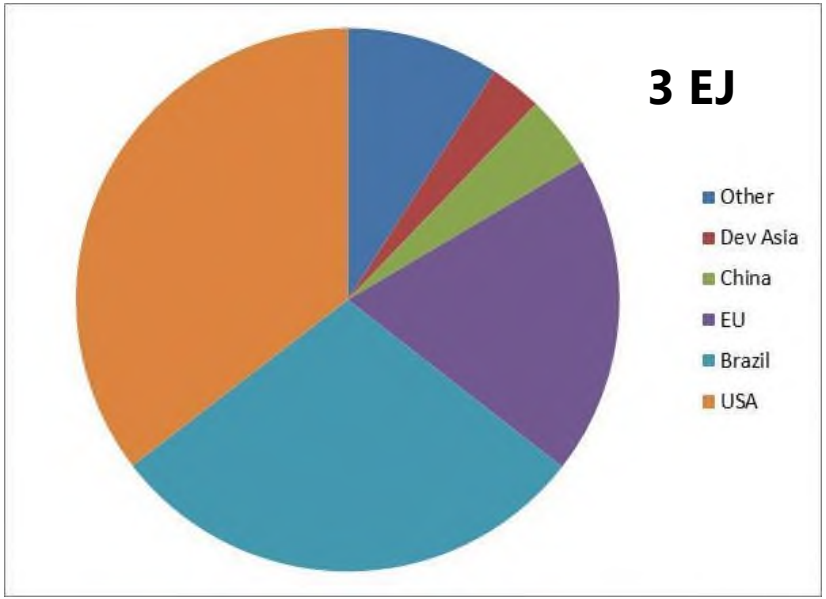
Biofuels: an important option in a portfolio of transport solutions



While demand of transport services more than doubles , biofuels complement end-use efficiency and strong growth in electricity, providing almost 30% of transport final energy demand in 2060

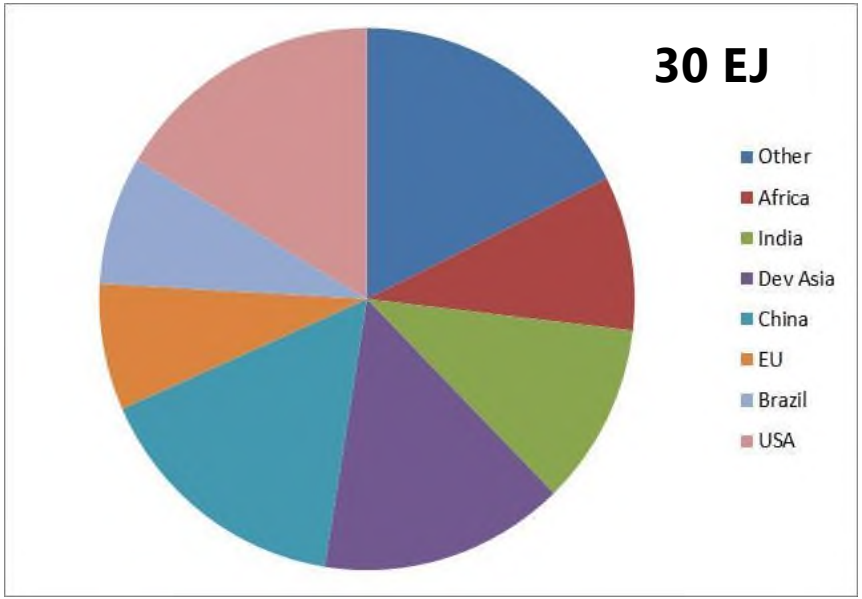
Achieving uptake of bioenergy in more regions

Regional Biofuels Demand 2015



85% of biofuels used in US, Brazil and EU

Regional Biofuels Demand 2060 – 2DS



China, Other Asia, India and Africa become major markets

Four key areas for action

1. Promote short term deployment of **mature options**

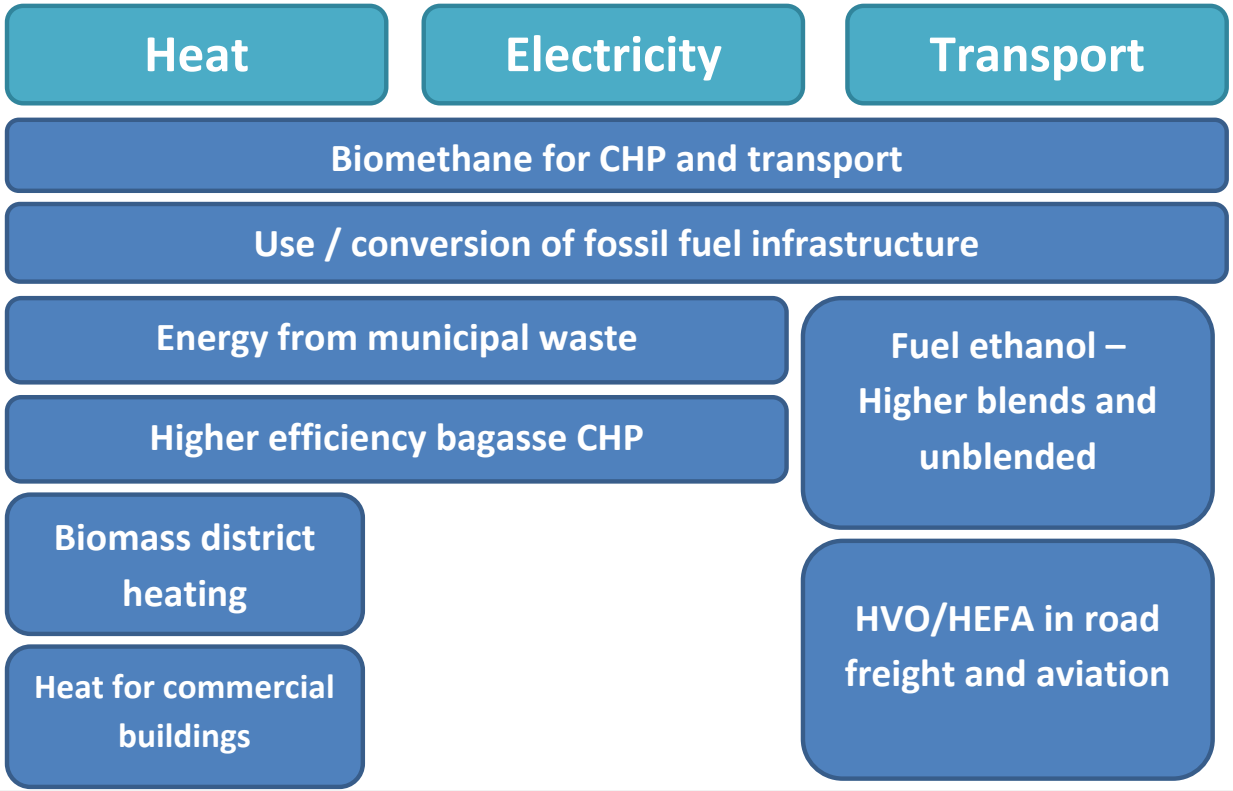
2. Stimulate the development and deployment of **new technologies**

3. Deliver the necessary feedstock **sustainably**, backed by a supportive sustainability governance system

4. Develop capacity and catalyse investment via a coordinated **international collaboration** effort

Need for appropriate policy frameworks along four main axis: i) Level the playing field; ii) Provide low risk investment climate; iii) Catalyse and support innovation; iv) Develop a fair, stringent and stable sustainability regime

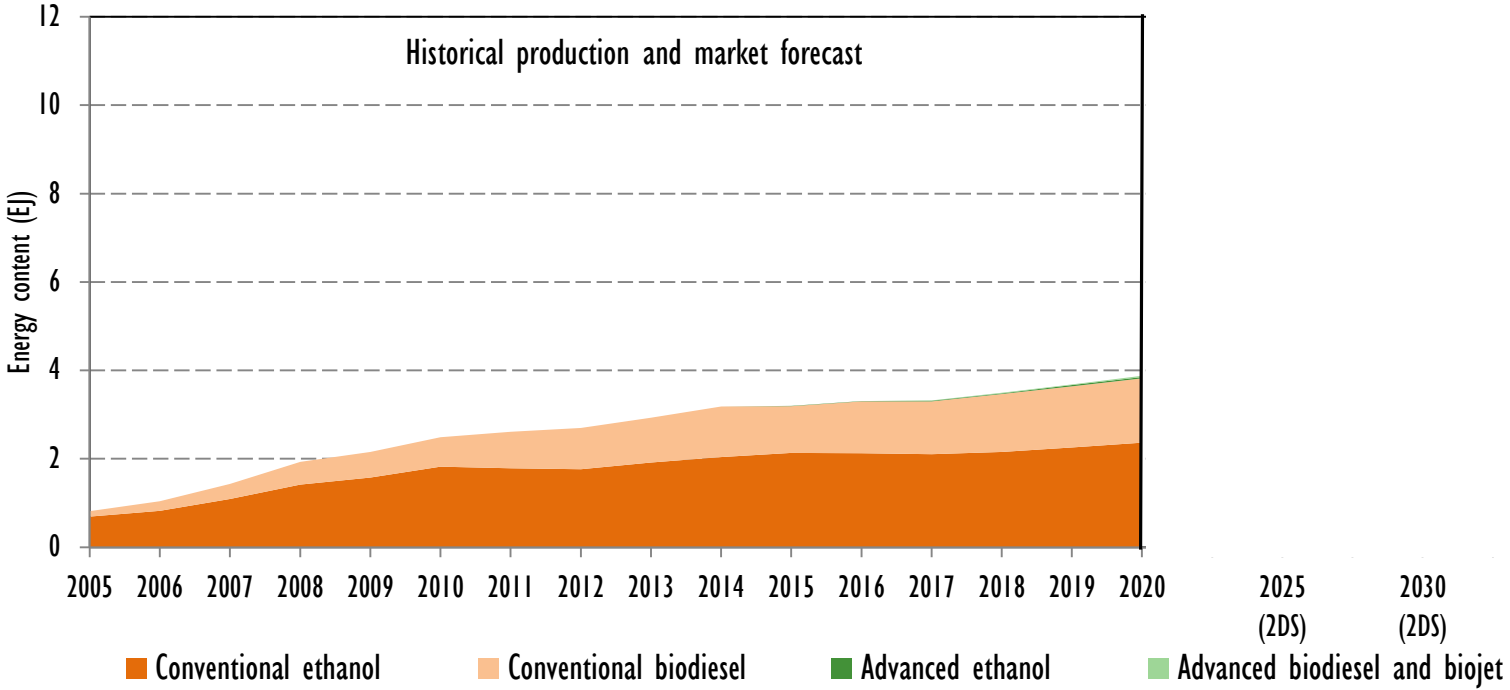
A range of mature bioenergy solutions can scale up immediately



Accelerating bioenergy deployment up to 2025 will depend on greater utilisation of technically mature solutions which can roll out quickly under supportive policies and market conditions.

A massive scale up needed for advanced biofuels

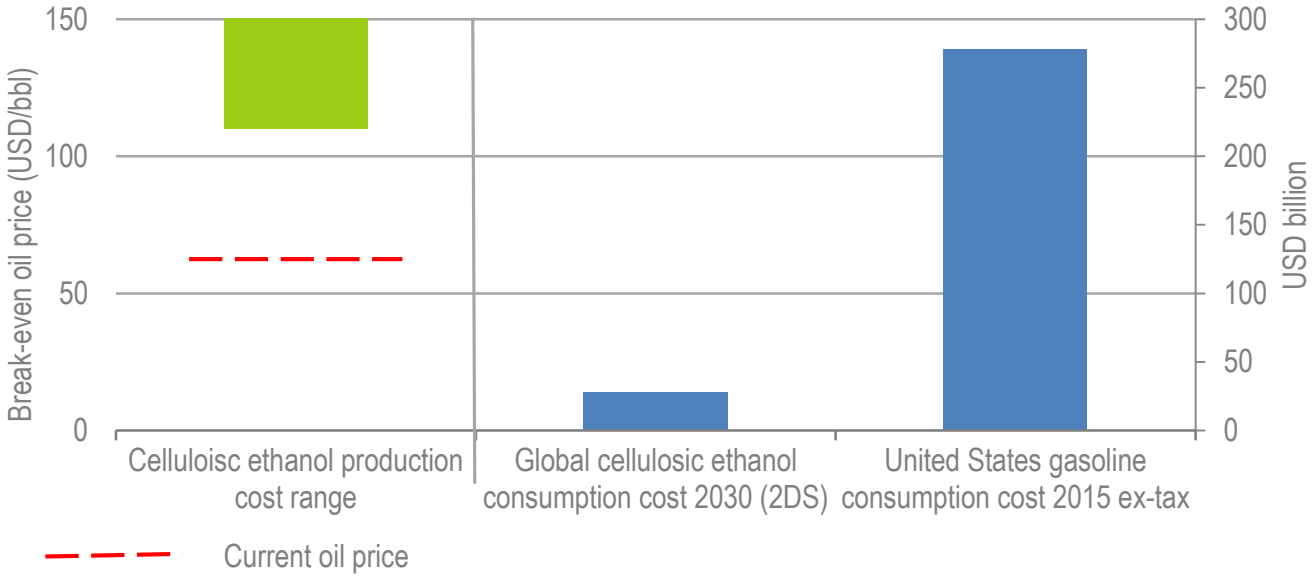
Recent trends, market forecasts and 2DS requirements for transport biofuels



Biofuels can complement EVs and play important roles in heavy freight, shipping and air transport – but a step change is needed in support policies for advanced biofuels

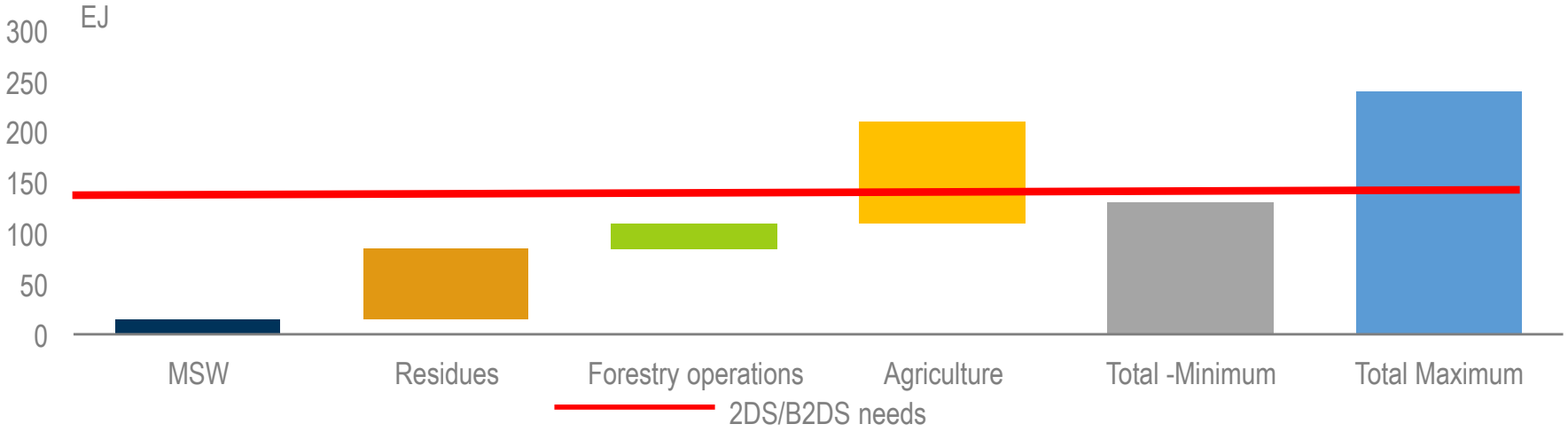
Advanced biofuel production costs remain above oil price break-even

Cellulosic ethanol break-even oil price at current cost estimates and total cost of consumption comparison



Even with no production cost reduction, delivering the ambitious global scale up required by the 2DS for cellulosic ethanol by 2030 is a fraction of the US total gasoline cost in 2015.

Deliver the necessary feedstock sustainably



- **Deployment will need wastes, residues, forestry and energy crops**
  - Produced in line with sustainable resource management, forestry and agricultural practice
  - Produced with minimized impacts on land use change emissions by co-production with food, use of under-productive land, improved production
  - Supported by general effort to improve agricultural productivity and efficiency

Conclusions and next steps

- **Sustainable bioenergy is an indispensable component** of the necessary portfolio of low-C technologies in climate-change mitigation scenarios
- Biofuels plays an important role in **de-carbonising transport** especially in in aviation, shipping and other long haul transport
- A **step-change is needed in support policies for advanced biofuels**, in order industry to demonstrate economies of scale and deliver necessary cost reductions towards competitiveness
- Massive opportunities for **technology diversity and innovation** in the context of **advanced bioeconomy**
- IEA's **Technology Roadmap: "Delivering Sustainable Bioenergy"** provides technology milestones and policy actions needed to unlock the potential of bioenergy in a sustainable energy mix
- Focus on bioenergy in *Renewables 2018* Market Report and in *Tracking Clean Energy Progress* 2018

ETIP Bioenergy
European Technology and Innovation Platform

Technology Needs in Advanced Biofuels

Antti Arasto

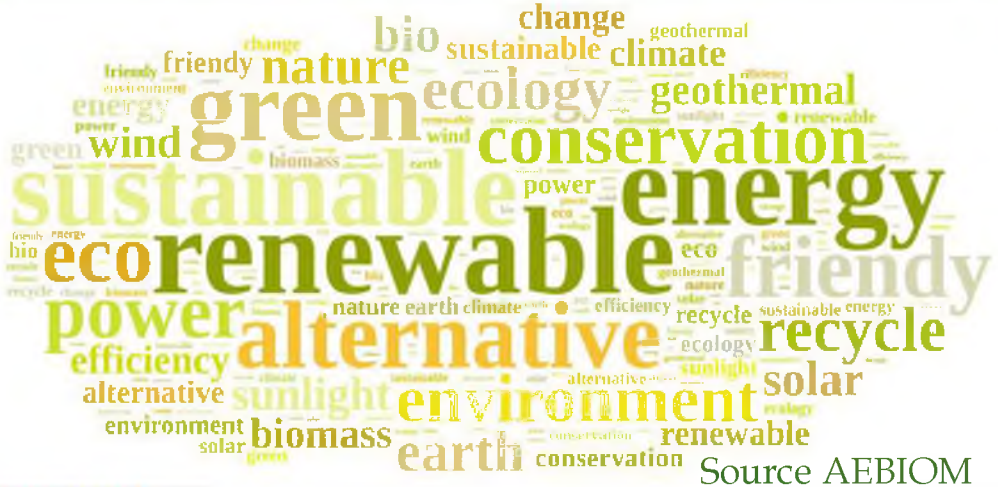
EU Policy and Industry Perspectives on Biofuels in a Global Context

EUBCE 2018, Copenhagen

ETIP Bioenergy
European Technology and Innovation Platform

It is not all about technology and innovation

Source Hedgeeye



Source AEBIOM

ELSEVIER

Energy Policy

Volume 117, June 2018, Pages 100-107

Demonstrating climate mitigation technologies: An early assessment of the NER 300 programme

Max Åhman [a], Jon Birger Skjærseth [b], Per Ove Eikeland [b]

Highlights

- The EU demonstration programme NER300 did only partly deliver as intended.
- CCS and large scale biofuels failed whereas as renewable electricity succeeded.
- The design put large-scale projects at a disadvantage.
- The wider energy and climate policy including demand pull did not deliver as intended.

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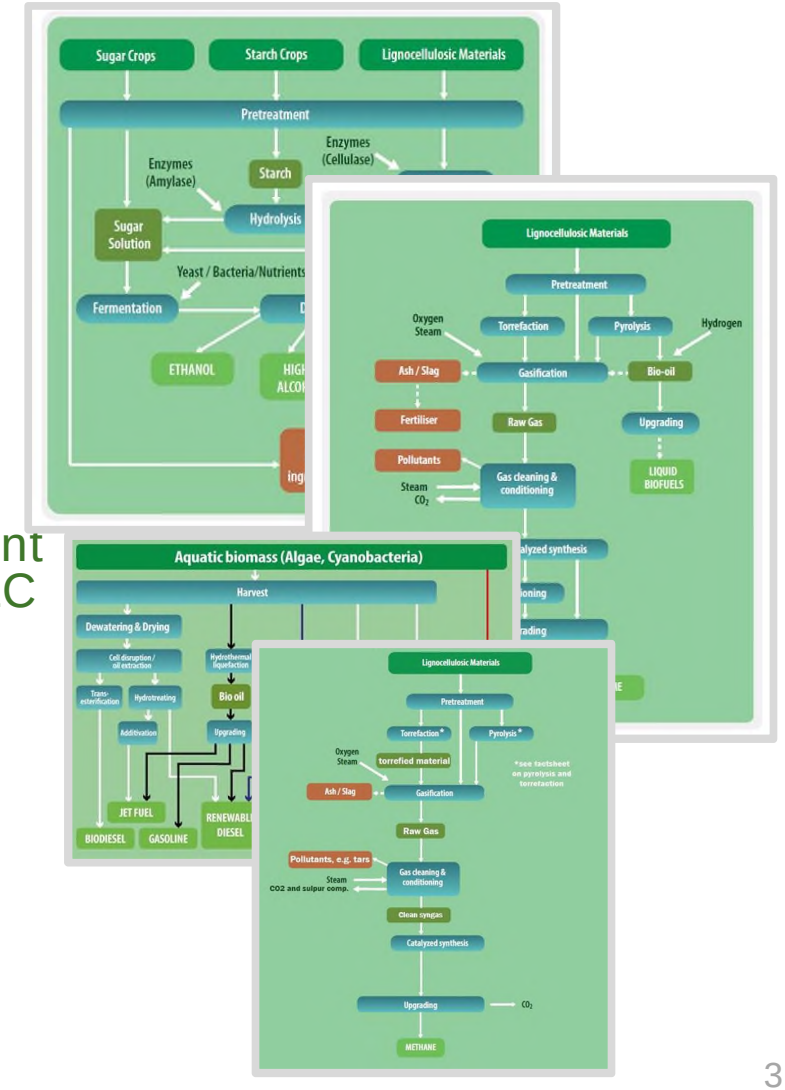
Development of advanced biofuels carries a number of risks for potential investors

- Long-term sourcing of reliable supplies of feedstock (waste streams, residues and energy crops), which do not currently all have well-developed supply chains;
- Deployment of innovative conversion technologies with high capex and opex, which have not been proven under commercial conditions;
- Dependence on a stable and supportive long-term regulatory framework (including consistent policy and financial incentives) at national or EC level.
- From technology perspective => Enlarge the feedstock basis and enhance conversion efficiency



The fundamentals for biofuels still have not changed

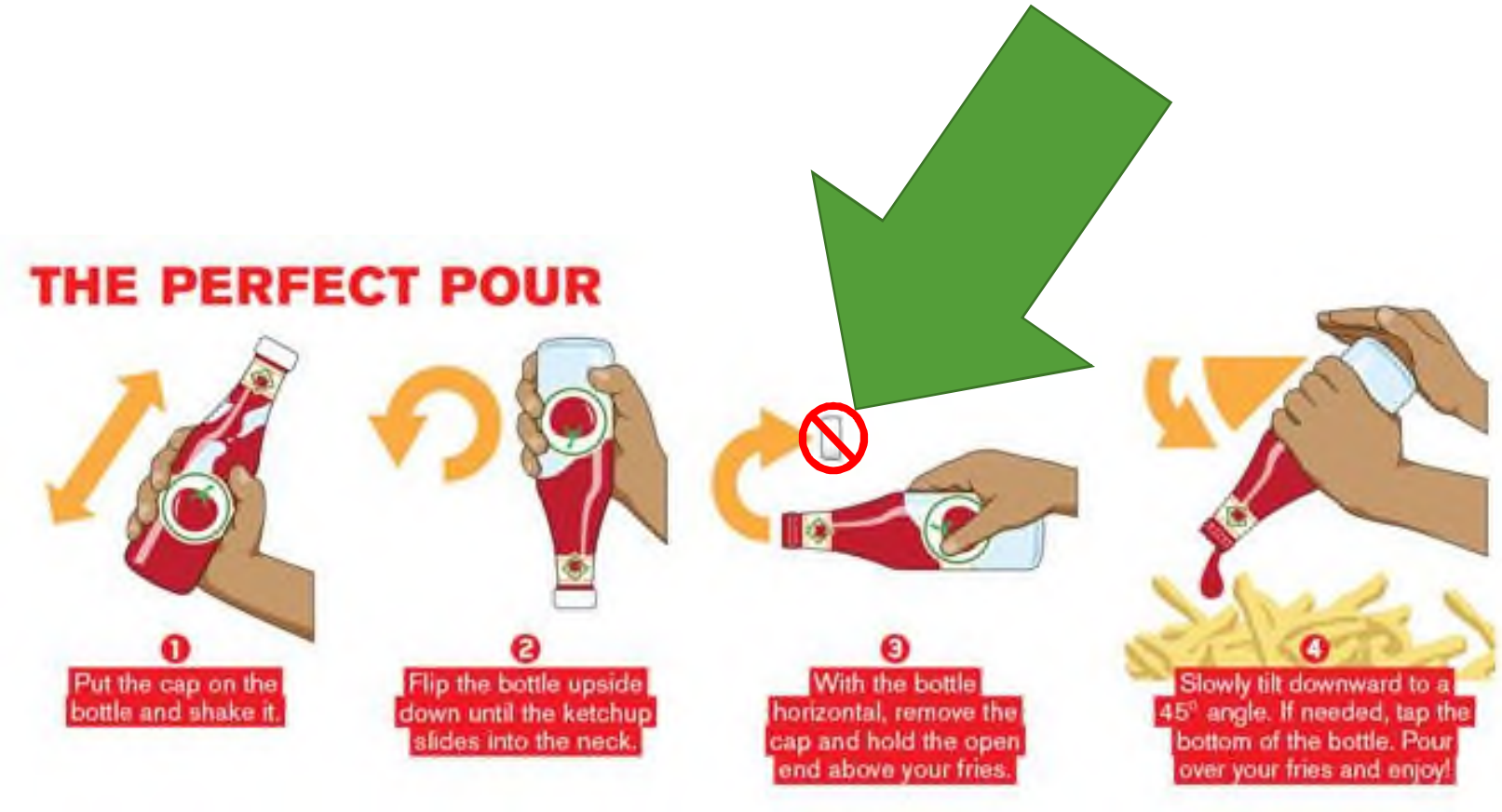
- Different perspectives, from technological challenges and potential for significant improvement to market and policy challenges in Strategic Research and Innovation Agenda: http://www.etipbioenergy.eu/images/EBTP-SRIA-2016.pdf
- Currently commercially deployed feedstock and conversion technologies should provide a significant contribution to the EU 2020 targets but will probably not be sufficient

Developer/project		Feed	Year	Cap. MWth	Type	Status
Ambigo	NL	LC Biomass		4 SNG	Demo	Plan.
Bioliq	DE	PO+char	2013	5 feed	Demo	Op.
BioTFueL	DE/FR	Torr. ag. resid.	2017	15 feed	Demo	Com.
Enerkem	CA	RDF	2014	30 EtOH	1st ind.	Com.
	NL	Plastic waste		220 MeOH	Comm.	Plan.
EON Bio2G	SE	LC biomass		200 SNG	1st ind.	Plan.?
Fulcrum	USA	RDF		50 BTL	1st ind.	Plan
Gobigas	SE	LC biomass	2013	20 SNG	1st ind.	Op.
GoGreenGas	UK	RDF	2018	4 SNG	Demo	Constr.
GTI	USA+	LC biomass	2009	2 BTL	Demo	Op.
Kaidi Ajos	FI/CN	LC biomass		300 BTL	1st ind.	Plan.
LTU Green Fuels	SE	Black liquor, PO	2009	1 DME	Demo	Idle
Red Rock	USA	LC biomass		75 BTL	1st ind.	Plan.
Sekisui/Lanzatech	JP/NZ	MSW	2013	EtOH	Pilot	†2017

http://www.etipbioenergy.eu/databases/production-facilities

Sufficient funding through innovation funnel is needed…

…but the major bottleneck is opening the cap for market pull



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Power-to-X; some examples

MANY MORE EXAMPLES EXIST

HYDROGEN

ITM POWER
Energy Storage | Clean Fuel

0.2-10 MWE

BUTANOL

EVONIK

RHETICUS R&D PROJECT

2018-2020

METHANOL

CARBON RECYCLING INTERNATIONAL

4 000 TPA PLANT

AMMONIA

VATTENFALL

FEASIBILITY STUDY

FT DIESEL

sunfire

150 KWE/ 130 LITER/DAY

METHANE

Audi

*3*2 MWE*

FORMIC ACID

TEAM FAST

R&D PROJECT TU/e

GASOLINE

GLOBAL BIOENERGIES

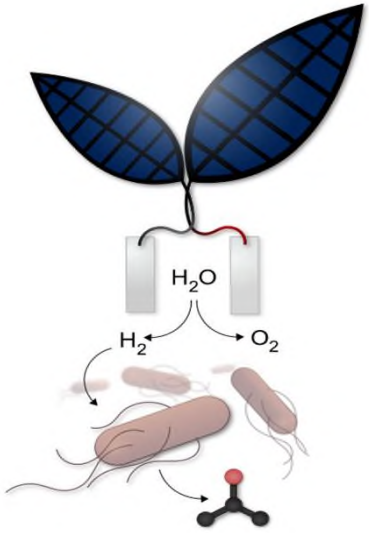
PILOT 100 TPA ISOBUTENE

*2*ISOBUTENE +H2=ISOOCTANE*

Examples of novel ideas in early stage development

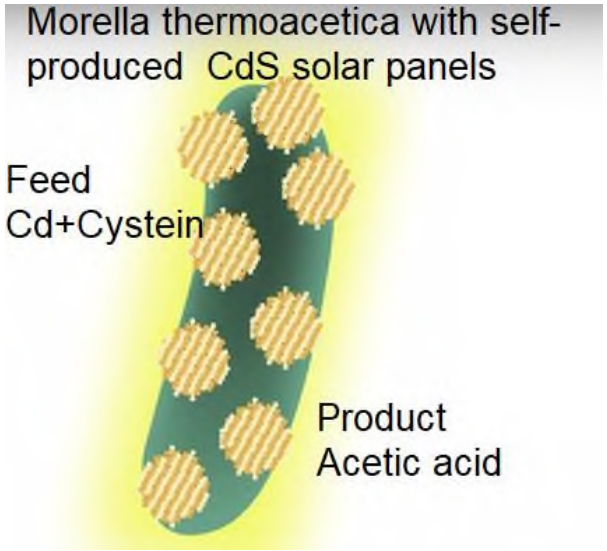
Bionic leafs which uses solar light to split water into hydrogen and oxygen, combined with another microorganism consumes hydrogen and carbon dioxide to produce hydrocarbons, e.g. iso-propanol

Source The Conversation 2015-02-12

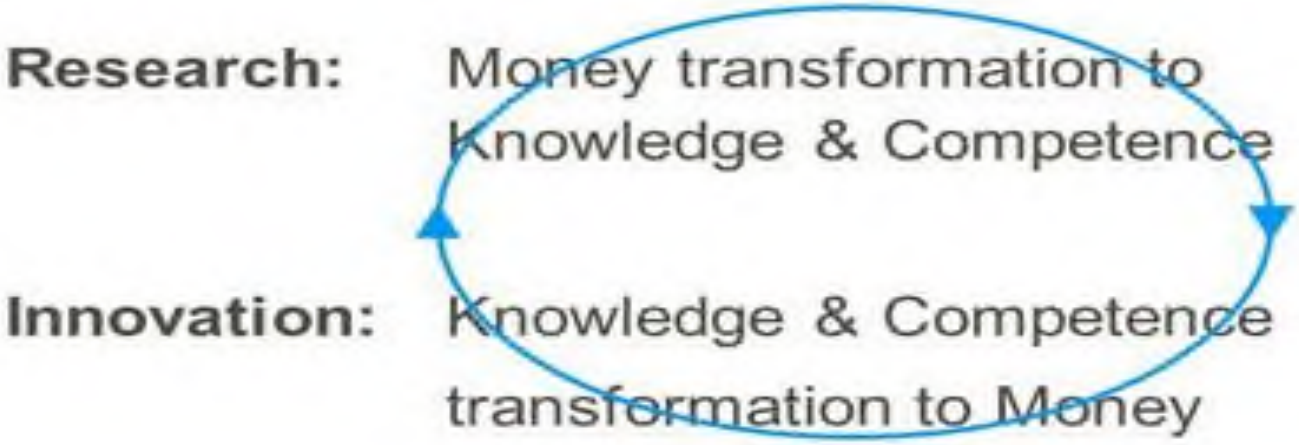


Bio-solar cell factories (BSCF), in which phototrophic micro-organisms (e.g. cyanobacteria, eukaryotic algae) directly catalyze the conversion of CO_2 and H_2O into oxygen and chemical energy, e.g. fuel molecules.

Source CleanTecnica 2017-08-22



Summing up and take-away messages



- Industrial implementation of R&D requires patience.
- The economics of bridging the "development gap" to an operational 1st industrial plant is a main bottleneck for biofuels, in particular challenging for one-product start-ups.
- Support e.g. Investment Fund should be designed with this in mind to be effective in reaching the desired impact.
- Also policy must be sustainable over time, not only biofuels

ARTFuels

Support for alternative and renewable liquid & gaseous fuels forum (policy and market issues)

Policy Needs and Industry Perspectives

Eric van den Heuvel
studio Gear UP

EUBCE 2018
EU Policy and Industry Perspectives on biofuels in a Global context

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01

About ART Fuels Forum

About ART Fuels Forum

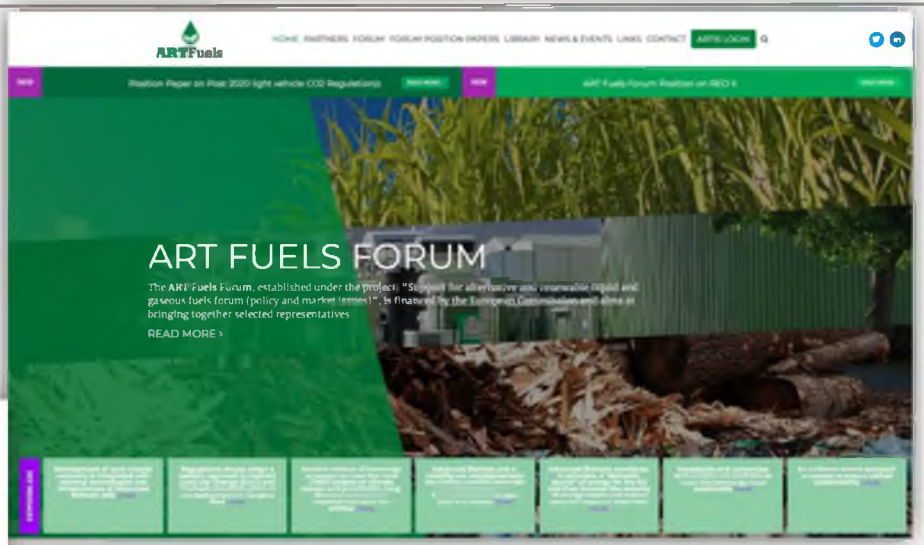
- Alternative and Renewable Transport Fuels Forum – supported by EC DG Energy

- Facilitate discussion and elaboration of common issues on policy and market penetration barriers for these fuels
  - policy understanding and its implementation at European level
  - appreciation of market uptake issues
  - technology insight and deployment issues
  - appreciation of international cooperation, WTO and GHG emissions issues

- Brings together 100+ participants
  - the European Alternative and Renewable Transport Fuels (ART Fuels) production industry
  - the transport consumption industry
  - the main international cooperation actors and
  - the EU policy makers and stakeholders

About ART Fuels Forum

http://artfuelsforum.eu/



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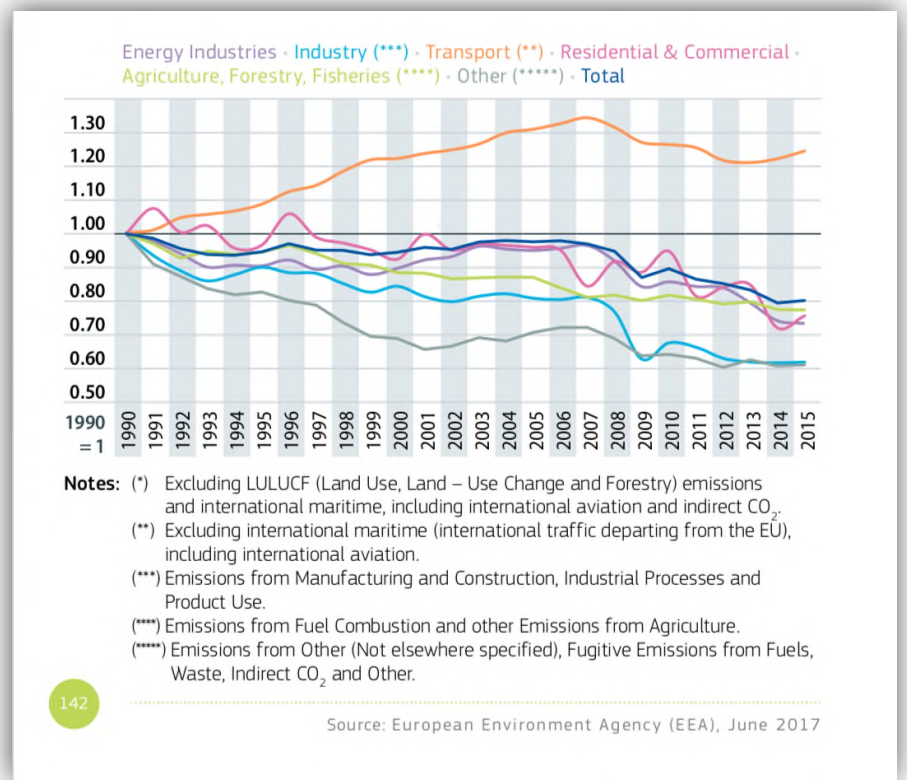
European Commission

02

On RED II



Source: EC 2017, Statistical Pocketbook, Transport in figures

On RED II

- ART Fuels Forum work is focused on the new EU Directive on Renewable Energie (RED II)
  - This legislative framework id decisive for the advanced biofuels and low carbon fuels industries
  - Art Fuels Forum endorsed the work done in 2016/17 by the EC-STF Subgroup on Advanced Biofuels (SGAB)

- General approach to definitions by SGAB:
  - EU universal, transparent and straightforward.
  - Follows in a flexible and transparent way any future EU legislation change without need for modifications
  - Not based on a list of feedstocks - as in RED Annex IX

On RED II – definitions for advanced biofuels

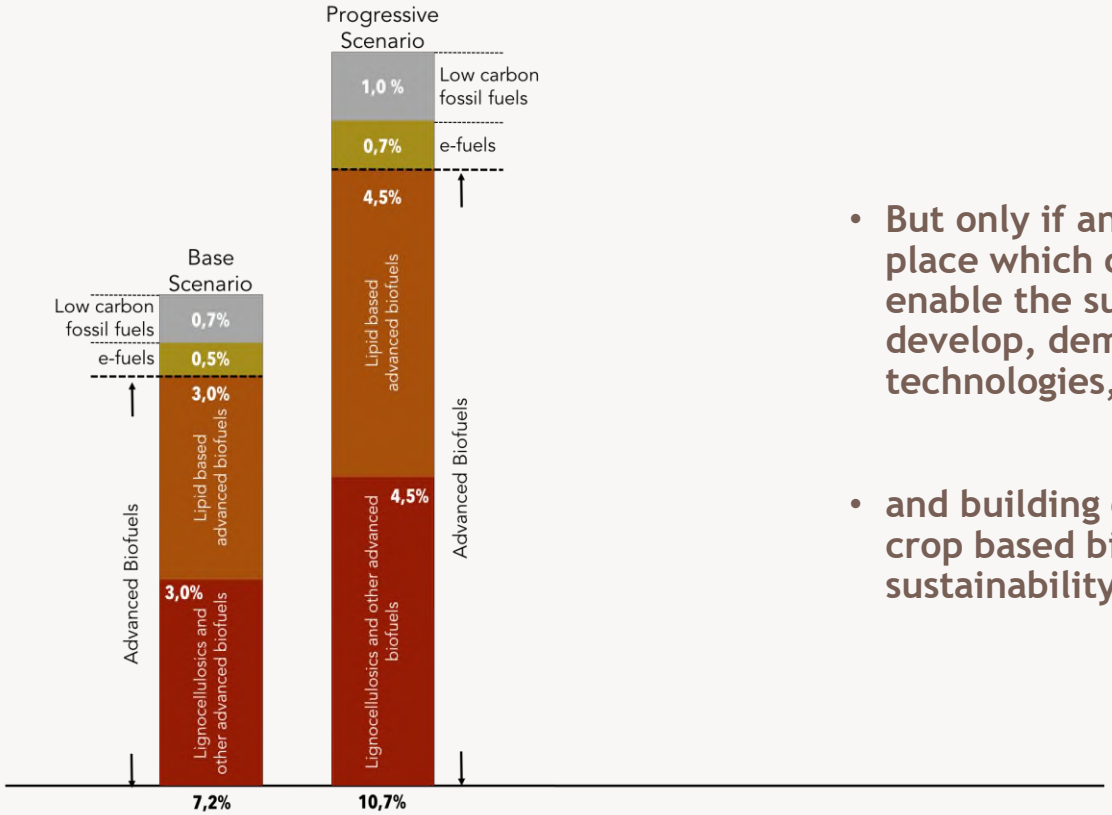
- Advanced Biofuels are those produced from biomass[1] other than food/feed crops while meeting the EU sustainability regime[2] under the legislation in force[3].
  - 1 Biomass as defined under RED or any amendment to it.
  - 2 Sustainability regime as defined under EU Legislation
  - 3 Existing legislation in force at the time of consideration.

- Advanced Renewable Fuels are advanced biofuels, and, liquid and gaseous fuels produced from renewable intermediates or renewable process by-products (H2, CO, CO2 etc.)

- e-Fuels are Advanced Renewable Fuels produced from renewable electricity via electrolysis

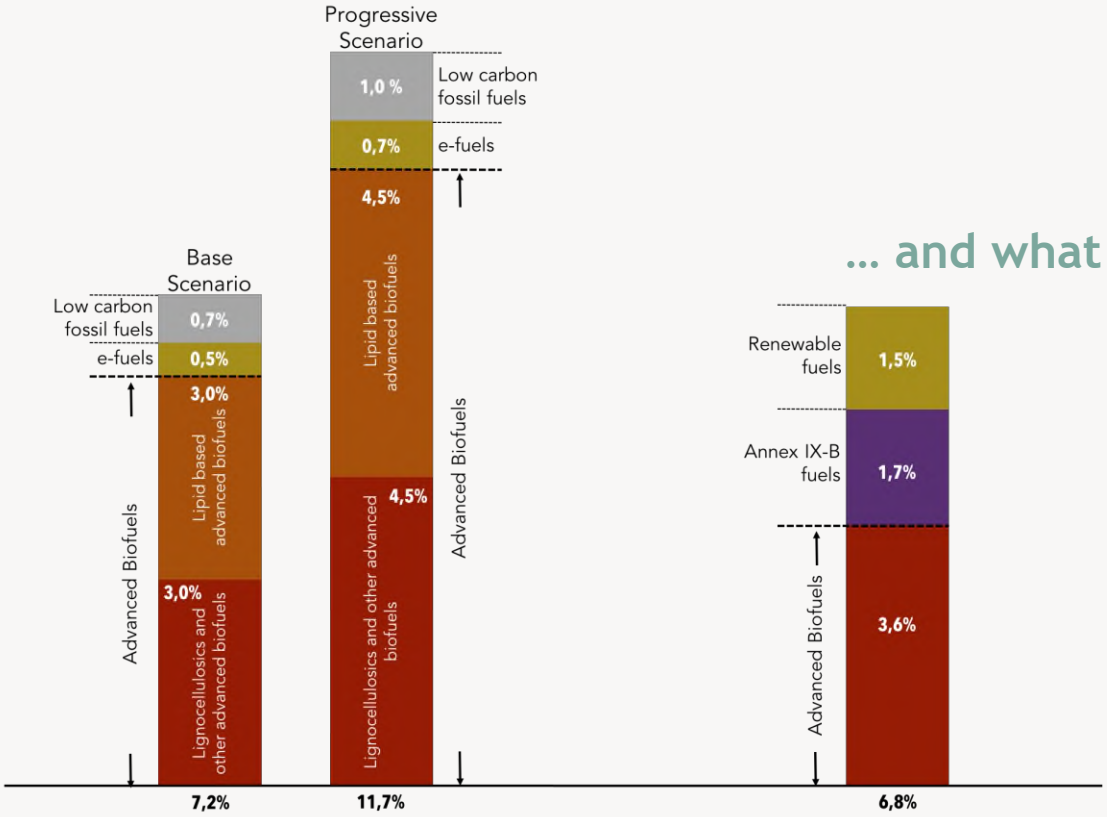
- Low Carbon Fossil Fuels are liquid and gaseous fuels produced by the conversion of exhaust or waste streams of fossil fuel industrial applications via catalytic, chemical, biological or biochemical processes

On RED II – what industry said it can deliver in 2030…



- But only if an appropriate policy framework is in place which creates the conditions which enable the substantial investments required to develop, demonstrate and deploy the technologies,
- and building on top of maintained 2020-share of crop based biofuels, subject to stringent sustainability requirements

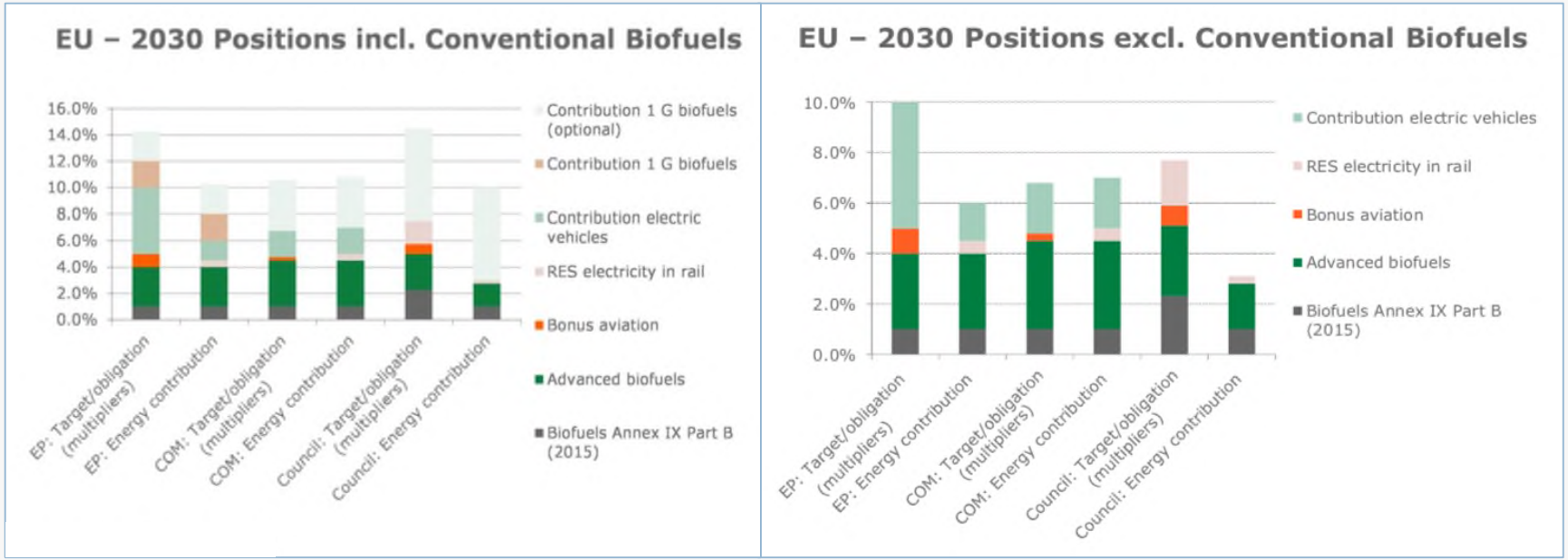
On RED II - what industry said it can deliver in 2030…



… and what is proposed bij EC (2016)

Reminder: not taking into account crop based biofuels

Current status on RED II – different positions



Source: FO Licht 2018, Vol. 16, no 14, 19-Mar-18, R. Vierhout, The new challenge ahead for the EU Biofuel industry: RED II

On RED II – Industry can deliver, needs financial support schemes

- Advanced biofuel plants take on average 3 years to build, and have to operate for 15-20 years to ensure economic viability and appropriate pay-back to the investor. Therefore:
- A clear plan and mechanism is needed for
  - dedicated investment support for advanced renewable fuels production plants and
  - targeted support for R&D and Innovation
- Financing tools (like the RSFF and NER300) need to be improved to fit the specificities of advanced biofuels and enable first-of-a-kind project realisation
  - ART Fuels Forum provided suggestions for the ETS Innovation Fund
- The industry emphasises that both policy makers and EIB understand the shortcomings of their policies
- A dedicated support mechanism to introduce Advanced Biofuels in aviation (and shipping) needs to be developed

03

Case of the Netherlands

Clarifying remark;

The following slides describe the process towards the development of a Netherlands Climate Agreement. Various stakeholders provide input and recommendations to this process.

This still needs to be materialized into Dutch policies in the coming months and years

The viewpoints presented here are of the author of this presentation

Case of the Netherlands

- 2013 Energy Agreement -> 2015 Vision on Sustainable fuel mix:
  - 60% less GHG emissions in transport in 2050 compared to 1990
- 2015 Paris Agreement further framed the urgency -> -60% in transport is not enough
- 2017 new Government: NL should reduce total GHG-emissions by 49% in 2050 compared to 1990
  - Near to zero GHG emissions in transport in 2050
  - Climate Agreement among all stakeholders to be reached summer 2017: Work in Progress

Case of the Netherlands

Work in Progress

Development of actual and policy based CO2-emissions (ttw) up to 2030:

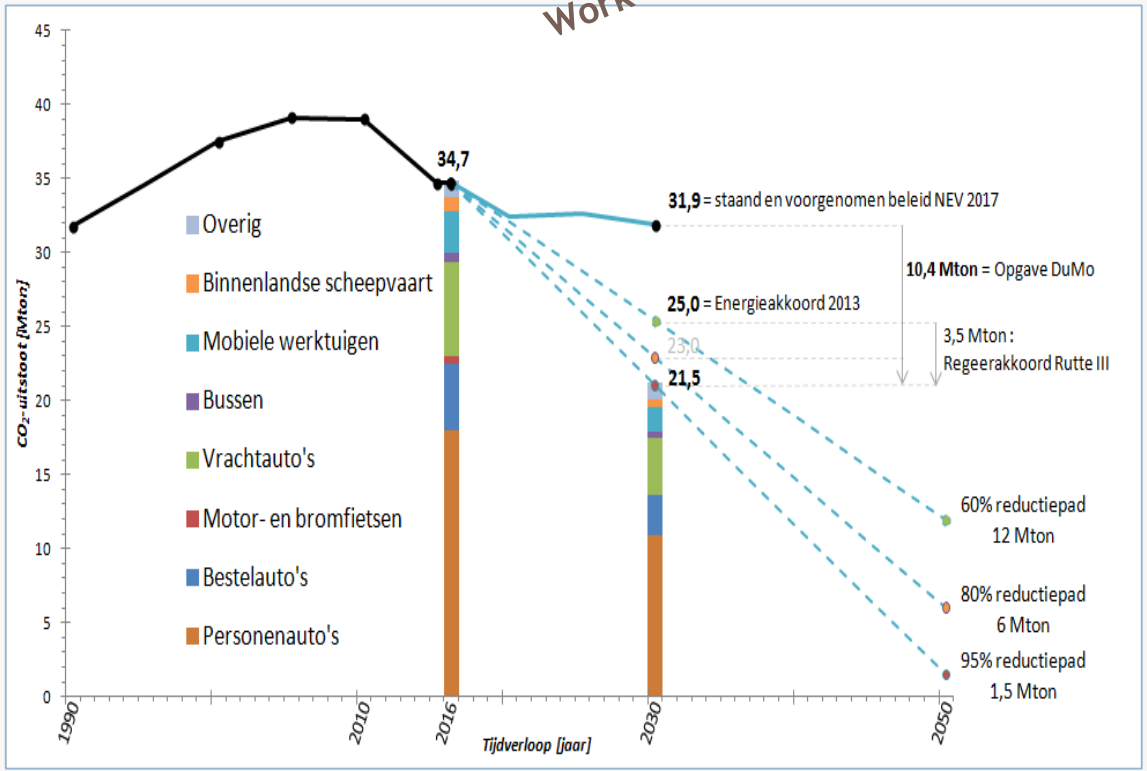
- 34,7 Mton in 2016
- 31,9 Mton in 2030

To be on track for near to zero in 2050:

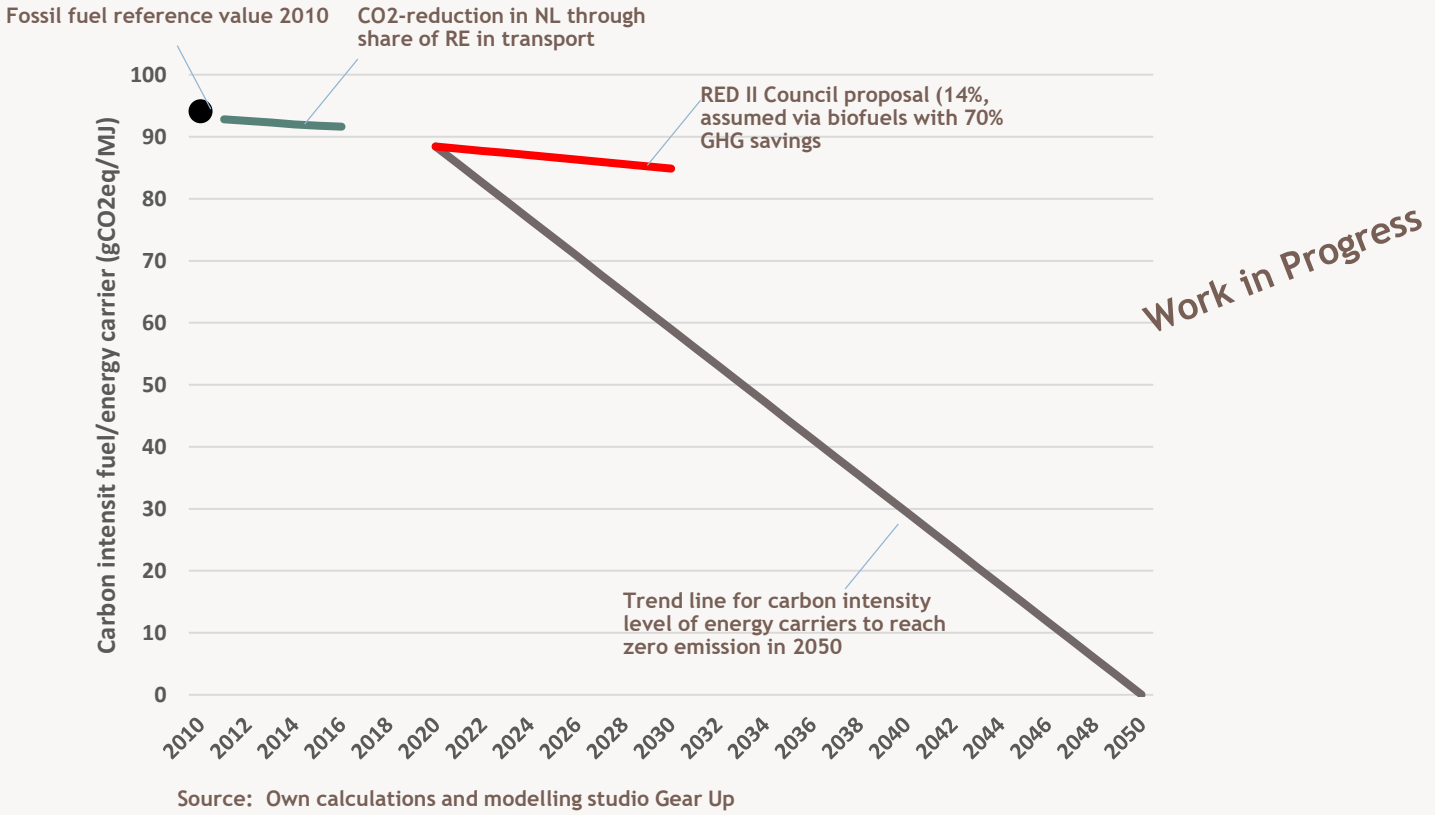
- Max 21,5 Mton in 2030

Recommendation by Platform Sustainable Biofuels :

- At least 33% renewable energy in transport needed by 2030



Case of the Netherlands

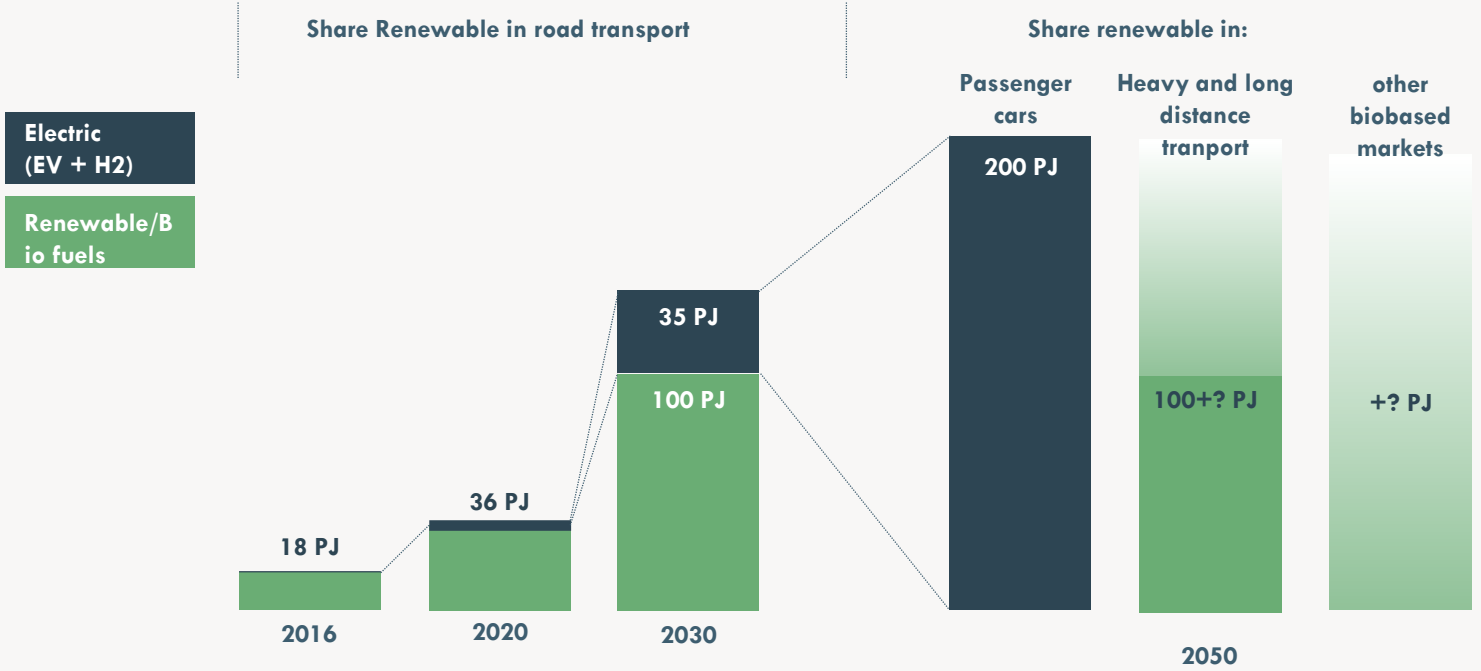


Work in Progress

Source: Own calculations and modelling studio Gear Up

Case of the Netherlands

Work in Progress



Source: projections and modelling by Netherlands Platform Sustainbable Biofuels

04

Conclusions

Conclusions

- ART Fuels Forum serves strategic discussions and debates on policy needs and industry perspectives
- Industry is convinced and committed to significantly contribute to the decarbonisation of the transport sector in Europe
- Industry needs a clear, long lasting and ambitious policy framework, to provide confidence to investors
- Industry needs financial instruments that enable the development and deployment throughout Europe
- The Netherlands case further frames the urgency: We have to lower carbon emissions beyond RED II levels
- Advanced and Reneweable fuels and Electric Mobility are allies