IEA Bioenergy

Potential for cost reduction for advanced biofuels

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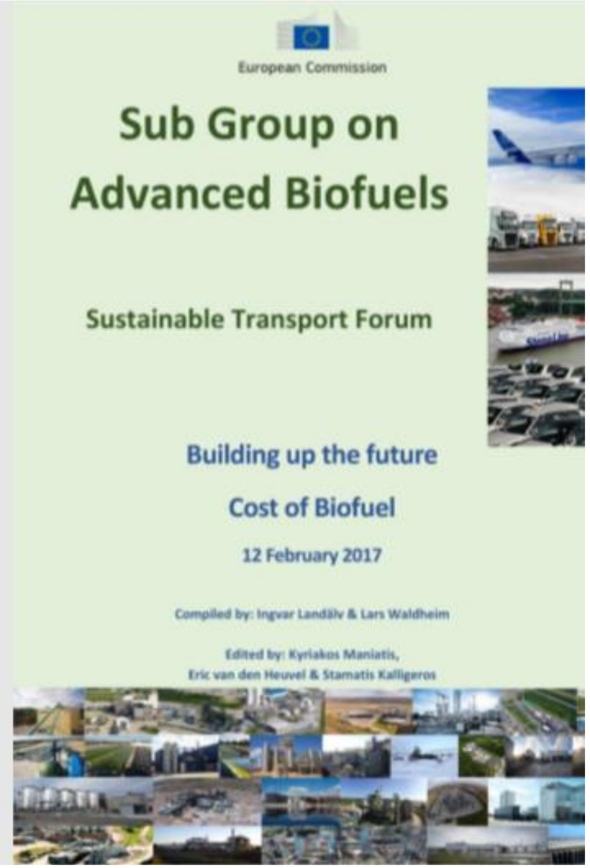
Project Objectives

- Project under Task 41 of IEA Bioenergy, funded by EC with in kind contributions from Sweden, Netherlands and Germany
- Update and extend the SGAB Cost study to provide estimates of the current costs of producing a selection of relevant novel advanced biofuels;
- Identify the scope for cost reduction for advanced biofuels in the medium and long term;
- Compare these costs with likely trends in fossil fuel prices, and those of conventional biofuels.
- Examine the consequences for policy measures, including carbon pricing, required to stimulate advanced biofuels production.



Methodology

- Collect/update information from industry and other sources on current costs, and scope for cost reduction
- Normalise and rationalise the data on current costs (capital/operation/feedstock) in final product cost
- Evaluate potential for cost reduction
  - For next x plants based on data information from industry
  - Sensitivity to lower cost capital
  - Extrapolate to large scale deployment
- Compare with future fossil fuel price scenarios with and without policy support

Companies contacted by pathway

Pathway	No of Contacts
Synthetic fuels via gasification	18
Pyrolysis and upgrading	9
HTL	3
Lignin to fuels	3
HVO and UCOME	7
Lignocellulosic ethanol via fermentation	14
Lignocellulosic ethanol by co-fermentation of starch	3
Fermentation and sugars to hydrocarbons	5
Alcohols to hydrocarbons	6
Biogas and biomethane	8
Other aviation fuels	2
Power to X	5
Other processes and contacts	6
Total	**89**

22 substantive responses

Units

- **Default energy unit in report is MWh**

- 1 MWh = 3.6 GJ = 0.086 toe = 3.41 MBTU
- 1 litre ethanol is equivalent to 5.86 kWh or 21.1 MJ
- 1 litre of gasoline is equivalent to 8.89 kWh or 32.0 MJ
- 1 litre diesel fuel is equivalent to 10.0 kWh or 36.0 MJ
- 1 EUR/MWh= 0.277 EUR/GJ =0.265 EUR/MMBTU =11.63 EUR/toe.

1 tonne of dry biomass contains around 18 GJ or 5 MWh

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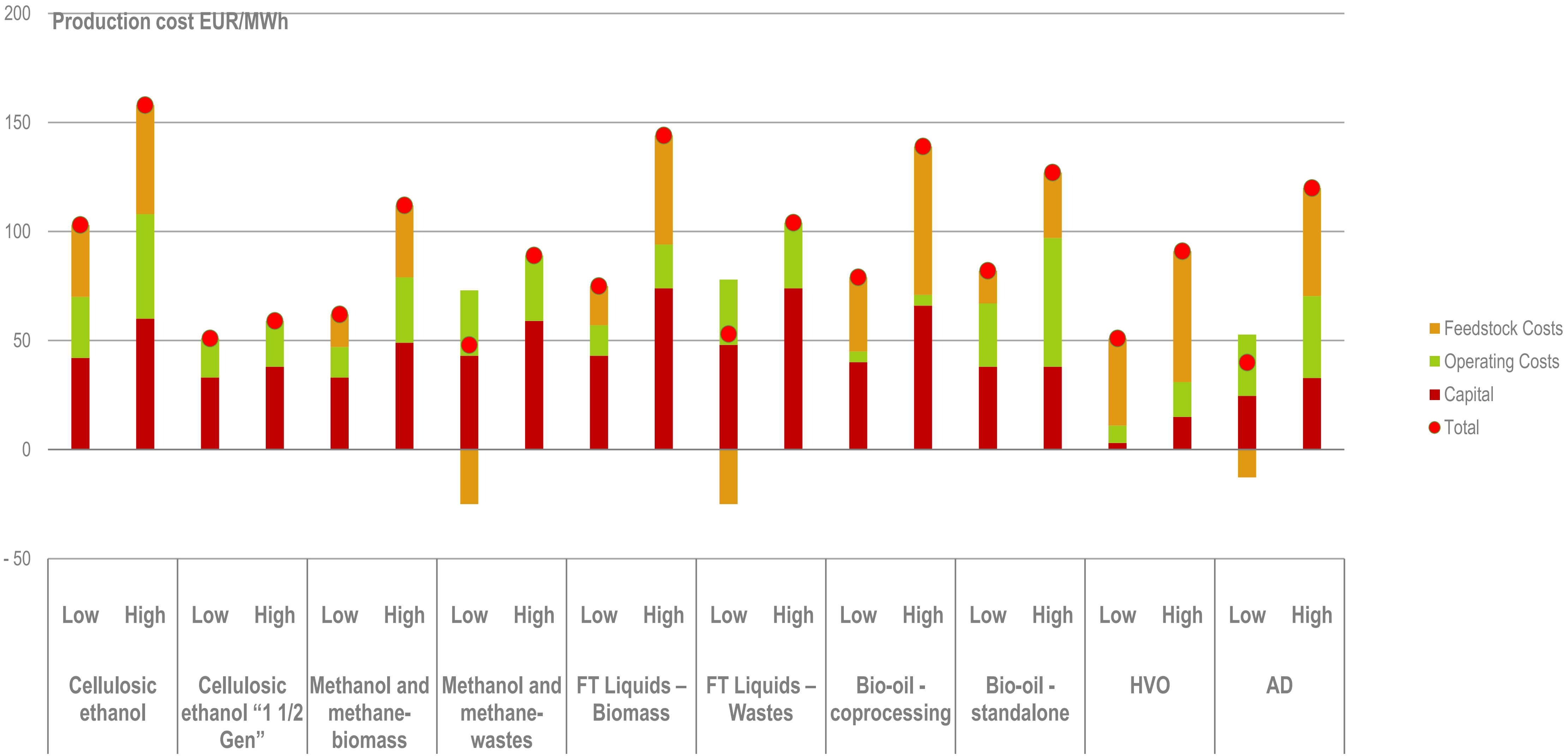
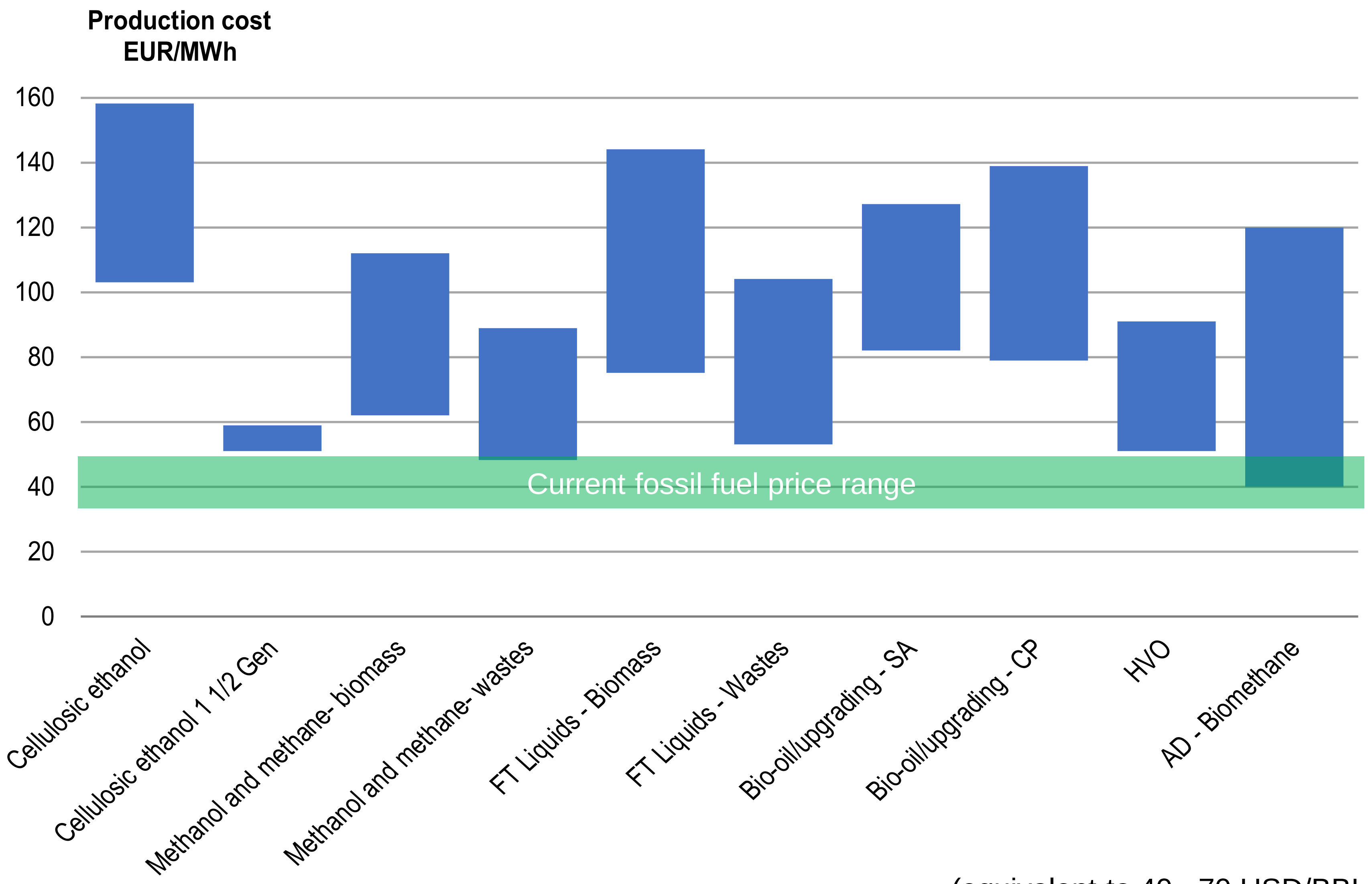
A feedstock cost of 20 EUR/MWh is therefore equivalent to some 5.56 EUR/GJ, or 100 EUR/dry tonne

Current cost estimates



Current cost estimates



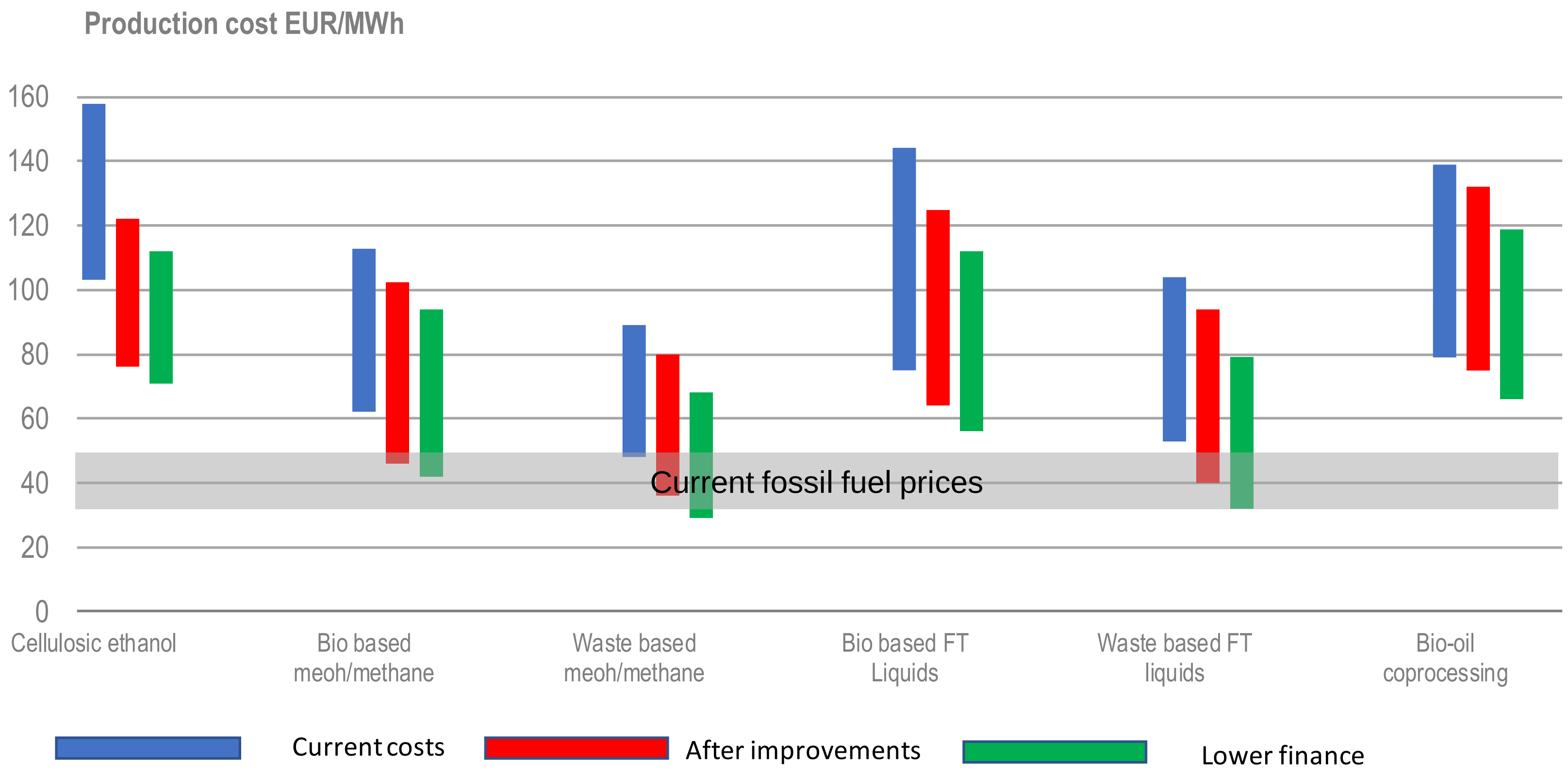
(equivalent to 40 - 70 USD/BBL)

Scope for cost reduction – medium term

- Capital and operating cost reductions
  - capital reduced by between 25 and 50 % (cellulosic ethanol) and 10 and 20% for thermal processes
  - operating costs reduced by 10 to 20 %
  - fuel component assumed constant

- Reduction in capital charge
  - from 10%/15 years to 8%/20 years

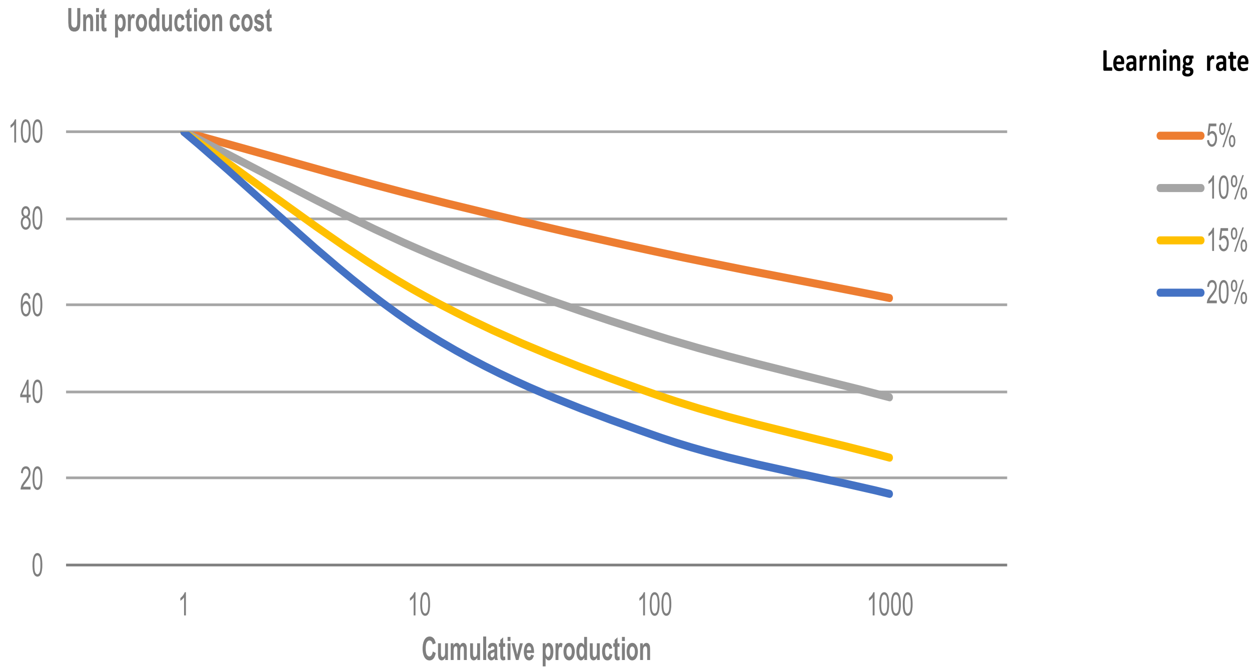
Scope for cost reduction – medium term



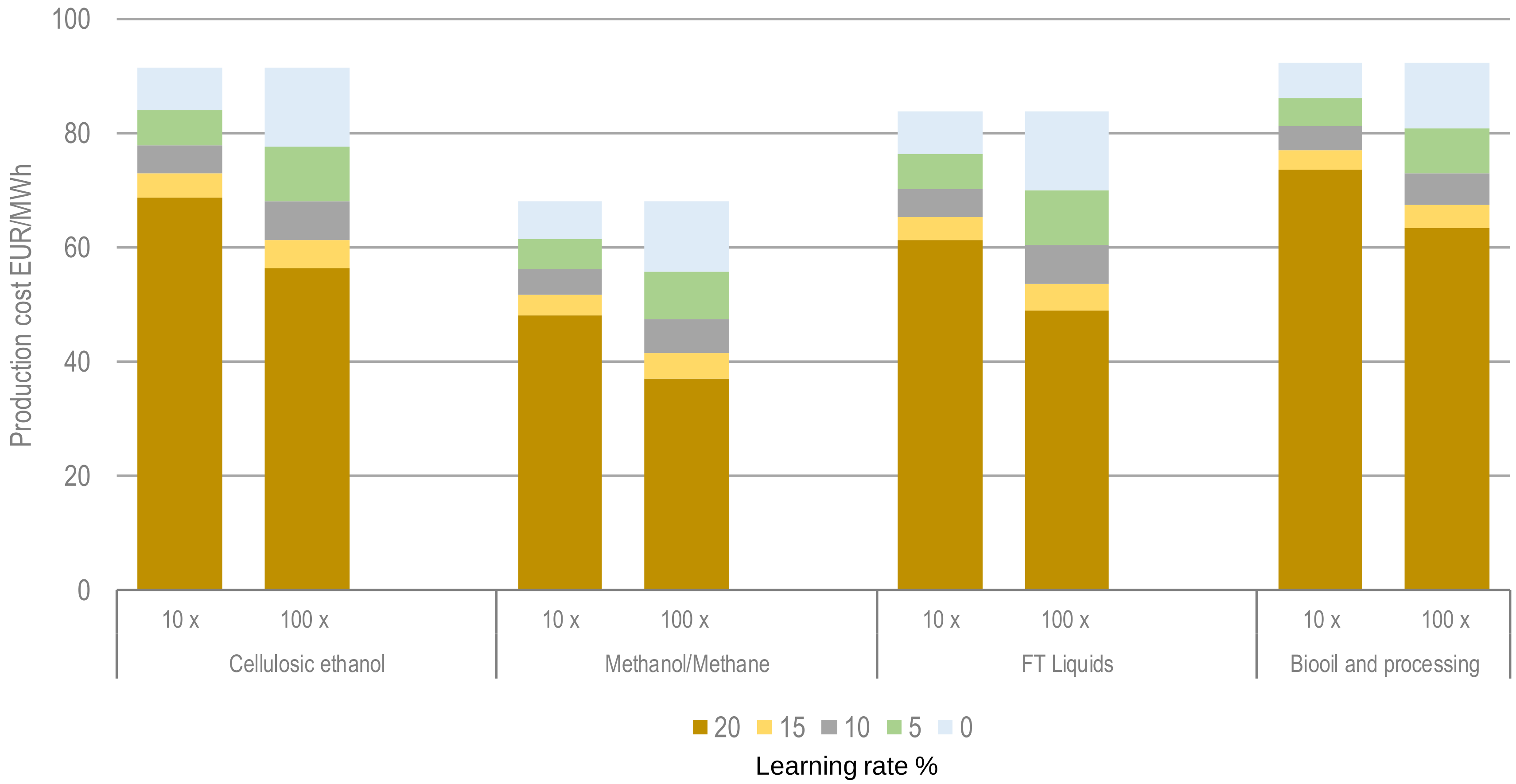
- Cost reduction 10 - 27% for capital/operating costs
- Further 5-16 % for improved capital charges

Long term cost reduction potential

- Contribution of advanced biofuels in lower carbon scenarios implies massive ramp up in production
- Over 4000 large scale (200MW output) plants to provide 25 EJ as in IEA's long term 2DS scenario
- Learning curve approach used to examine potential impact on costs

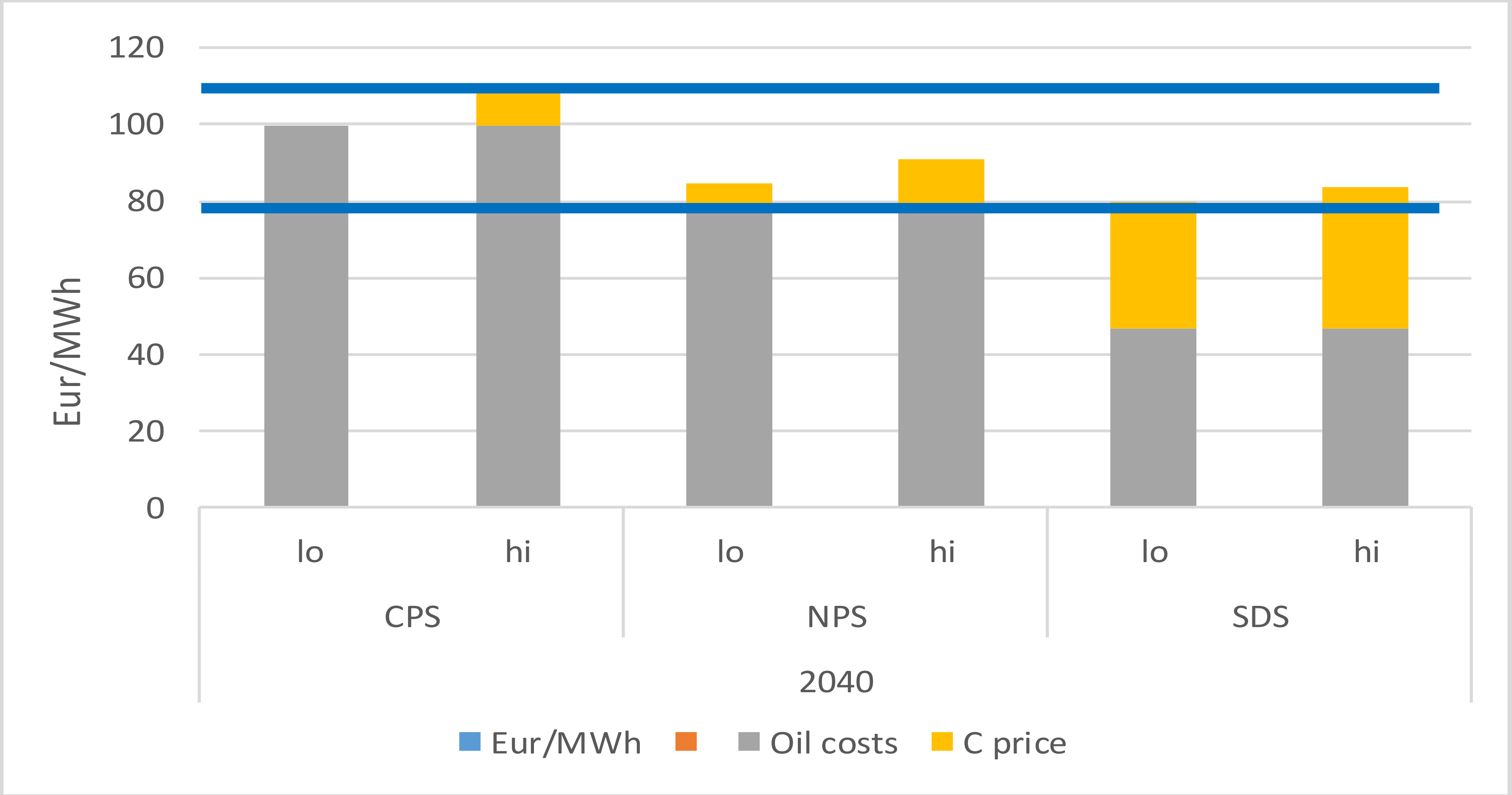


Long term cost reduction potential



- Graph shows impact of learning for 10 and 100x capacity expansion at different learning rates

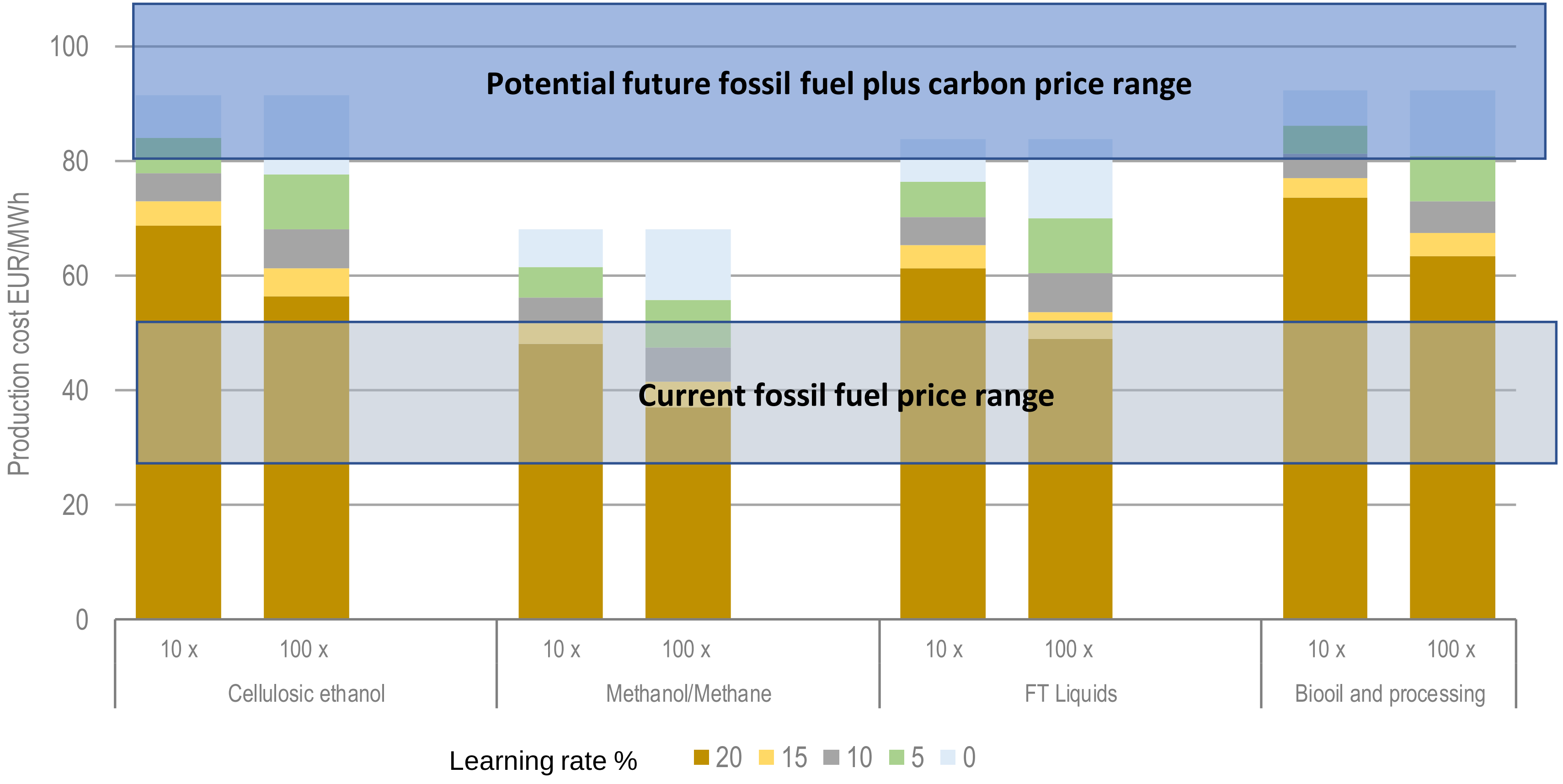
Fossil fuel and carbon price trends



Source: IEA WEO 2018

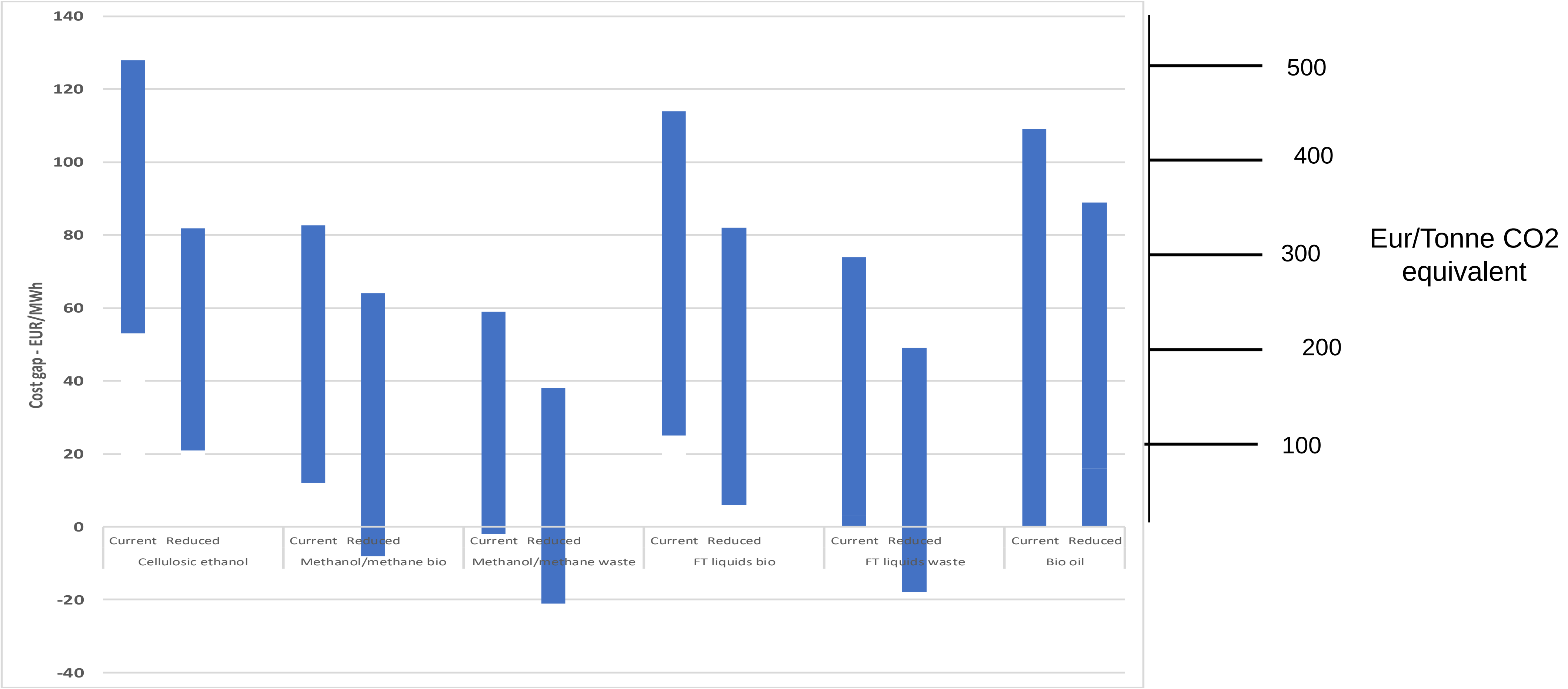
Note:
CPS: Current policy scenario; NPS: New Policy Scenario; SDS: Sustainable Development Scenario

Long term cost reduction potential

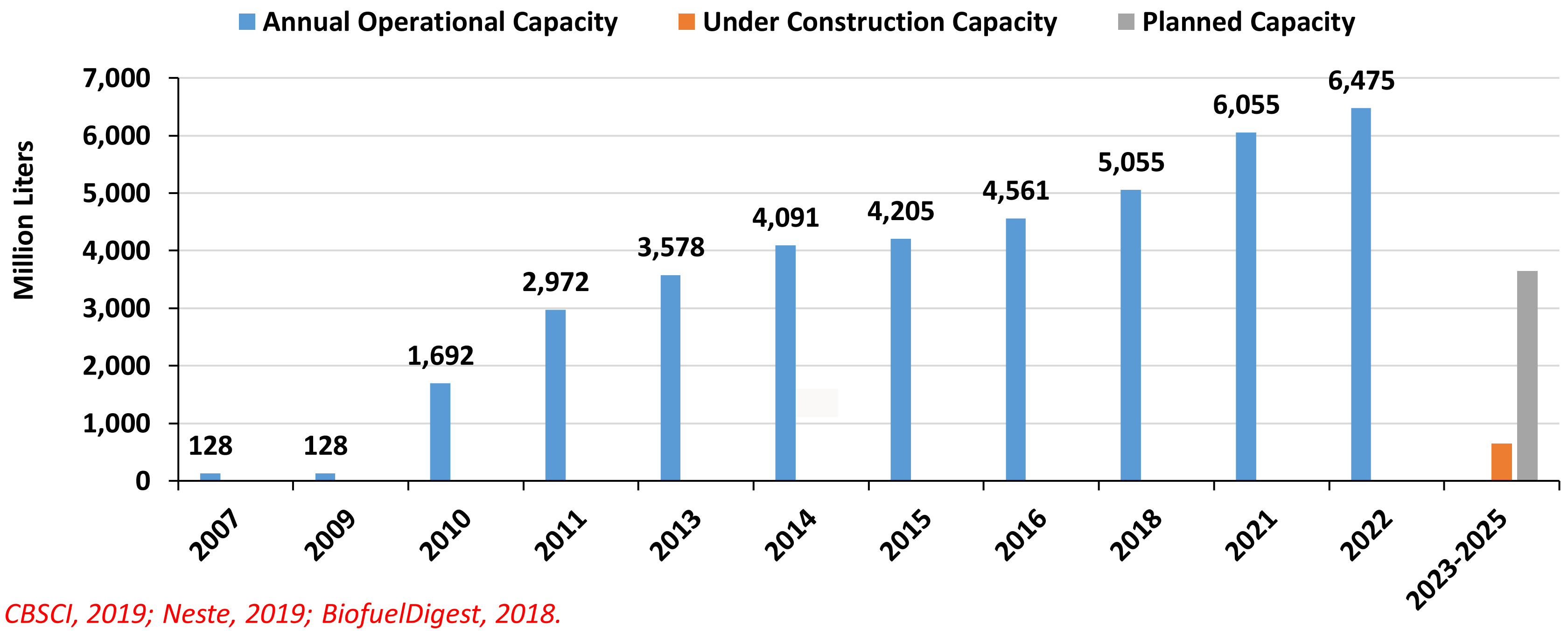


- **Comparison with fossil fuel and carbon prices from IEA scenarios (2040) shows advanced biofuels can be competitive under these conditions**

Cost gap and equivalent carbon price



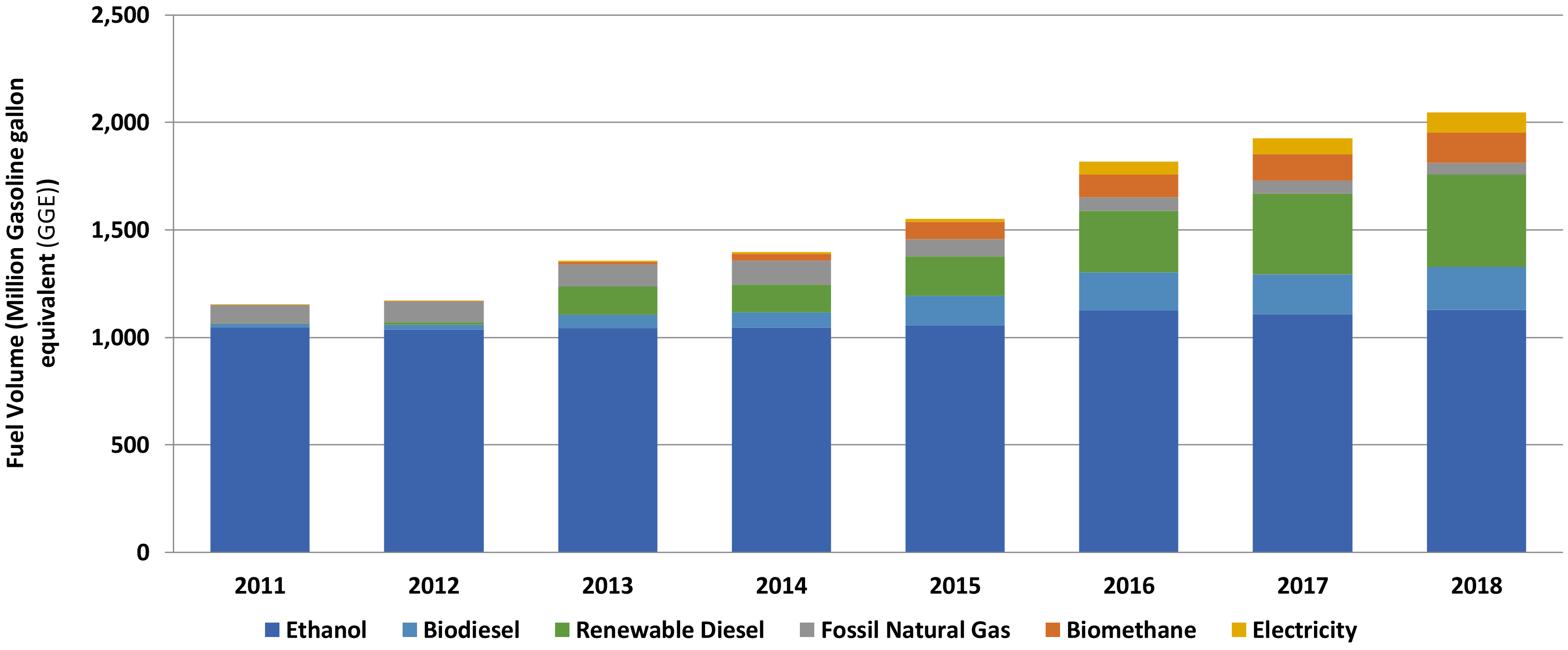
Continuous growth of "conventional" drop-in biofuels over the last decade (HVO/HEFA/renewable diesel)



Source: CBSCI, 2019; Neste, 2019; BiofuelDigest, 2018.

- Currently, over 5 billion liters of HVO/HEFA drop-in biofuels are produced in 8 facilities in the EU, the US and Singapore
- HVO/HEFA drop-in biofuels grew at an annual rate of 170% since 2007.
- All of the operational capacity is coming from standalone/repurposed facilities (little co-processing at oil refineries).
- Currently one facility is producing biojet (World Energy Paramount), the rest producing "renewable diesel".
- The feedstocks used in all existing facilities are oleochemicals/lipids (tallow, UCO, vegetable oils, tall oil, etc.)

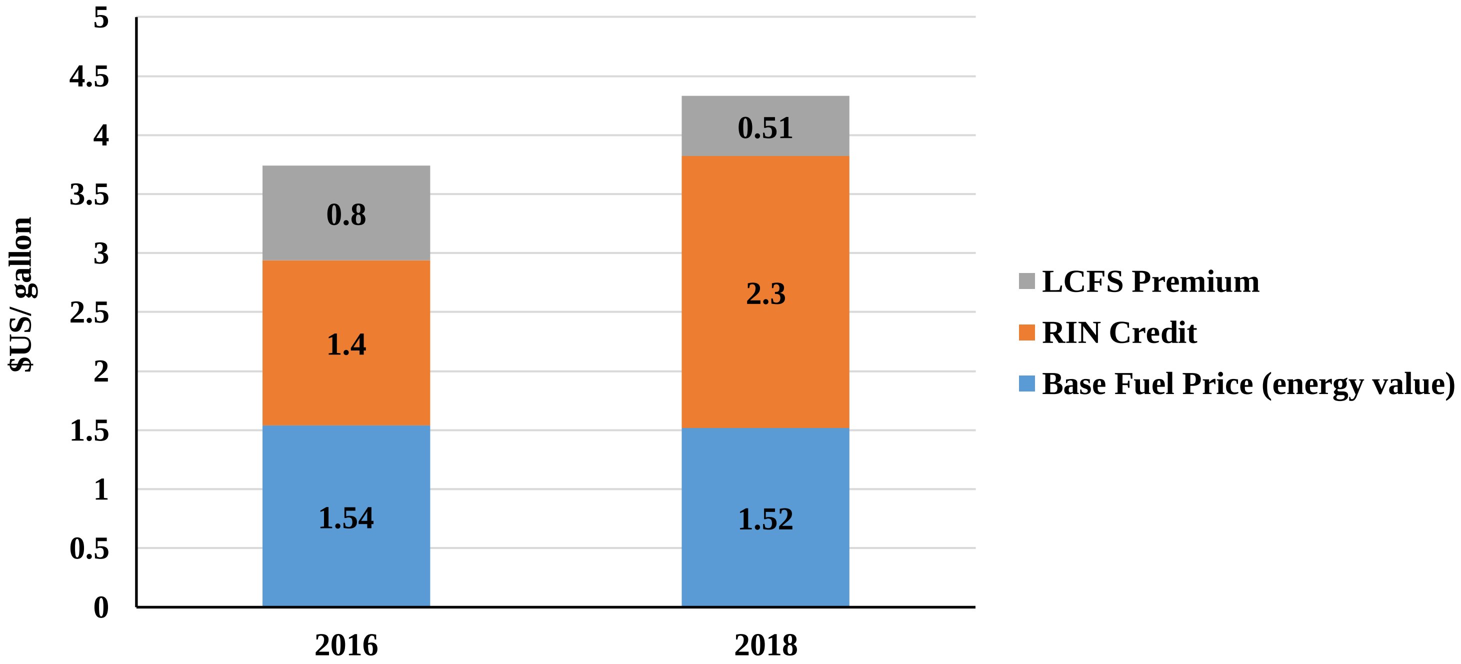
How the LCFS has influenced the California biofuels market



Source: CARB, 2019.

- Increase use of renewable diesel from **2 million gasoline gallon equivalent (GGE) in 2011 to 429 million GGE in 2018**
- Increase use of biomethane from **2 million GGE in 2011 to 139 million GGE in 2018**
- While **ethanol contributed the largest amount of biofuel on a volume and energy basis in 2018**, 70% of the LCFS credits were generated by non-ethanol biofuels with lower carbon intensities.

"Market value" of cellulosic ethanol in California - Impact of biofuel policies



Source: Biofuels Digest, 2018

- About **60% of the market value is policy driven (RINs and LCFS premium).** This makes those biofuels with low carbon intensities cost-competitive with fossil fuels in the California market.
- **Market-pull** policies will be critical for the short-to-mid-term economic viability of low carbon "advanced" biofuels.
- **Technology-push** policies such as R&D and grants dedicated to advanced biofuels will continue to be required to drive early stage technologies towards demonstration and commercialization.

Cost not the only issue!

Cost

Resource availability

Market access

Low carbon transport fuels

Social and other sustainability issues

GHG impacts

Infrastructure costs

Overall Key Conclusions

- Comparison of the estimates of the current costs of production of the range of advanced biofuels with the prices of the fossil fuels that they aim to replace indicates a significant cost gap.
- There is scope for medium term cost reductions of between 20 - 50% due to technical advances and improved financing terms.
- If the medium-term cost reductions discussed above can be achieved the gap will be narrowed but will still be significant for many of the pathways.
- In the longer term, there is further scope for cost reduction due to learning effects, if there is an extensive increase in the production capacity of advanced biofuels. There is the prospect of the technologies being competitive in the context of anticipated fossil and carbon prices.
- Large scale deployment will depend on continuing policy support. First industry will need support during the demonstration and the risky and costly early commercialisation of the technologies, so as to bridge the “valley of death”.
- Continuing strong support will be needed either via strong carbon price signals, or by incentivising low carbon fuels.
- Cost is not the only issue!

The full report is available at:
https://www.ieabioenergy.com/publications/new-publication-advanced-biofuels-potential-for-cost-reduction/

Thanks for your attention

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