Concawe
Environmental Science for European Refining

High Octane Petrol

Making gasoline relevant for the future of road transport

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Content

1 Concawe _ Industry Association

Concawe - Environmental Science for European Refining

Concawe Membership

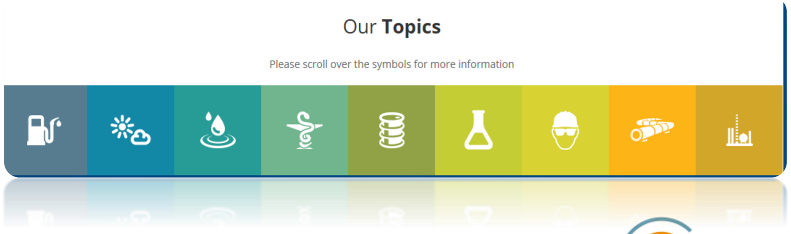
Concawe represents 40 Member Companies ≈ 100% of EU Refining

Open to companies owning refining capacity in the EU

Concawe mission

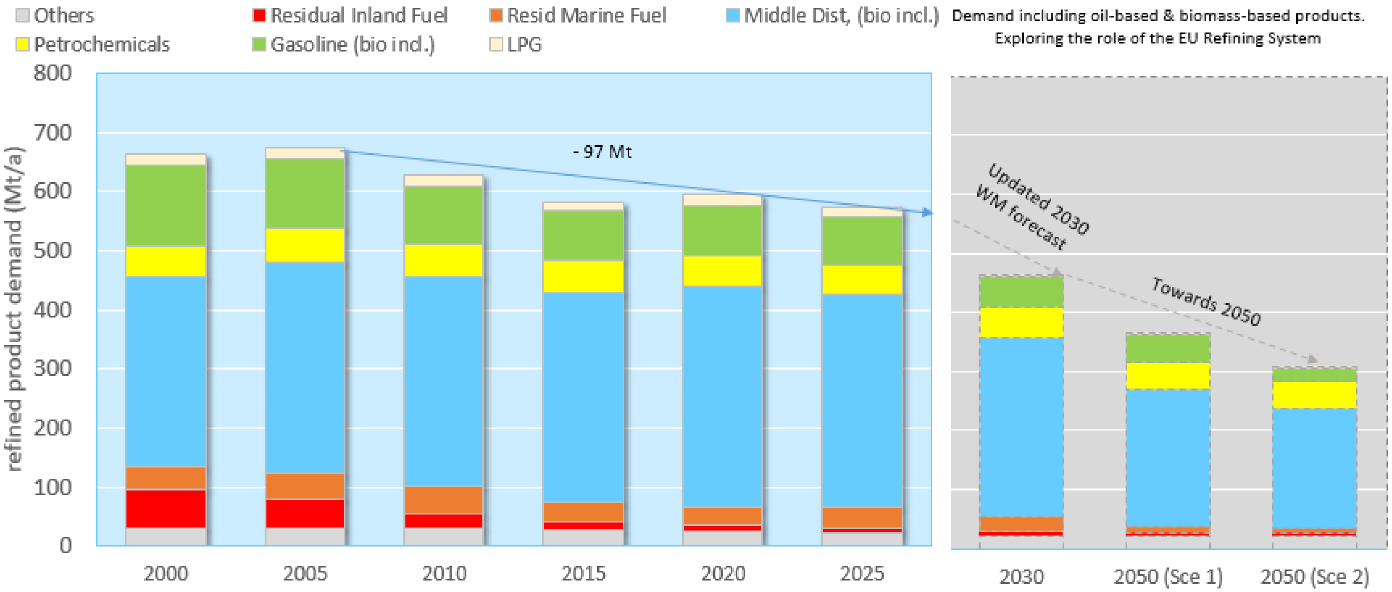
To conduct **research** to provide **impartial scientific information regarding:**

- scientific understanding
- Assist the development of technically feasible and cost effective policies and legislation
- Allow informed decision making and cost effective legislative compliance by Association members



2 Passenger cars and liquid fuels

Demand Scenario towards 2050



Two different **2050 demand scenarios** inspired by the **IEA scenarios** (***WEO 2107*** – *New Policies and Sustainable Development*).

=> Update ongoing with new hypothesis: « **EU Green Deal** » and now « **2030 Impact Assessment** »

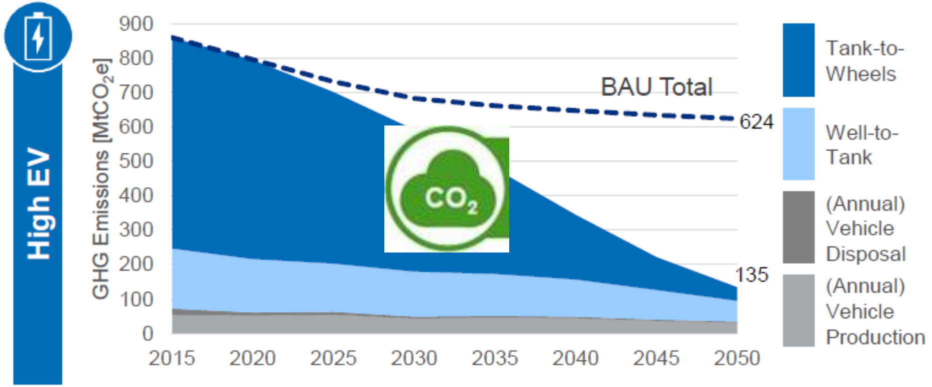
Concawe

Mass EV vs Low Carbon Liquid Fuels - CO2 emissions (LCA)

High EV scenario = “mass EV adoption”

100% EV registration by 2040

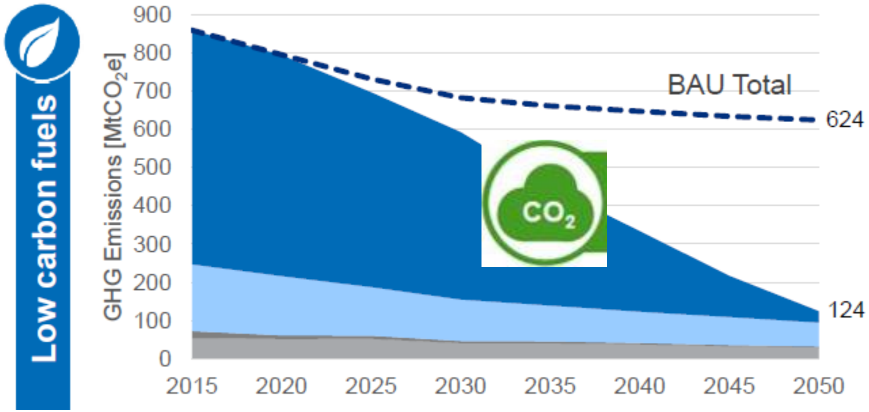
~90% EV in total fleet by 2050



Low carbon fuels Scenario: by 2050 total fleet,

46% EV + PHEV and 40% HEV

Energy = 23% electricity and 68% Low carbon Fuels



Same Total cost of ownership in both scenarios

Long term future for Internal Combustion engines thanks to Low Carbon Liquid Fuels

https://www.concawe.eu/publication/impact-analysis-of-mass-ev-adoption-and-low-carbon-intensity-fuels-scenarios/

3 High Octane Petrol (HOP)

Interest for HOP _ Concawe data

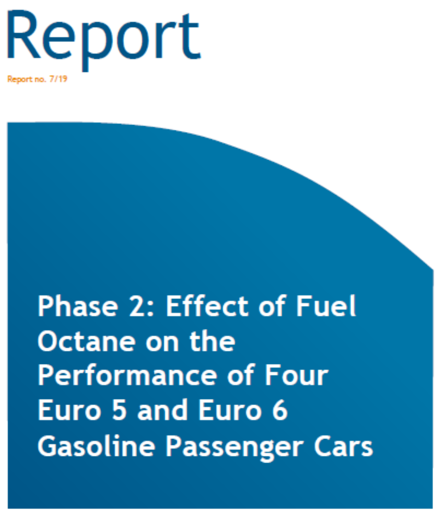
Engine efficiency impact* on HOP

- Literature shows 3 to 15% efficiency for RON 95 -> 102 (+7 pts)
- Concawe made its own study:

RDE (Real Drive Emissions) Cycle data

RDE Cycle data	L / 100 km	Gain / RON 95	Gain / RON 98
RON 95	8.129	-	-1.33%
RON 98	8.022	1.32%	-
RON 100	7.927	2.48%	1.18%
RON 102	7.827	3.72%	2.43%
RON 104	*(*) 7.727*	*4.95%*	*3.68%*

(*) Linear extrapolation of 100-102 data



(*) i.e. for the same passenger-km or weight-km, less energy is required for the transport system, which mechanically decreases the 'domestic' demand

Study objectives and assumptions

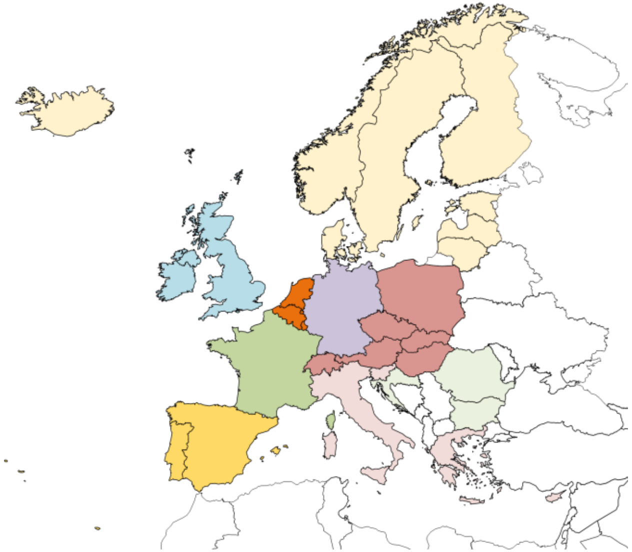
Assess the feasibility and impact of producing a "High Octane Petrol (HOP)" grade in the European (EU28+3) refining system, as a contribution to vehicle efficiency improvement up to 2030.

- **HOP RON cases: 102 RON as main target** (central scenario)
  - *Constant bio energy content of 3.4% (ETBE + ethanol mix) for domestic demand (RON 95 & HOP)*
  - *2 solution pathways*
    - **Oxygenate pathway:** **MTBE @ historical market price**
    - **Oxygenate 'light' pathway:** **reduced incentive** for Oxygenates (maximizing RON from refining components)

- **Extrapolation to 2030: 50% of EU gasoline Demand is HOP**

Highly sophisticated model with flexible structure

LP consists in an optimization driven by an objective function (profit maximization or costs minimization), where variables involved are constrained by means of linear equations



Model strengths

- **Accurate and exhaustive process units capacities**
  - *Grouping by regional capacities, preserving data confidentiality*
- **Comprehensive process modeling**
  - *Generated from rigorous simulators*
- **Entirely linear**
  - *Reduces risk of local optima*
  - *Improves the optimization speed*
- **S, C, H, (N, Ni, V) balanced**
  - *All process units, all streams*
  - *Ensures any impact on the refining system to be correctly reflected*
  - *RF burning CO_2 emissions from C content*

Simulation results (2030)

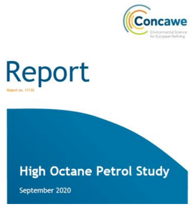
- **HOP RON cases: 98* (current) / 102 (target)**
  - *Overall pool results: average of HOP, RON 95 and export grades*

Overall domestic gasoline RON 95 + HOP + Export average	**HOP 98 Base**	**Oxy. light pathway HOP 102**
HOP ratio on domestic demand, wt%	**10**	**50**
Overall pool RON	**94.4**	**96.4**
Volume % of refining components	93.9%	91.6%
ETBE + MTBE content, wt% (in HOP & R95)	4.5%	**7.8%**
ETBE + MTBE content, MTPY	3.5	**5.9**
Naphtha content, wt%	4.0%	1.0%
Alkylate content, wt%	9.9%	12.5%
EtOH content, wt%	3.6%	3.6%

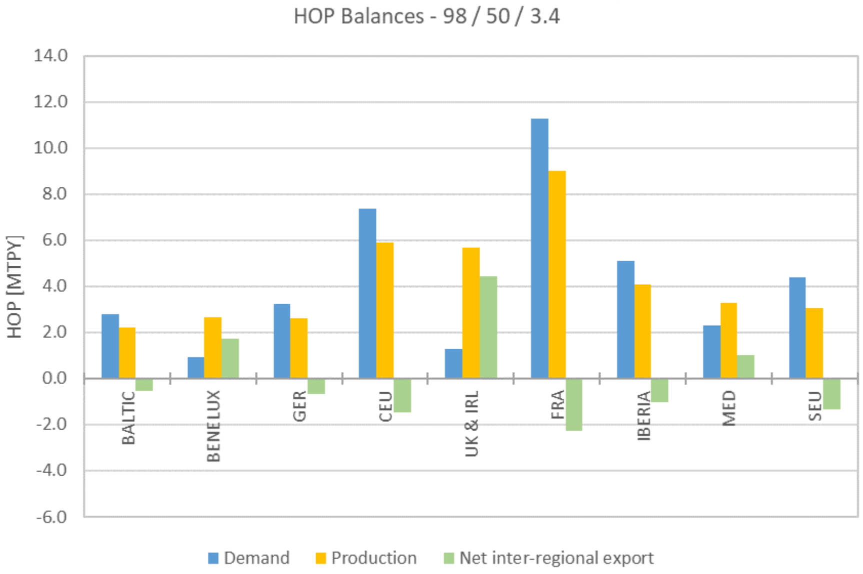
(**) Excludes oxygenates produced by the refining system

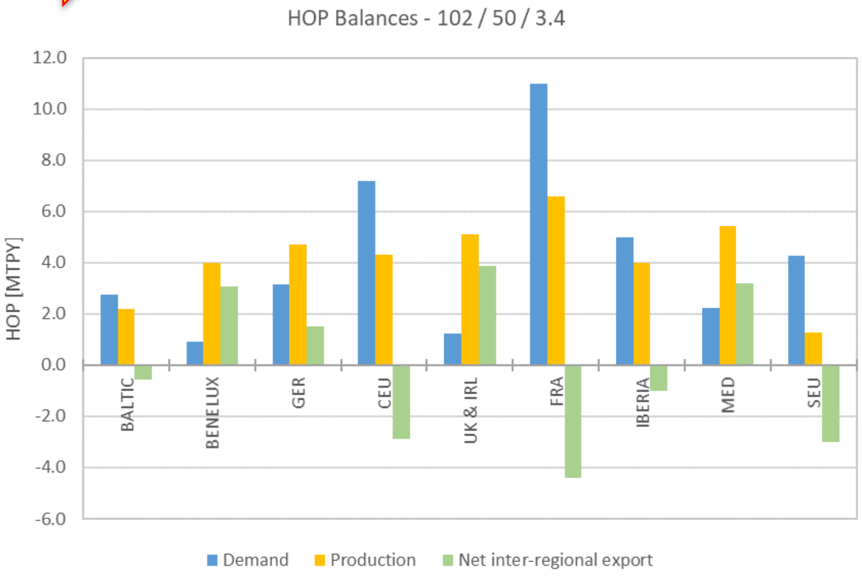
(*) Today, the High octane grade is RON98 and market demand is ~10% in Europe

Regional productions



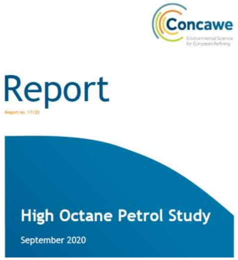
Base Case (2030) → HOP 102RON





Regional imbalances are increasing, but no blocking points

Direct CO_2 impacts

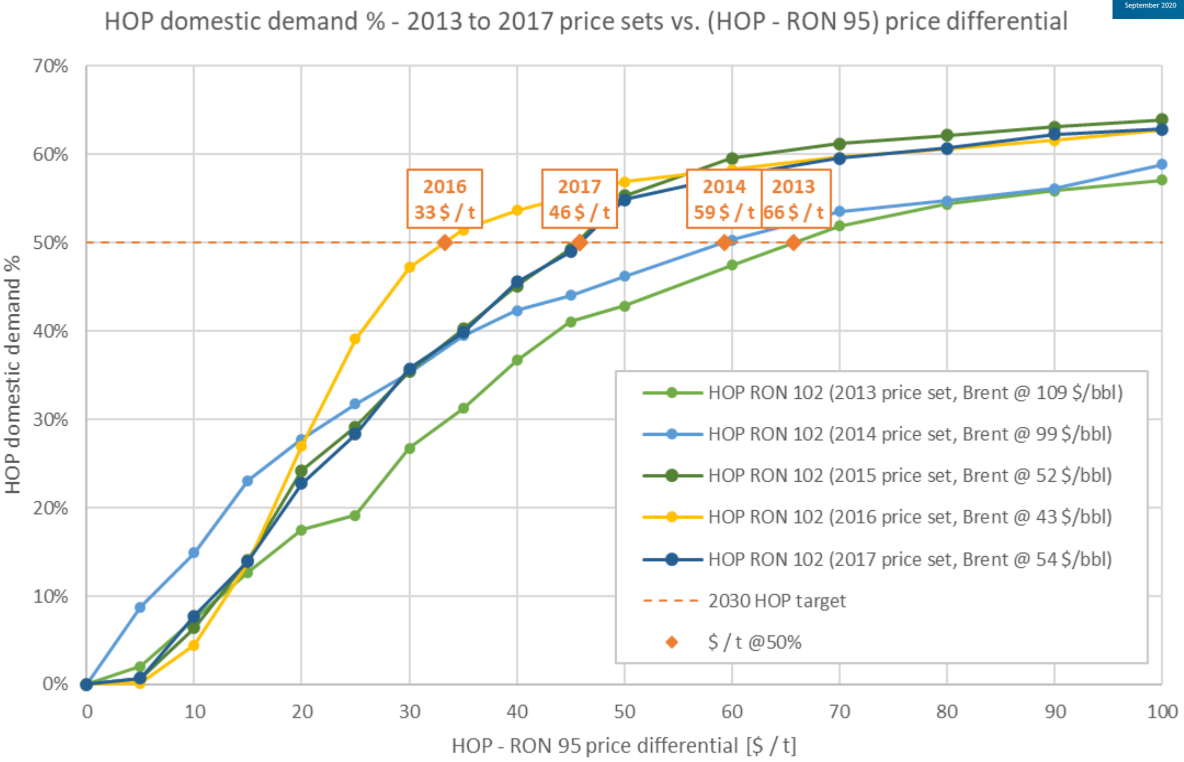


Emissions from cars are estimated from gasoline pools carbon content
(Concawe LP model is carbon balanced)

	Oxygenate light pathway
CO_2 MTPY vs. 2030 Base (long term)	**HOP 102 (2030 _ 50% fleet)**
Direct emissions from refining	**+ 0.2**
Direct emissions from HOP & RON 95 cars	- 6.0
Oxygenates WTT impact	**+ 1.6**
Total CO_2	**- 4.2**

Economics & HOP price sensitivity

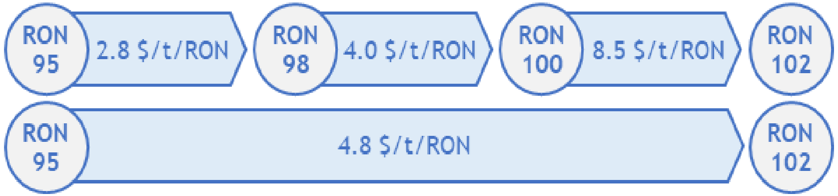
- Step changes on HOP price differential vs current RON 95
- Performed on 2030 cases, HOP 102RON
- 4 sets of prices, yearly average (2013 to 2017)



Economics _ drivers

Step changes on HOP price differential vs current RON 95

HOP – RON 95 differential, $ / t	HOP 102
Total differential	**33**
MTBE contribution	4
Other components contribution (i.e. refining system costs)	29



Octane cost increasing with RON target and the higher the RON, the more costly in $/t/RON

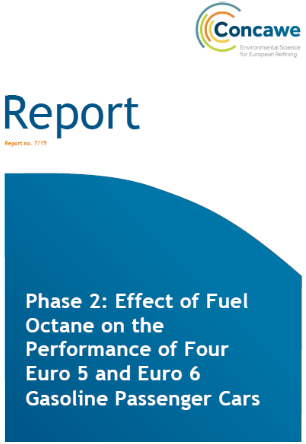
Average cost of octane - USGC 2016

4 Takeaways

Technologies and innovation to reduce GHG

- **Concawe study show efficiency gains of 3,7% for 7 points Ron increase (95 to 102RON)**

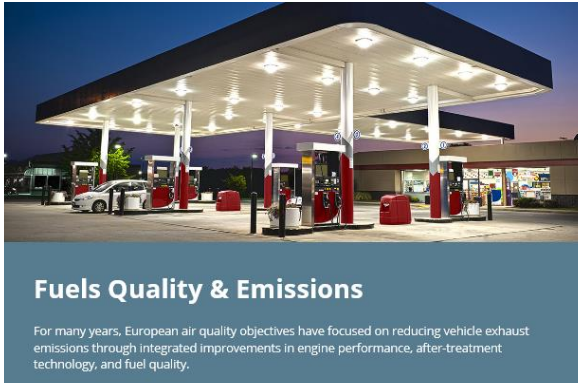
- **At EU level, feasibility has been demonstrated and cost increasing with octane target**

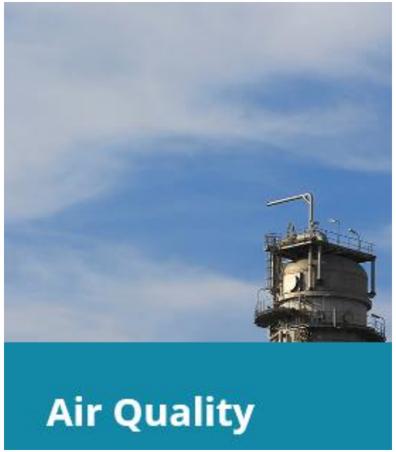


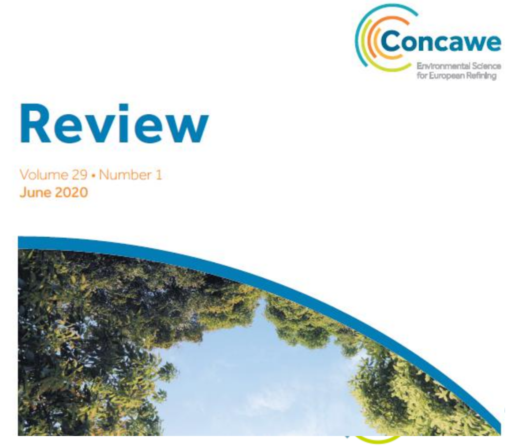
- **Regional imbalances for HOP are exacerbated**

- **Potential for CO_2 emission reduction ~4Mt/year** (refining process + combustion in ICE at high compression ratio)

Check-out on our web site https://www.concawe.eu







Our transformation has begun

[Full Report, click here]