

# How competitive is PtX Methanol (PtX-CH<sub>3</sub>OH) compared to Methanol from Natural Gas (CH<sub>3</sub>OH) if CO<sub>2</sub> is taxed?

*SOME THOUGHTS FOR ALL THOSE WHO LIKE TO GET A VIEW ON THE FUTURE OF METHANOL SUPPLY FOR SHIPPING.*

**Dr.-Ing. Gerd Wuersig**

**GMW Consultancy**

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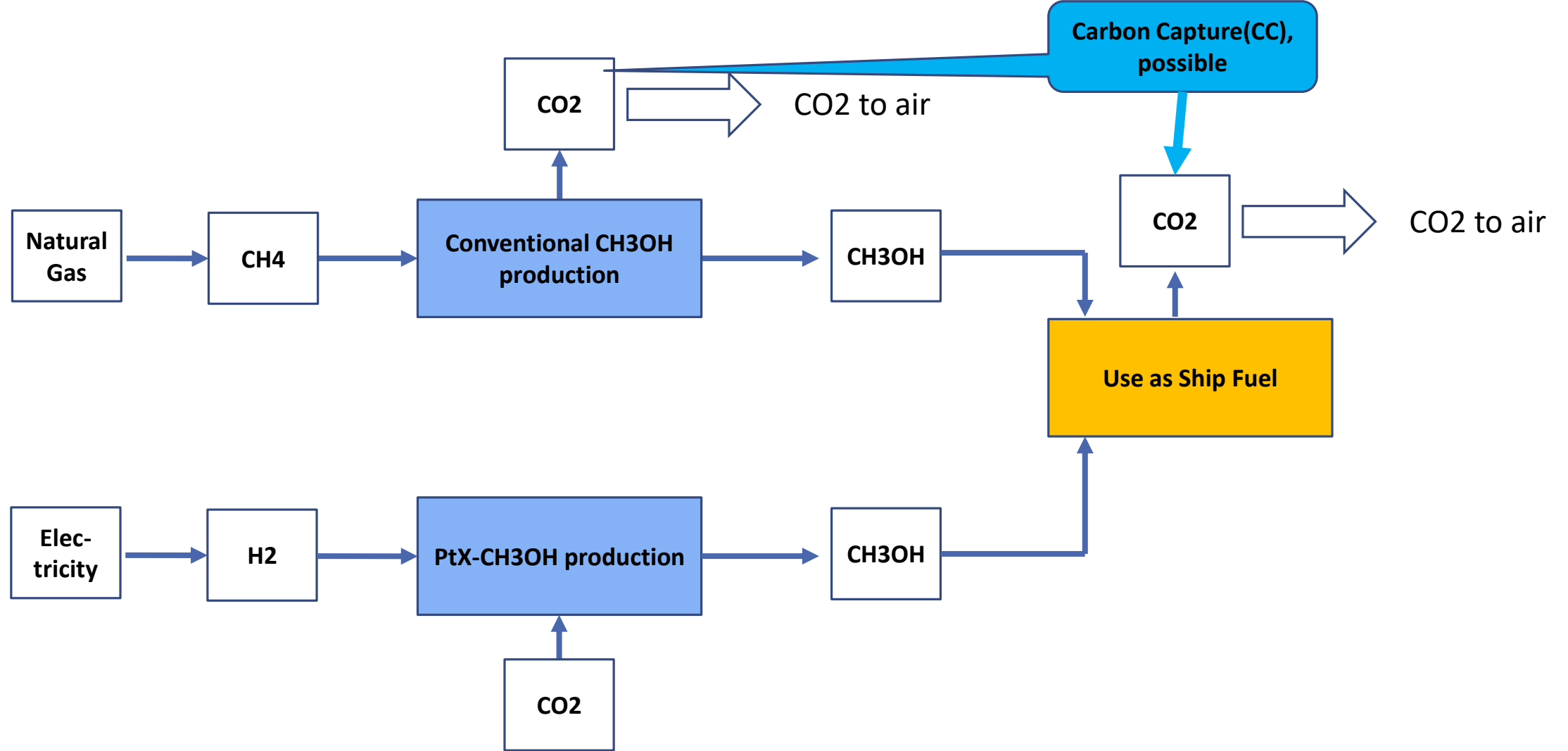
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# ***Summary for the relation between CO2 price, Carbon Capture and the use of Methanol as ship fuel.***

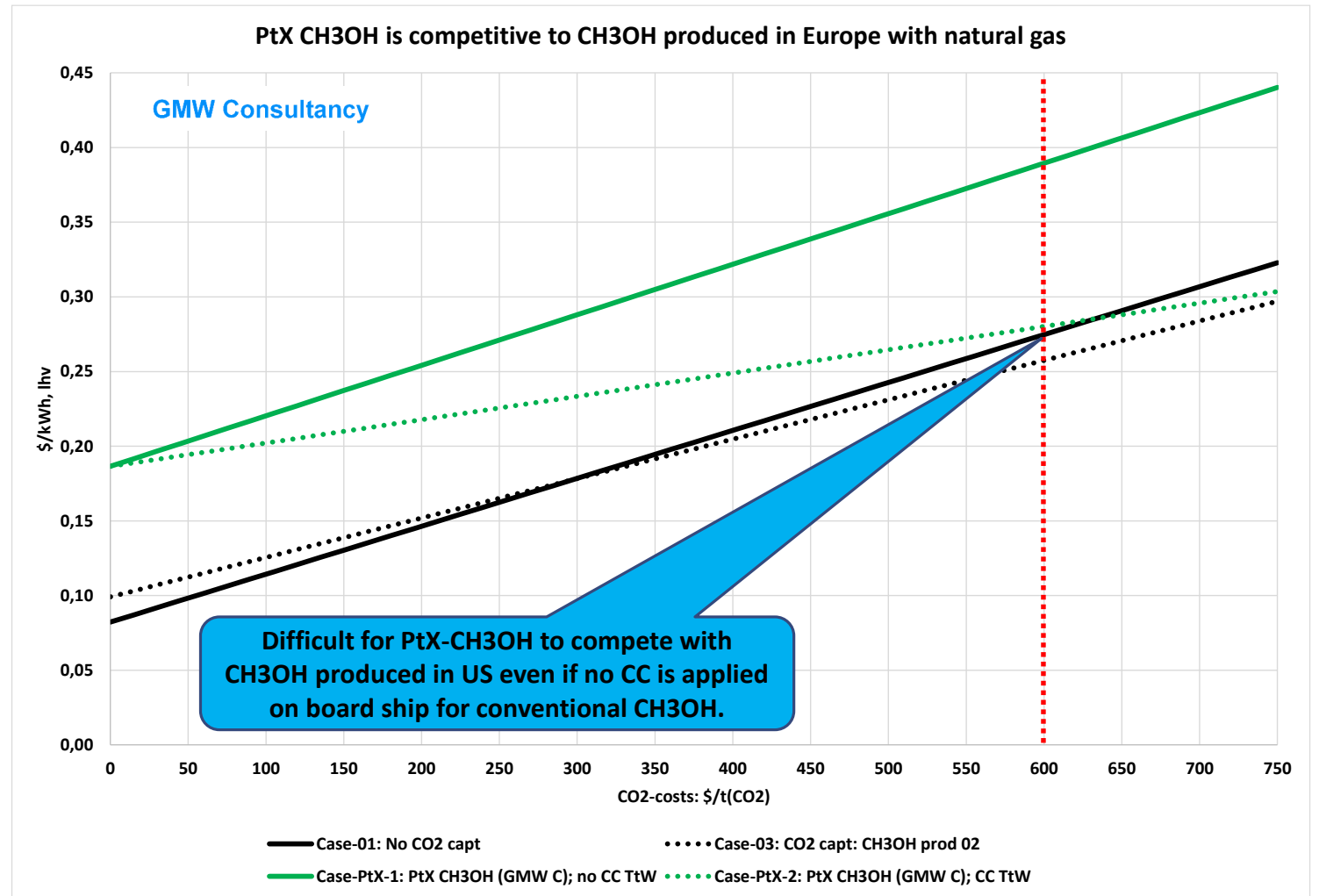
- The following is based on Natural Gas (NG) prices from December 2022 in the US and in Europe (0,025 \$/kWh, hhv, Henry Hub; 0,13 \$/kWh, hhv, TTF).
- It is assumed that Tank to Wake (TtW) CO2 emissions from Methanol used as ship fuel but produced by renewable energy are not taxed!
- At a low NG price (as it is in the US) taxation of CO2 will not make Methanol (CH3OH) from Hydrogen (H2) and CO2 (PtX-CH3OH) competitive to CH3OH from NG.
- A high NG price is the basic condition to make Power to X Methanol (PtX-CH3OH) competitive.
  - At a high NG price level (as it is in Europe) PtX-CH3OH would be already competitive without any CO2 taxation.
- With low cost NG Carbon Capture (CC) on board of the ship is the alternative to the use of PtX-CH3OH.
- CC in the production process of CH3OH from NG has a relatively low impact compared to CC on board of the ship.
- Two equivalent ways exist to make Methanol as ship fuel nearly carbon free if CC is applied on board of the ship:
  - Methanol from Natural gas with CC during production of the Methanol.
  - Production of Methanol from Carbon free generated electricity for Hydrogen production, Carbon Dioxide from fossil fuels by Carbon Capture from industrial processes, power generation.
    - **Note:** Use of Carbon Capture from Air has the same effect with significantly increased costs and negative impact for the overall Carbon Footprint of the world. (Compare free of charge presentation: “How shipping can contribute to reduce the overall CO2 footprint” ([www.GMW-Consultancy.com](http://www.GMW-Consultancy.com)))
- The small CO2 emissions caused by less than 100 % CC can be compensated by Carbon Capture and Storage (CCS) from air.

# Methanol ( $\text{CH}_3\text{OH}$ ) production from Natural Gas ( $\text{CH}_4$ ) and from Hydrogen ( $\text{H}_2$ ), Carbon dioxide ( $\text{CO}_2$ ) (PtX- $\text{CH}_3\text{OH}$ )



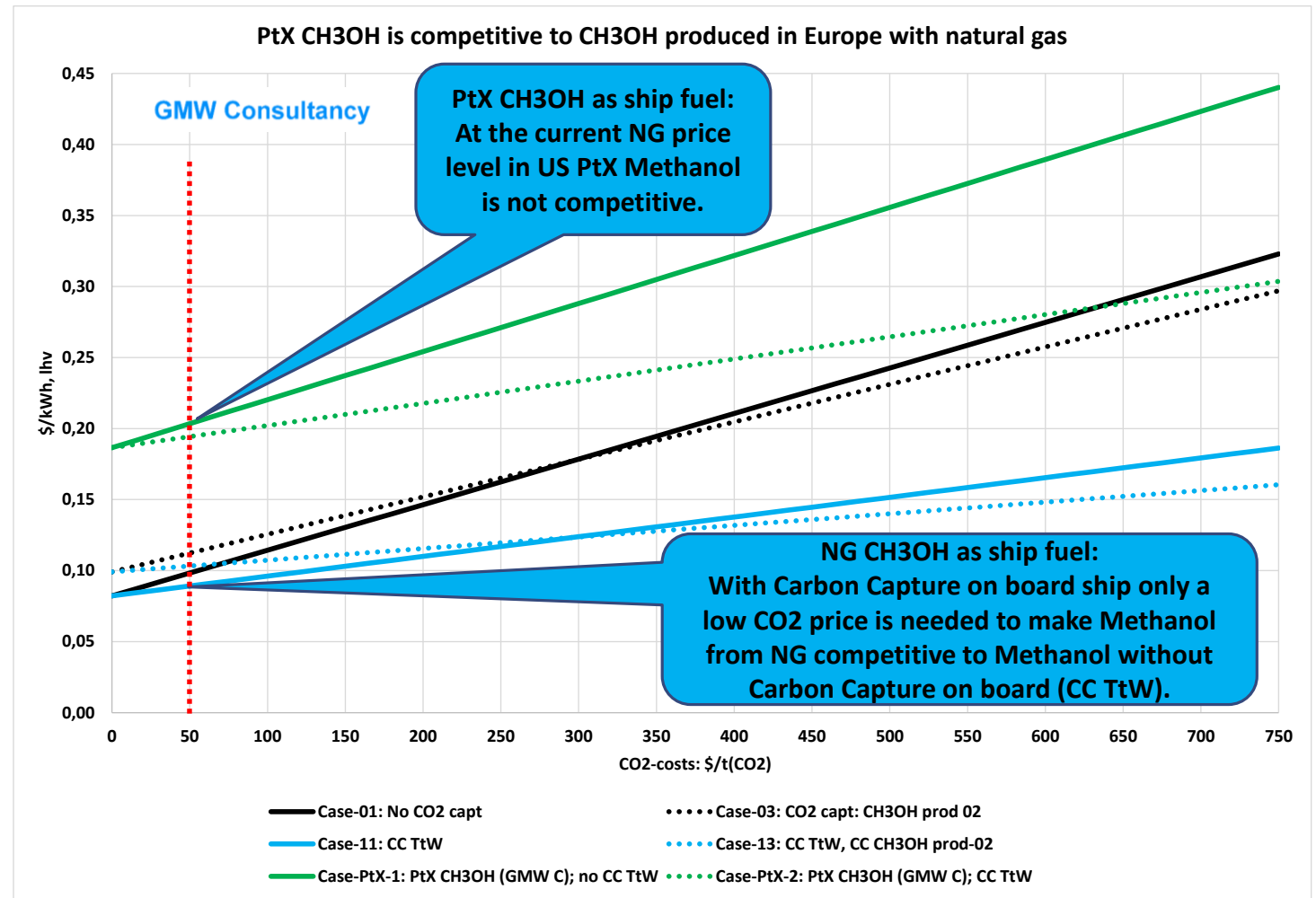
# ***PtX-CH<sub>3</sub>OH with CC on board ship (CC TtW) become competitive to CH<sub>3</sub>OH from NG Produced in US without any CC at a CO<sub>2</sub> price above 600 \$/t(CO<sub>2</sub>).***

- Case-01: base line (black);
  - Natural Gas in US used for CH<sub>3</sub>OH production.
  - No carbon capture in production and after CH<sub>3</sub>OH use as fuel.
- Case-03: as Case-01 but (black dotted)
  - with Carbon Capture (CC) for CO<sub>2</sub> related to CH<sub>3</sub>OH production.
- CH<sub>3</sub>OH produced as PtX from H<sub>2</sub> and CO<sub>2</sub>:
  - Case PtX-1 (green): without CC on board ship (no CC TtW)
  - Case PtX-2 (green dotted): with CC on board (CC-TtW)



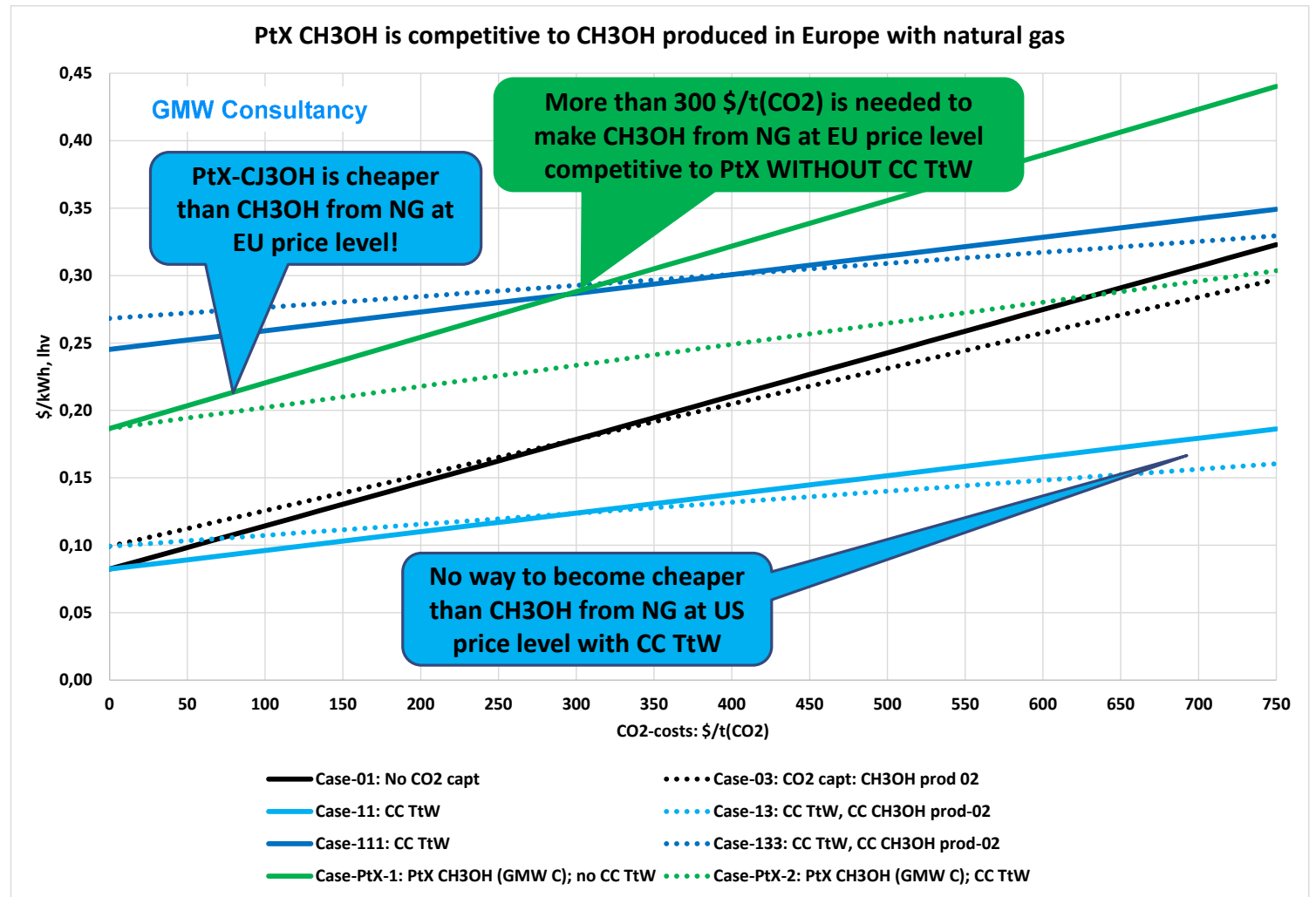
# ***PtX-CH<sub>3</sub>OH is competitive to CH<sub>3</sub>OH from Natural Gas produced in the US when CC on board ship is applied.***

- Case-01: base line (black);
  - Natural Gas in US used for CH<sub>3</sub>OH production.
  - No carbon capture in production and **no CC** when used as fuel.
  
- Case-03: as Case-01 but (black dotted)
  - with Carbon Capture (CC) for CO<sub>2</sub> related to **CH<sub>3</sub>OH production**.
  
- Case **PtX-1** (green), Case **PtX-2** (green dotted):
  - CH<sub>3</sub>OH produced from H<sub>2</sub> and CO<sub>2</sub> **without CC** on board ship and **with CC** on board (CC-TtW)
  
- Case-11 (light blue), Case-13 (light blue dotted):
  - CH<sub>3</sub>OH produced from Natural Gas in US **with CC on board ship** (CC-TtW) :
    - Case-11 (blue): **no CC** for CO<sub>2</sub> related to **CH<sub>3</sub>OH production**.
    - Case-13 (blue dotted): **with CC** CO<sub>2</sub> related to **CH<sub>3</sub>OH production**.



# Complete picture: PtX-CH<sub>3</sub>OH is competitive to CH<sub>3</sub>OH from NG Produced in Europe but not to CH<sub>3</sub>OH from NG Produced in the US.

- Case-01: base line (black);
  - Natural Gas in US used for CH<sub>3</sub>OH production.
  - No carbon capture in production and use as fuel.
- Case-03 (black dotted): as Case-01 but
  - with Carbon Capture (CC) for CO<sub>2</sub> related to CH<sub>3</sub>OH production.
- Case PtX-1 (green), Case PtX-2 (green dotted):
  - CH<sub>3</sub>OH produced from H<sub>2</sub> and CO<sub>2</sub> without CC on board ship and with CC on board (CC-TtW)
- Case-11 (light blue), Case-13 (light blue dotted):
  - CH<sub>3</sub>OH produced from Natural Gas in US with CC on board ship (CC-TtW) :
    - Case-11: no CC for CO<sub>2</sub> related to CH<sub>3</sub>OH production.
    - Case-13: with CC CO<sub>2</sub> related to CH<sub>3</sub>OH production.
- Case 111 (dark blue) , Case-133 (dark blue dotted):
  - same as Case-11, Case-13 but at European Natural Gas price level (Dec. 2022).
  - From the price level EU is prepared for the renewable future.



# GMW Consultancy

- Marine-, Process-, Energy Technology -

Dr. Ing. Gerd Wuersig  
Gerd.Wuersig@GMW-Consultancy.com

**Address:**  
Butendiek 14  
D-21714 Hammah, Germany  
+49-151-4066-9207

GMW Consultancy

- Marine-, Process-, Energy Technology -