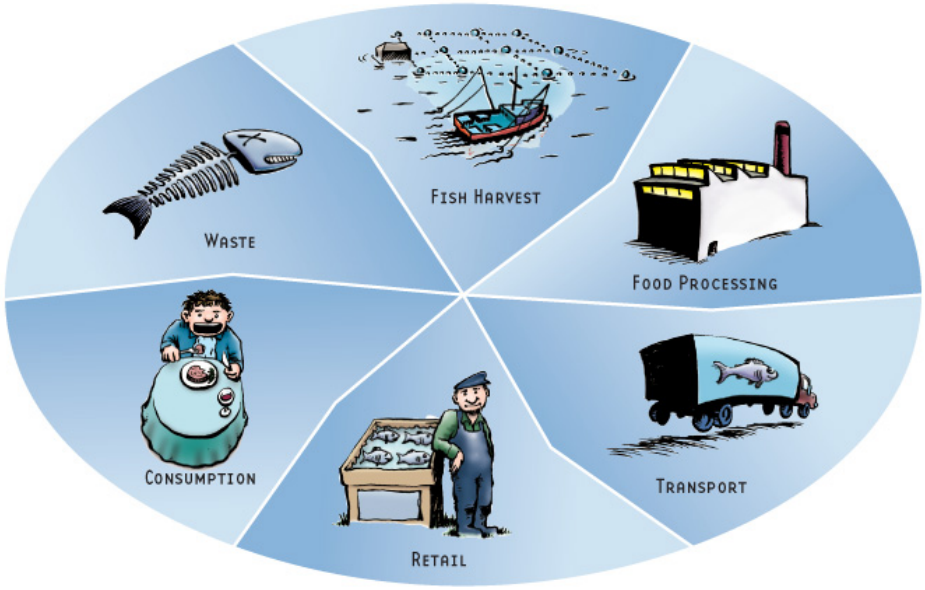
# Carbon footprint and energy use of Norwegian seafood products

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Andreas Emanuelsson, Veronica Sund, Harald Ellingsen

SINTEF Fiskeri og havbruk

SIK- Institutet för livsmedel och bioteknik

# Agenda

| | |
|---|---|
| 10.00–10.15: | Velkommen, Jon Arne Grøttum (FHL) |
| 10.15–11.00: | Presentasjon av resultater, Ulf Winther (SINTEF Fiskeri og havbruk) |
| 11.00–11.15: | Pause |
| 11.15–12.00: | Presentasjon av resultater fortsetter, Friederike Ziegler (SIK) |
| 12.00–12.30: | Spørsmål og diskusjon |
| 12.30–13.00: | Veien videre – oppsummering |

# Rapporten

- Vil bli sendt ut til møtedeltakerne denne uken
- Vil bli tilgengelig i pdf-format på hjemmesidene til FHF, Norges Fiskarlag, FHL, SINTEF Fiskeri og havbruk og SIK

# Bakgrunn og målsetting

- Spørsmålet om å gjennomføre et miljøregnskap for fiskeri- og havbruksnæringen kom opp i 2007
- Skulle være vekt på $CO_2$-utslipp
- SINTEF Fiskeri og havbruk og NTNU gjennomførte et forprosjekt, rapport ble presentert tidlig 2008
- Forprosjektet konkluderte med at det var mulig å utarbeide et klimaregnskap for utvalgte fiskeri- og havbruksprodukter

# Bakgrunn og målsetting

Målsettingen har vært:

- Sammenlignende analyse av energiforbruk og tilhørende CO2-utslipp for ulike matvarekjeder som villfisk, oppdrettslaks og landbruksprodukter
- Baseres arbeidet på få allment aksepterte effekter som er viktige i miljøsammenheng og som gir grunnlag for meningsfull sammenligning
- Vil kunne gi en referanse for hvor fiskeri- og havbruksnæringen står sammenlignet med andre relevante matvarer

# Bakgrunn og målsetting

- Vi har beregnet $CO_2$-utslipp og energiforbruk forbundet med produksjonen av 22 produkter fra fiskeri- og havbruksnæringen
- Og vi har sett på de samme parameterne for produksjon av kylling, svin og storfe

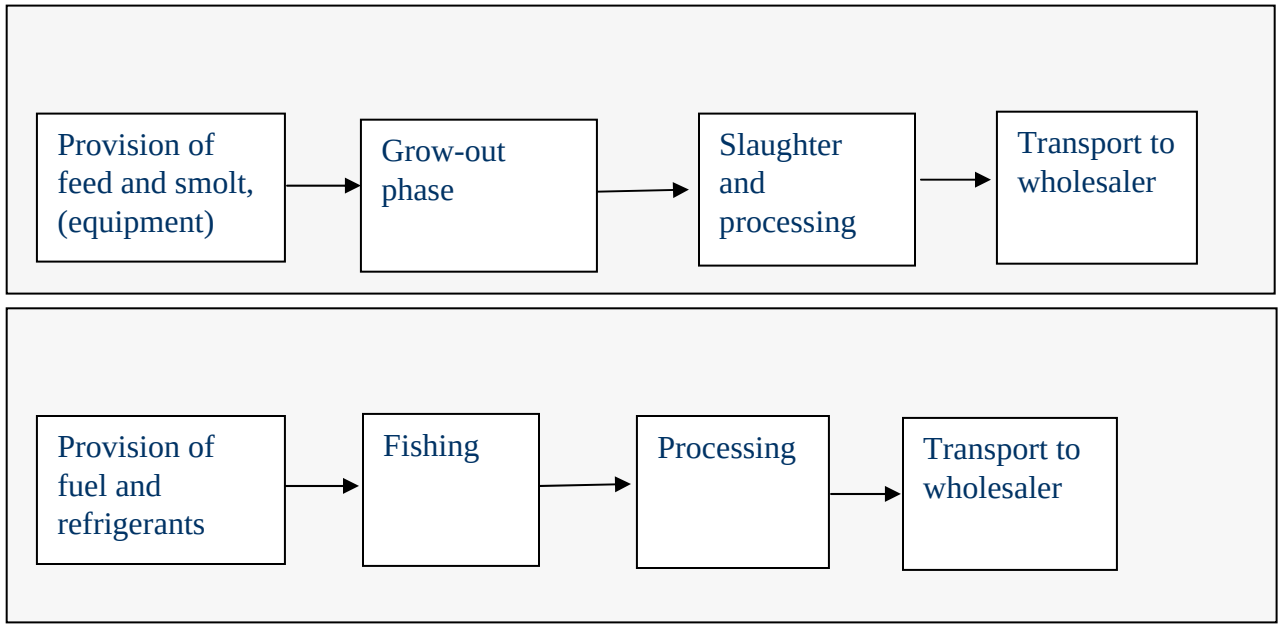
# Litt om prosessen

- Åpent oppstartsmøte høsten 2008
- Styringsgruppe fra FHL og Norges Fiskarlag
- Referansegruppe som vi har har flere møter med – gode innspill og bidrag til å innhente data
- ”Lekkasjer” underveis – Generalforsamling FHL og Landsmøtet Norges Fiskarlag
- Åpent avslutningsmøte i dag

# Ekstern granskning

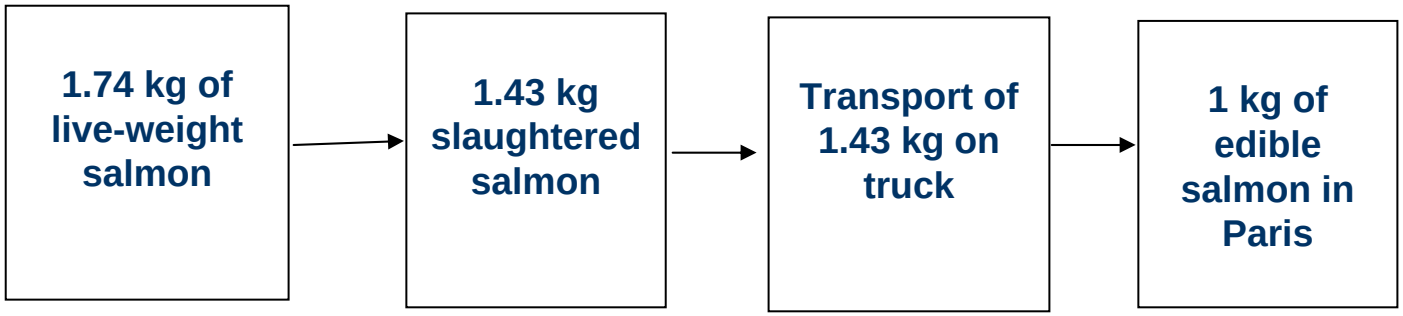
- Vi har fulgt ISO 14000-seriens krav til ekstern granskning
- Associate professor Mikkel Thrane, Ålborg Universitet
- Har tre ganger underveis gitt tilbakemelding på arbeidet – prinsipielle forhold
- Thranes rapport ligger som vedlegg til rapporten

# Systemgrenser




BACKGROUND SYSTEM:
Transport of feed inputs
Production of refrigerants
Production of energy carriers as fuels and electricity
Production of transport packaging

# Funksjonell enhet - eksempel




- Vi ser på 1 kg spisbart produkt: trimmet skinnfri spisbart produkt
- Viser her at 1,43 ganger mer sløyd laks transporteres enn det som blir spisbart produkt
- Vi har benyttet masseallokering

# Produktene

- Skulle være produkter fra havbruk og fiskeri
- Skulle være produkter som er representative for norsk eksport av sjømat og som representerer betydelige volumer
- Også enkelte andre produkter, som f.eks blåskjell
- Produktkategorier: Opprinnelse – art - produkt – leveringssted - transportmåte

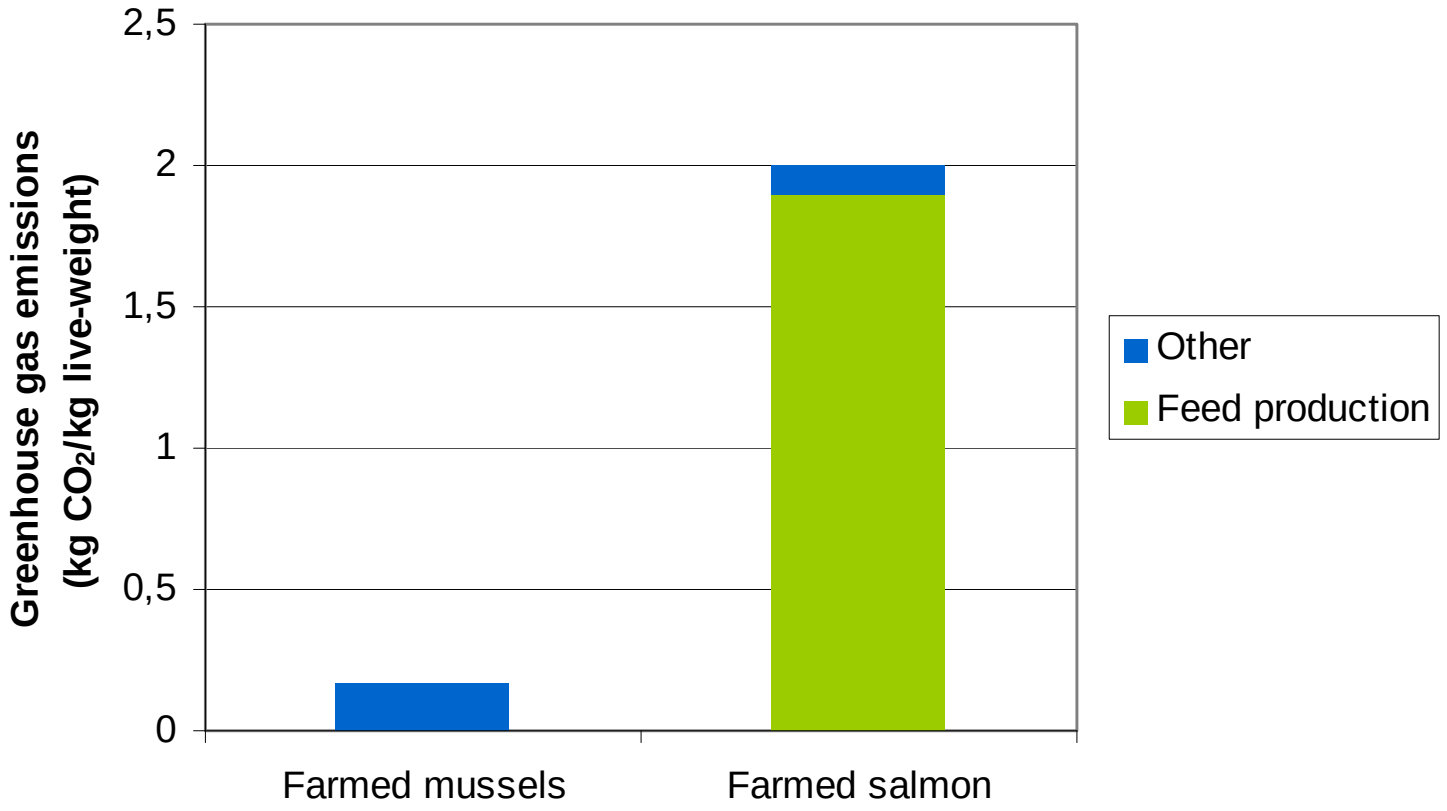
# Produktene - akvakultur

| Origin | Species | Product | Delivered to | Transport mode |
|---|---|---|---|---|
| Aquaculture | | | | |
| 1 | Salmon | Fresh, gutted head-on | Paris | Truck |
| 2 | | | Oslo | Truck |
| 3 | | | Moscow | Truck |
| 4 | | | Tokyo | Air |
| 5 | | Frozen, gutted head-on | Shanghai | Container freighter |
| 6 | | Fresh fillet | Paris | Truck |
| 7 | | Frozen fillet | Paris | Truck |
| 8 | Blue mussels | Living, fresh sorted | Paris | Truck |

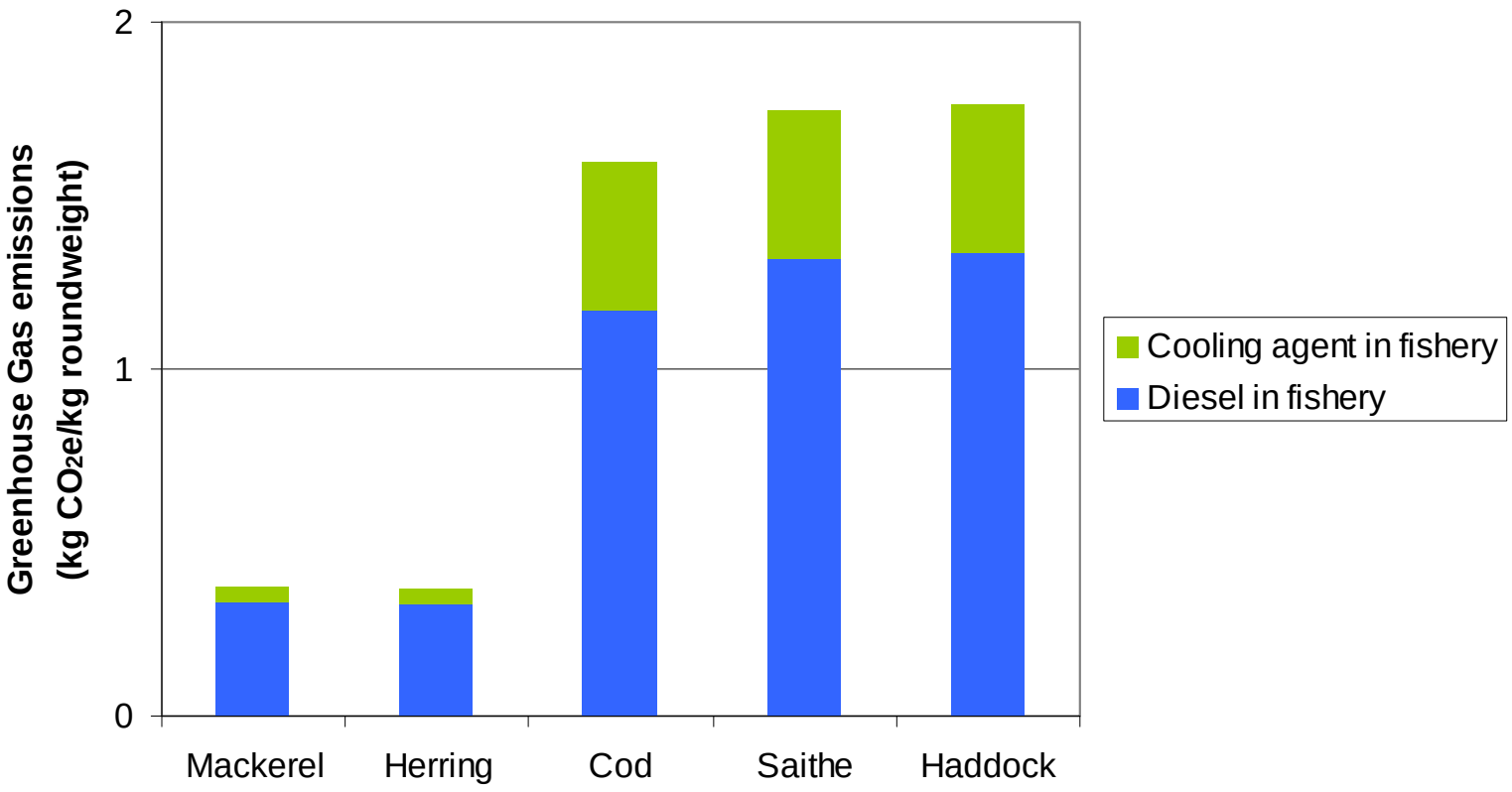
# Produktene - fiskerier

| Origin | Species | Product | Delivered to | Transport mode |
|---|---|---|---|---|
| Capture fisheries | | | | |
| 9 | Cod | Fresh, gutted head-on | Paris | Truck |
| 10 | | Fresh fillet | Oslo | Truck |
| 11 | | | Paris | Truck |
| 12 | | Frozen fillet | Paris | Truck |
| 13 | | | Paris | Truck/ Container freighter, processed in China |
| 14 | | Saltfish | Lisbon | Truck |
| 15 | | Clipfish | Lisbon | Truck |
| 16 | Saithe | Frozen fillet | Berlin | Truck |
| 17 | Haddock | Fresh, gutted head-on | London | Truck/RoRo vessel |
| 18 | | Frozen, gutted head-on | London | Truck/Bulk freight |
| 19 | Herring | Roundfrozen | Moscow | Bulk freight/ Train |
| 20 | | Frozen deskinned fillet | Moscow | Truck |
| 21 | Mackerel | Frozen round | Tokyo | Container freighter |
| 22 | | | Moscow | Bulk boat/ Train |

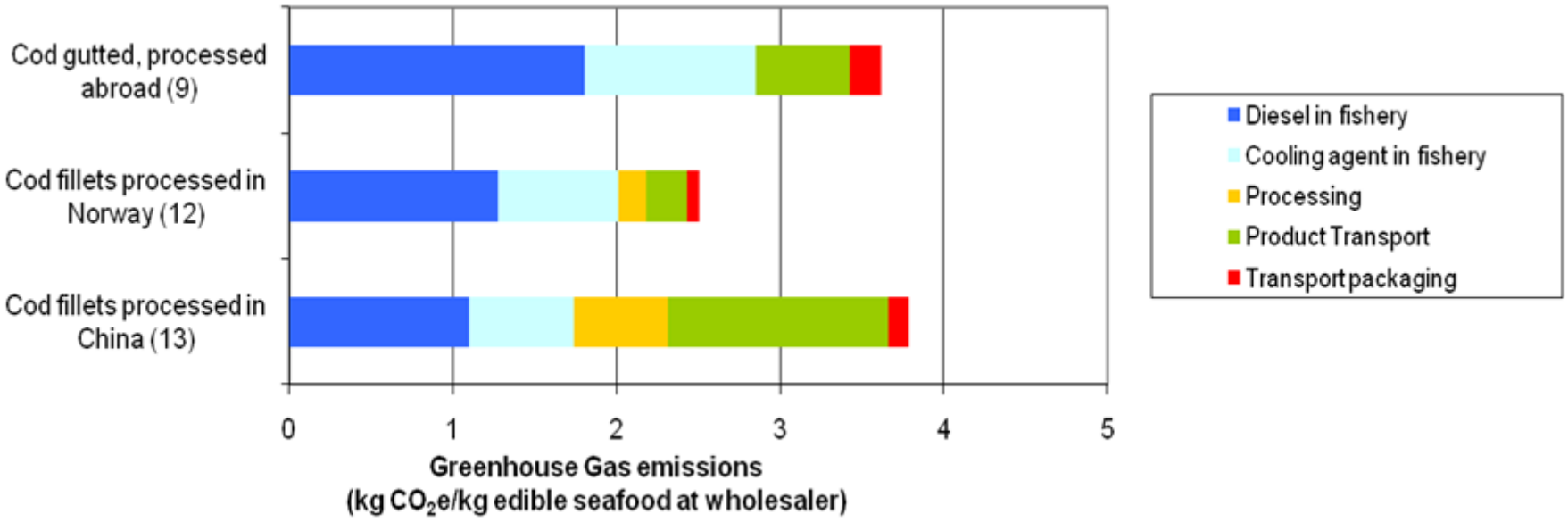
# Klimagassutslipp i oppdrettsfasen



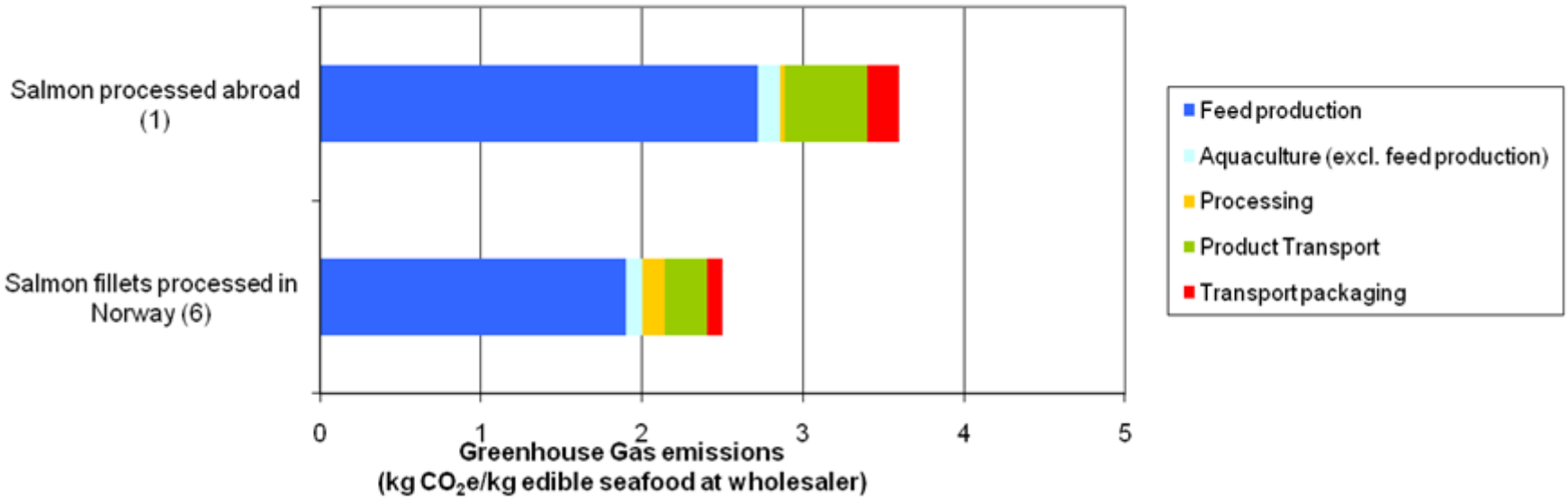
# Klimagassutslipp i selve fiskeriene



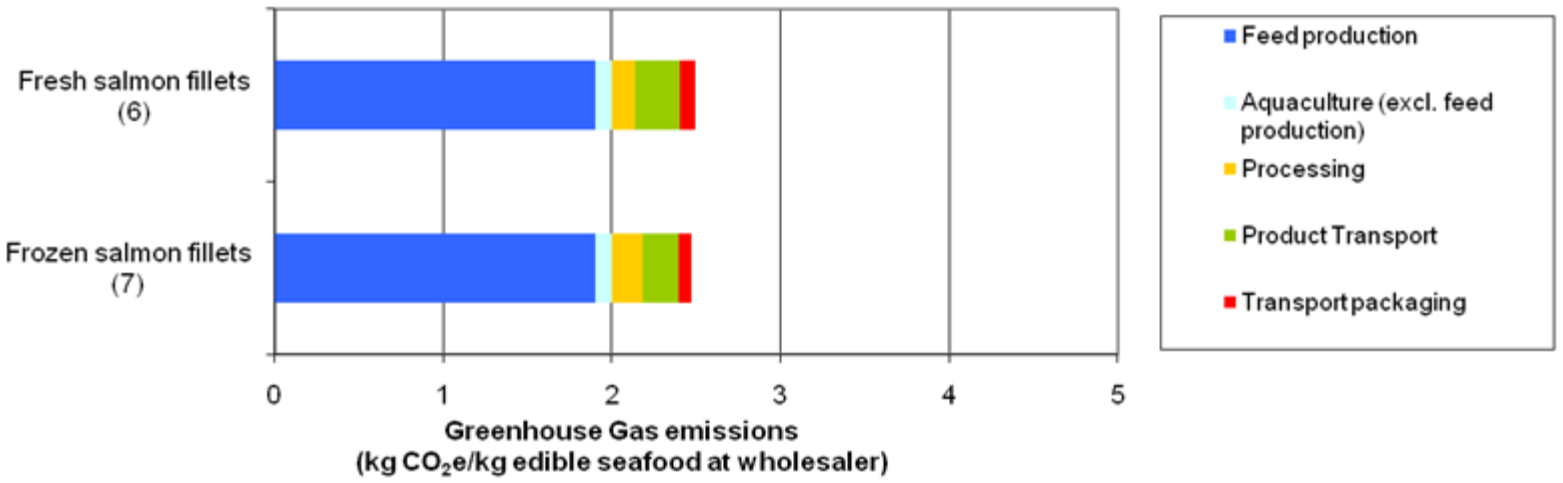
# Foredling i Norge vs. utlandet

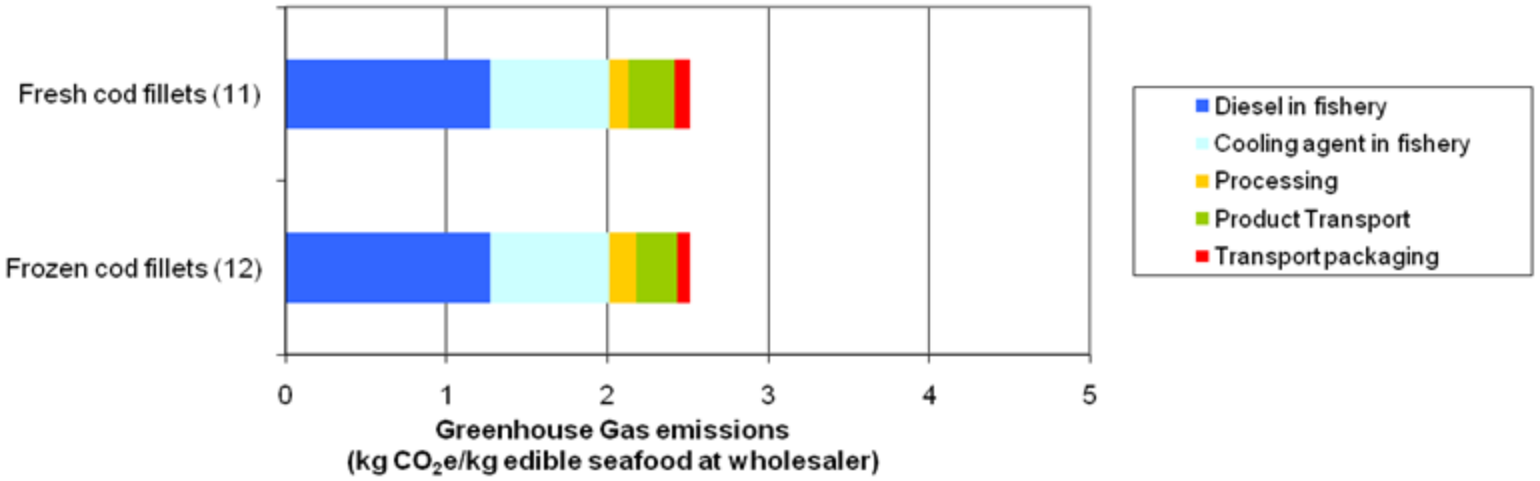


# Foredling i Norge vs. utlandet



# Fersk eller fryst



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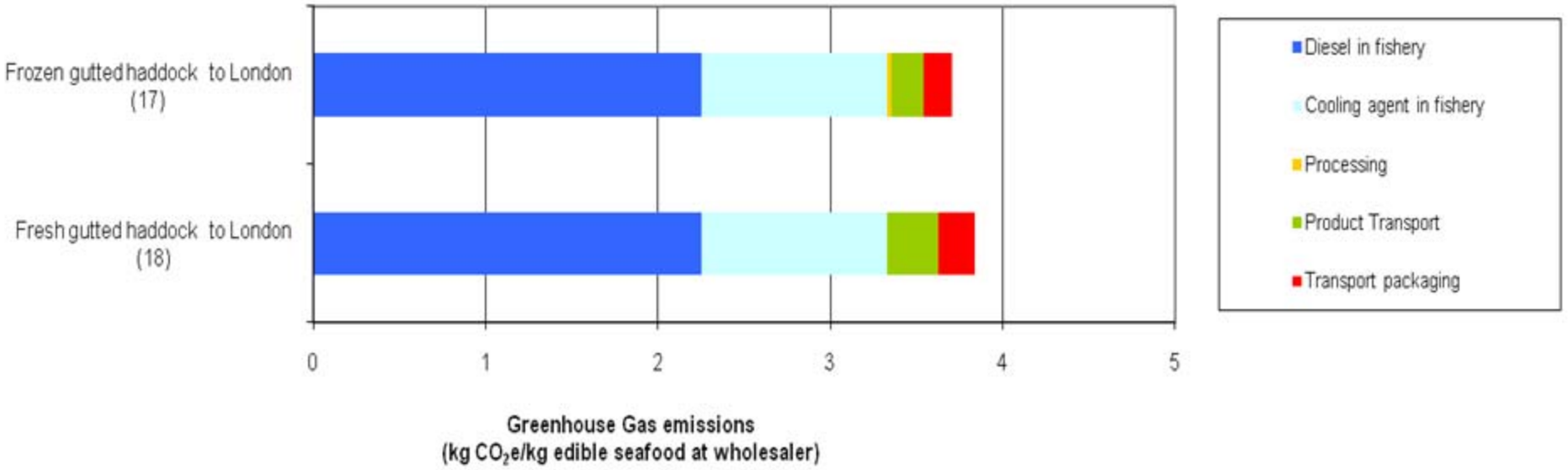

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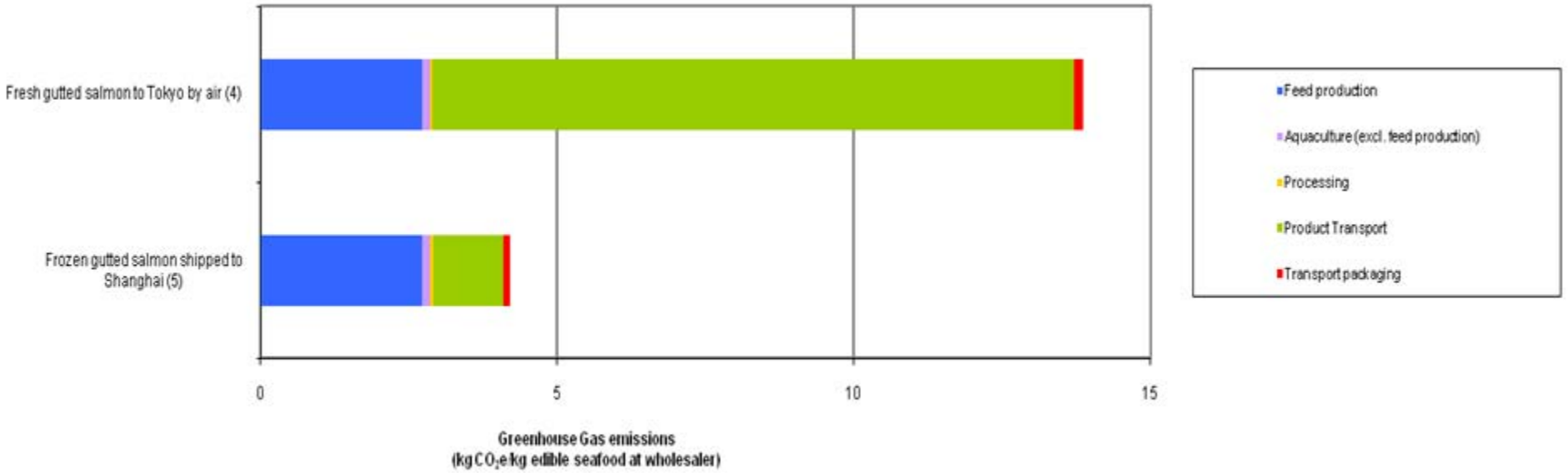
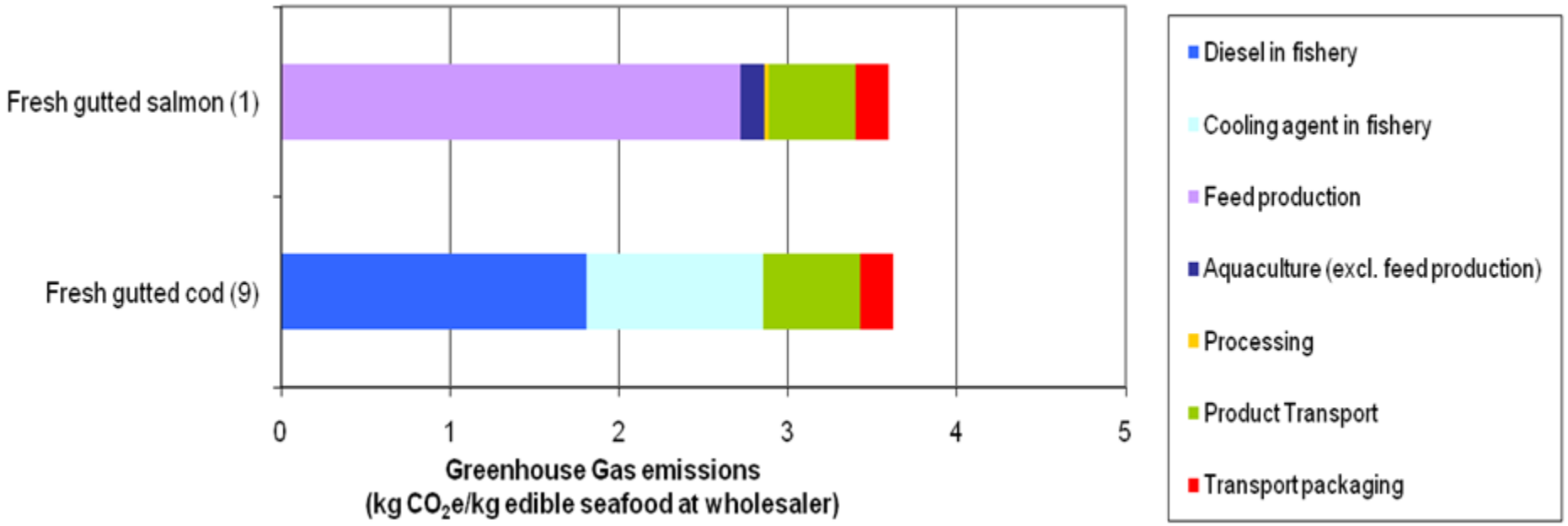
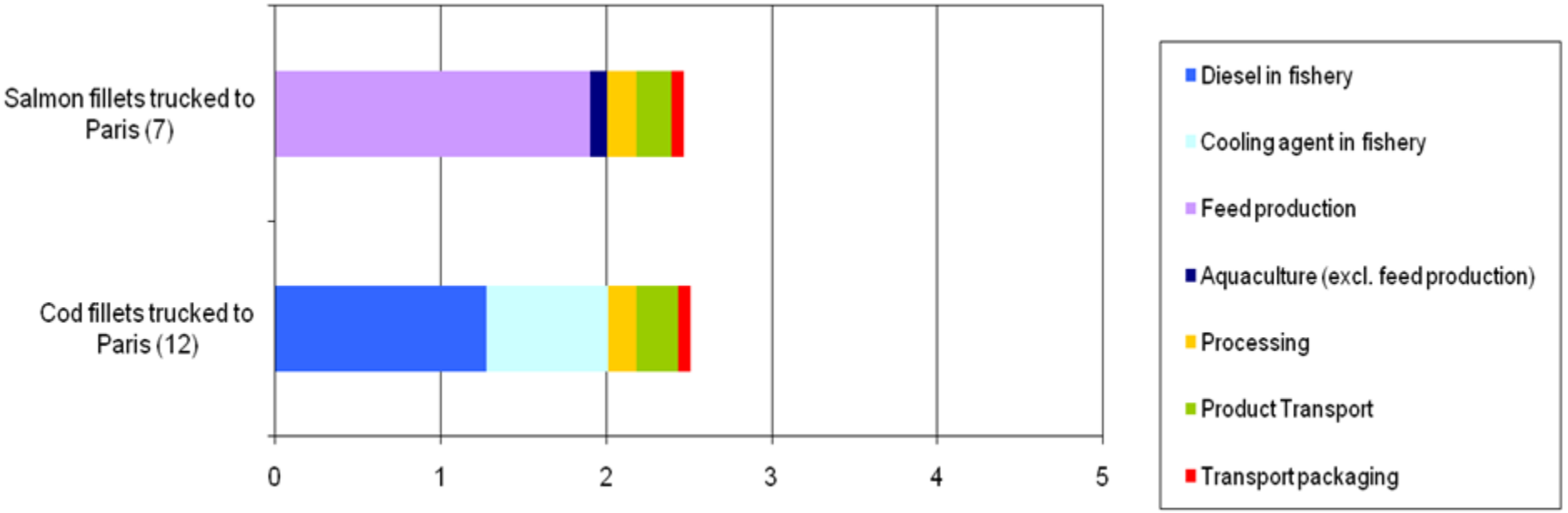


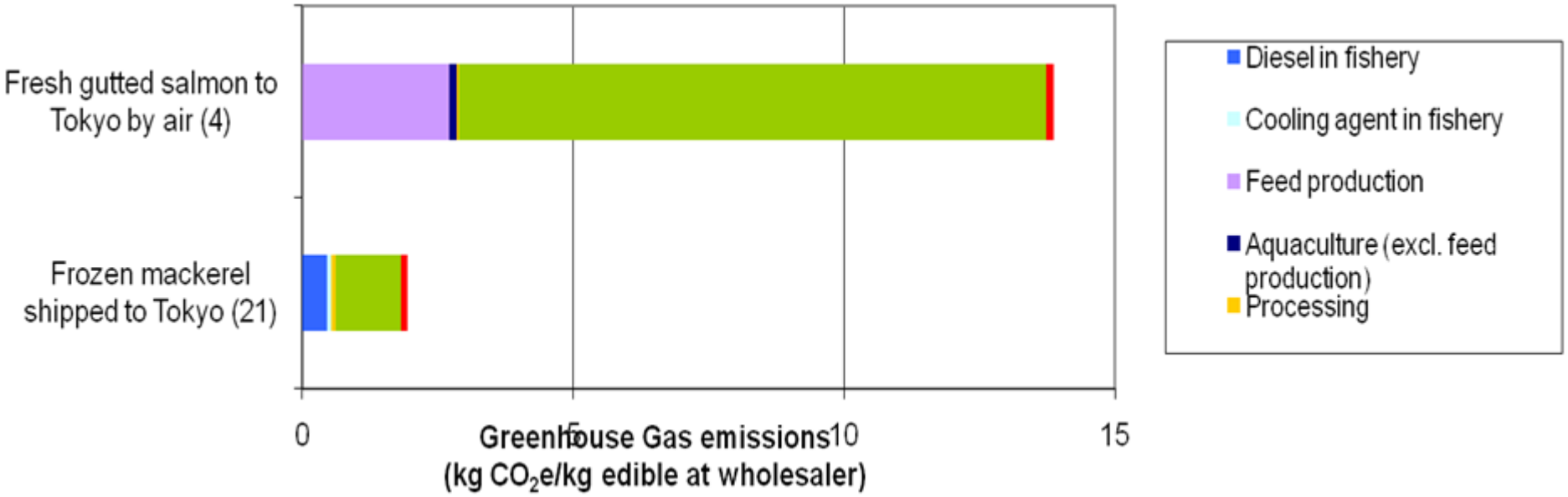
# Oppdrett eller villfisk



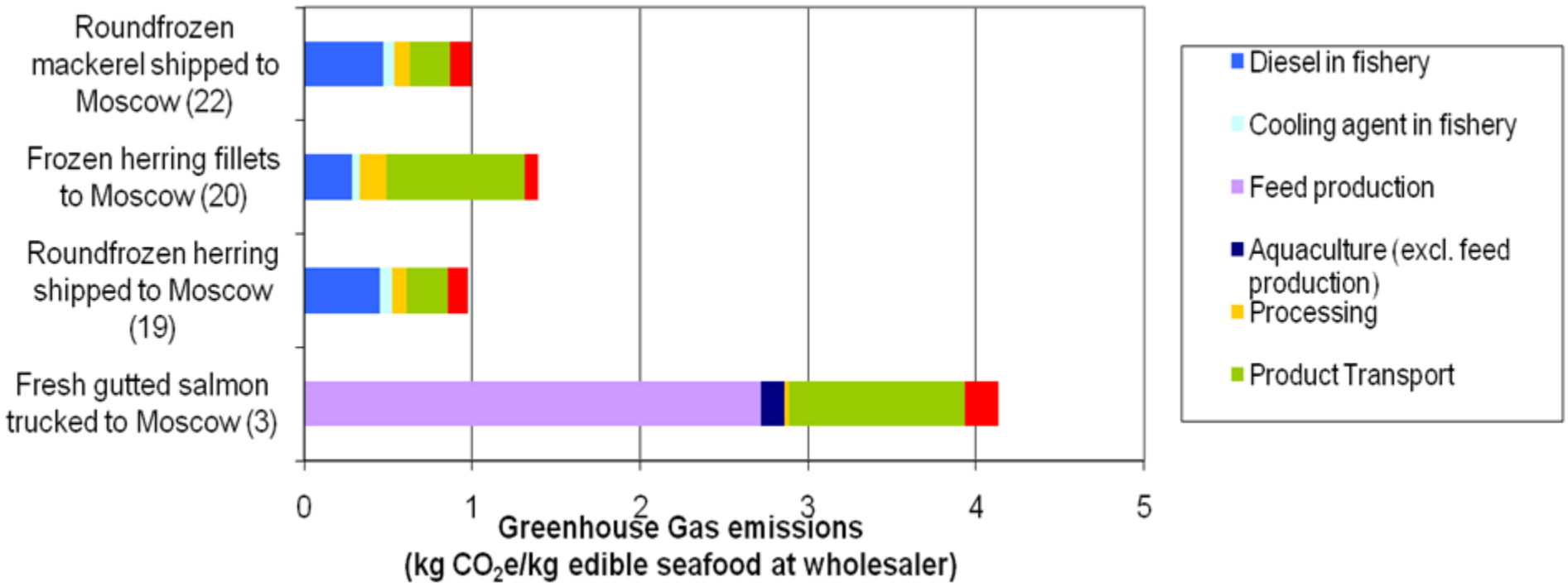
# Oppdrett eller villfisk i Paris



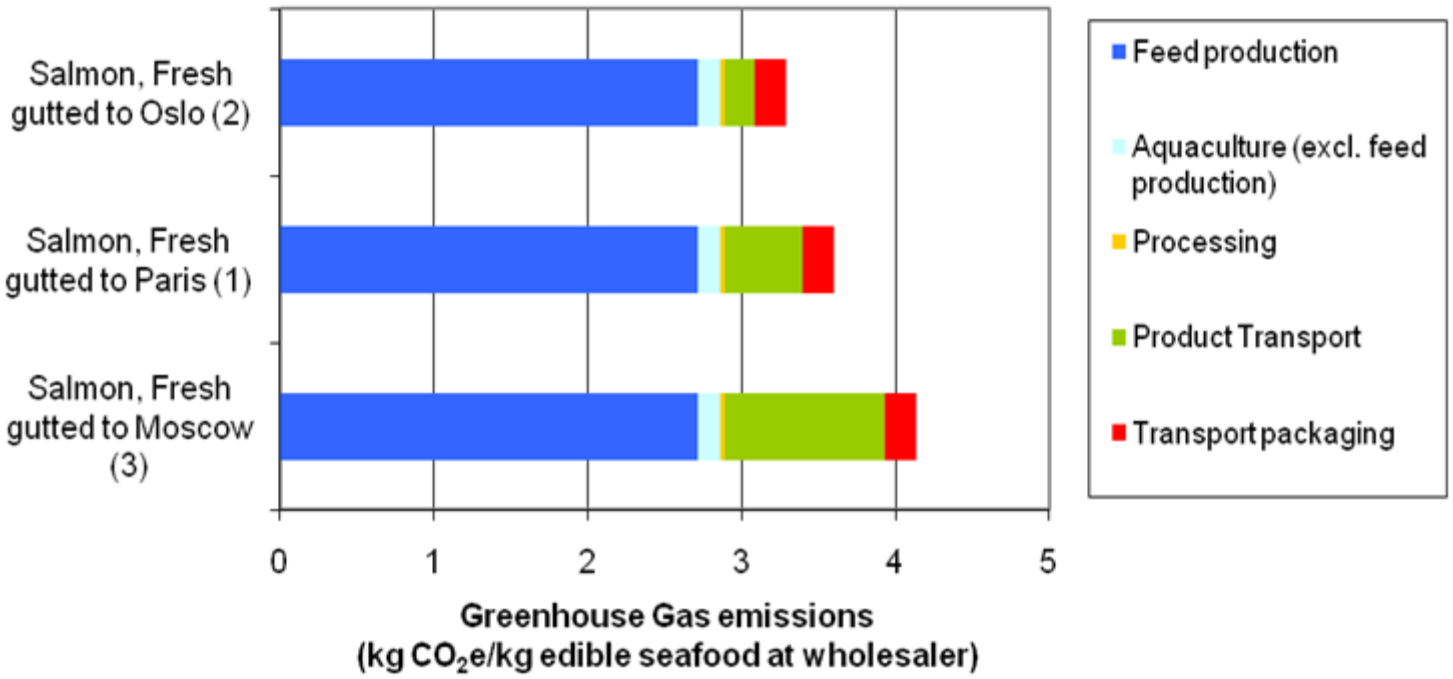
# Oppdrett eller villfisk i Tokyo



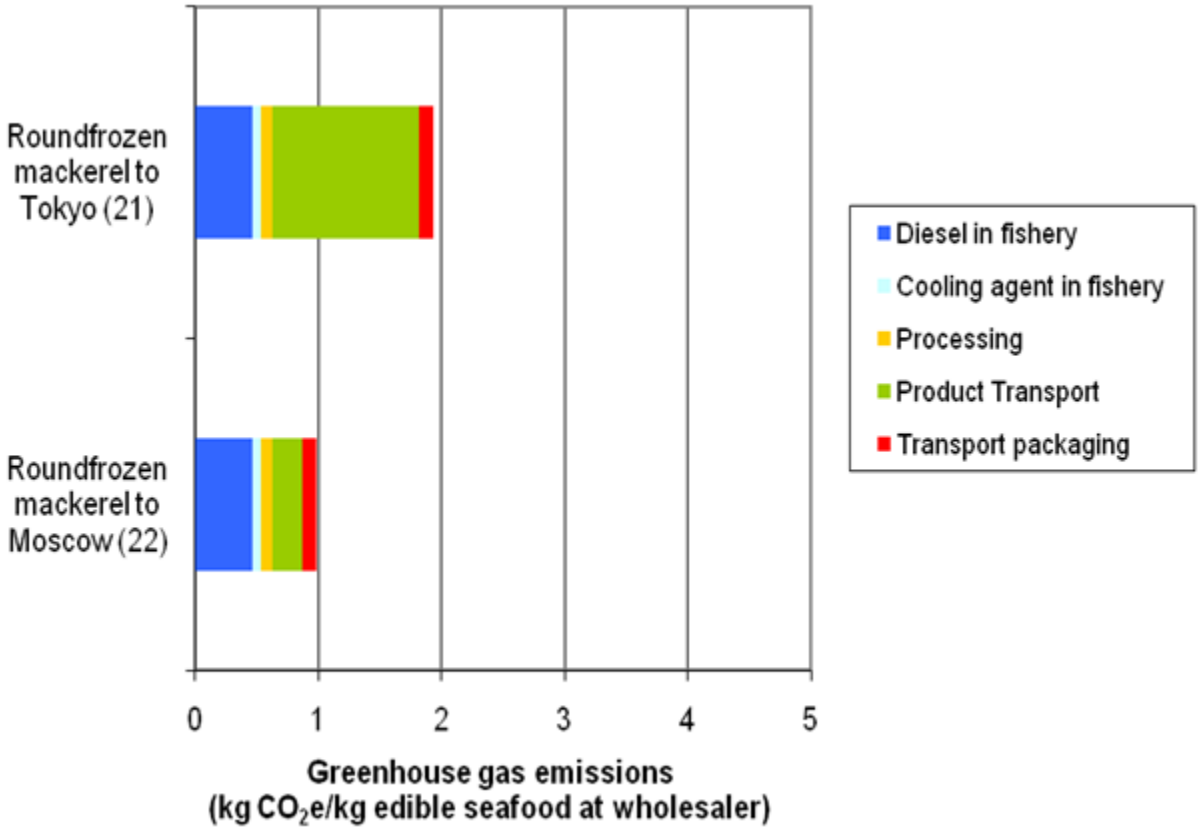
# Oppdrett eller villfisk i Moskva



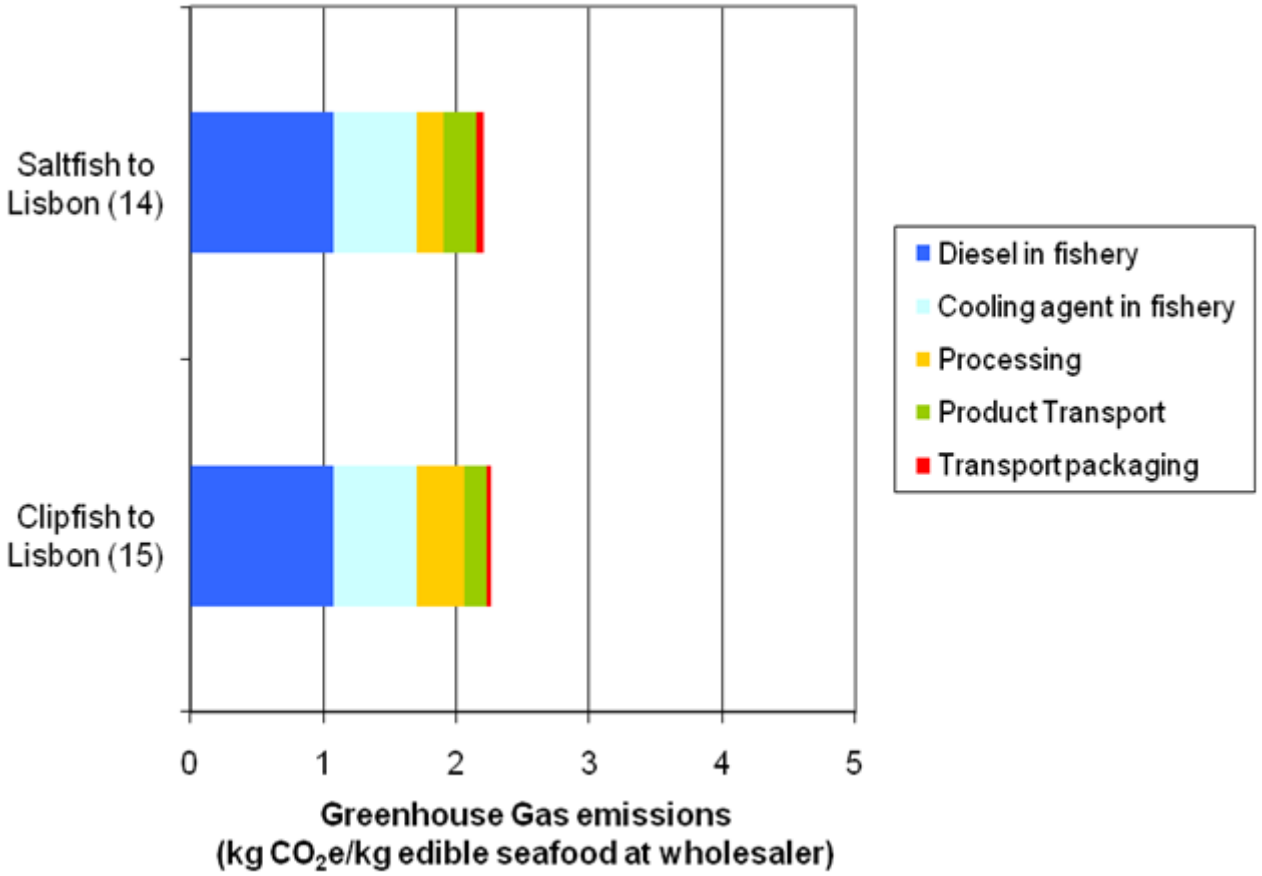
# Transportavstand



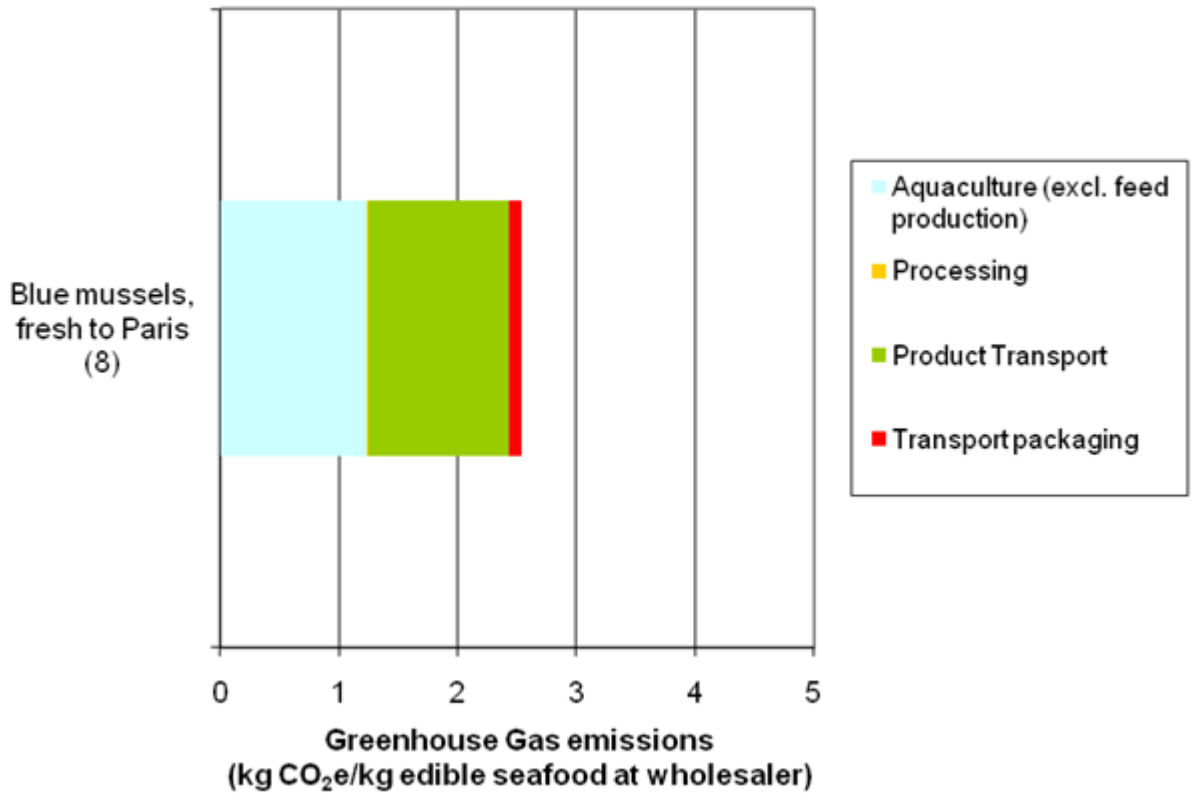
# Transportavstand og transportmåte



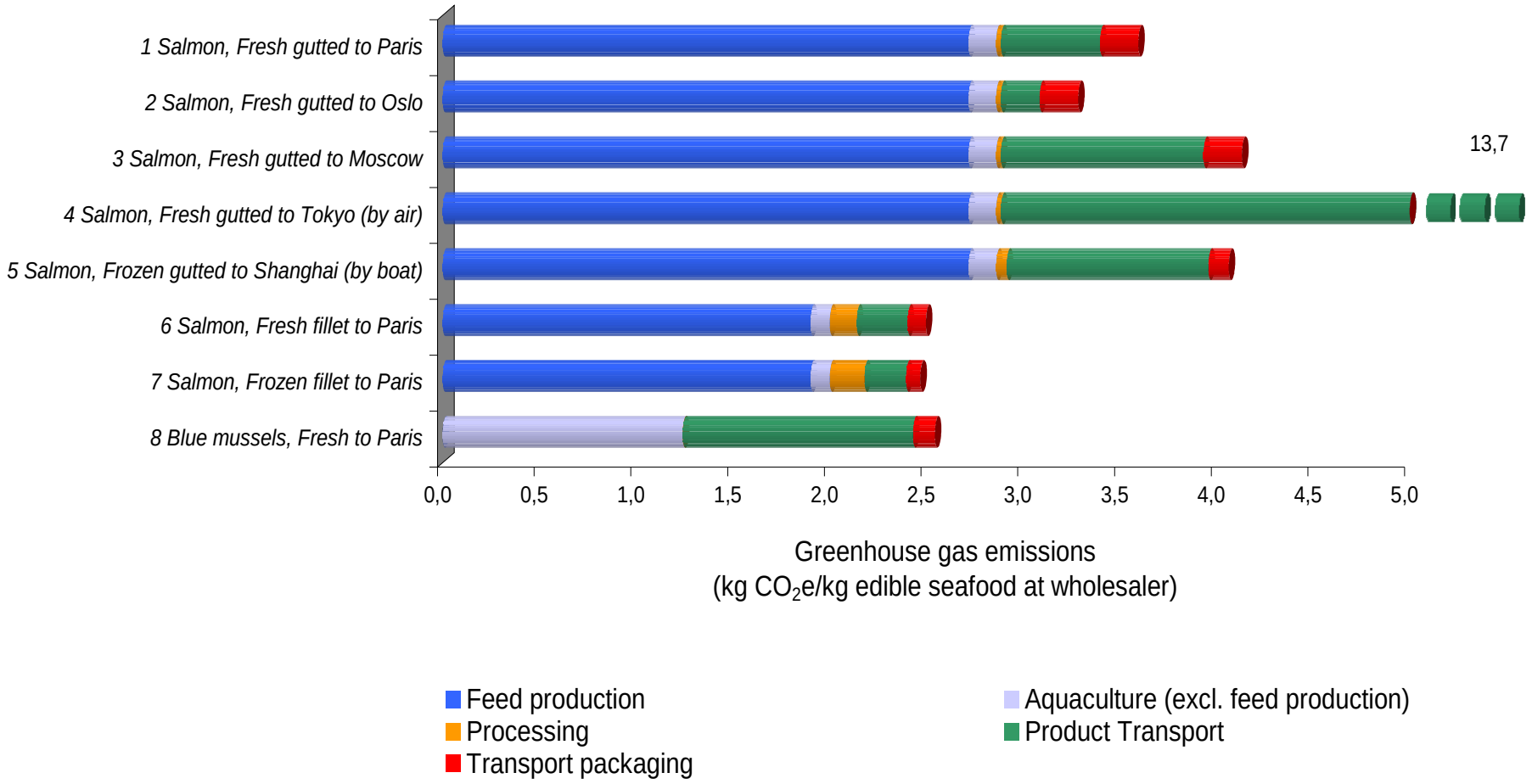
# Tradisjonelle og nye produkter



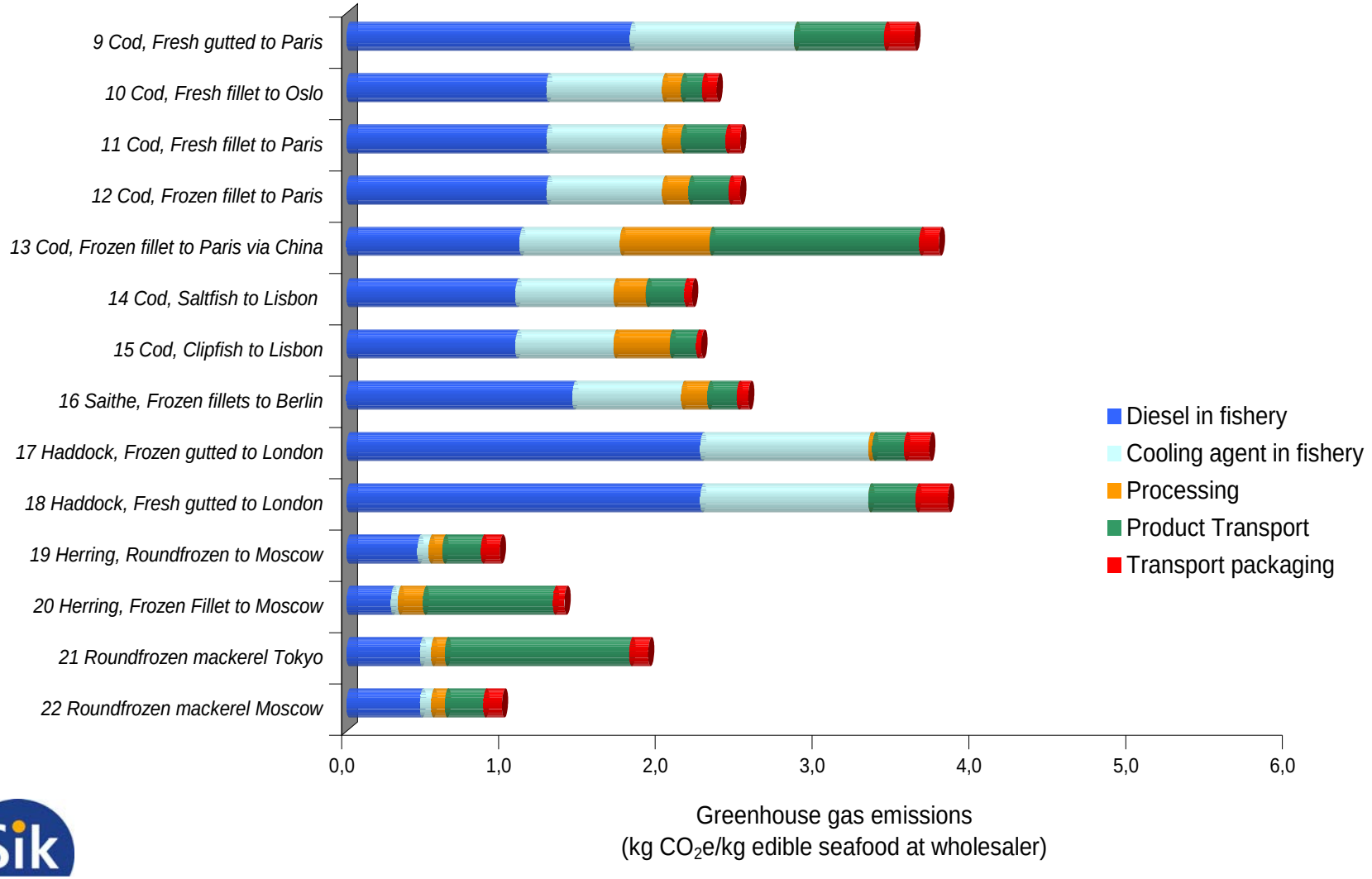
# Tradisjonelle og nye produkter



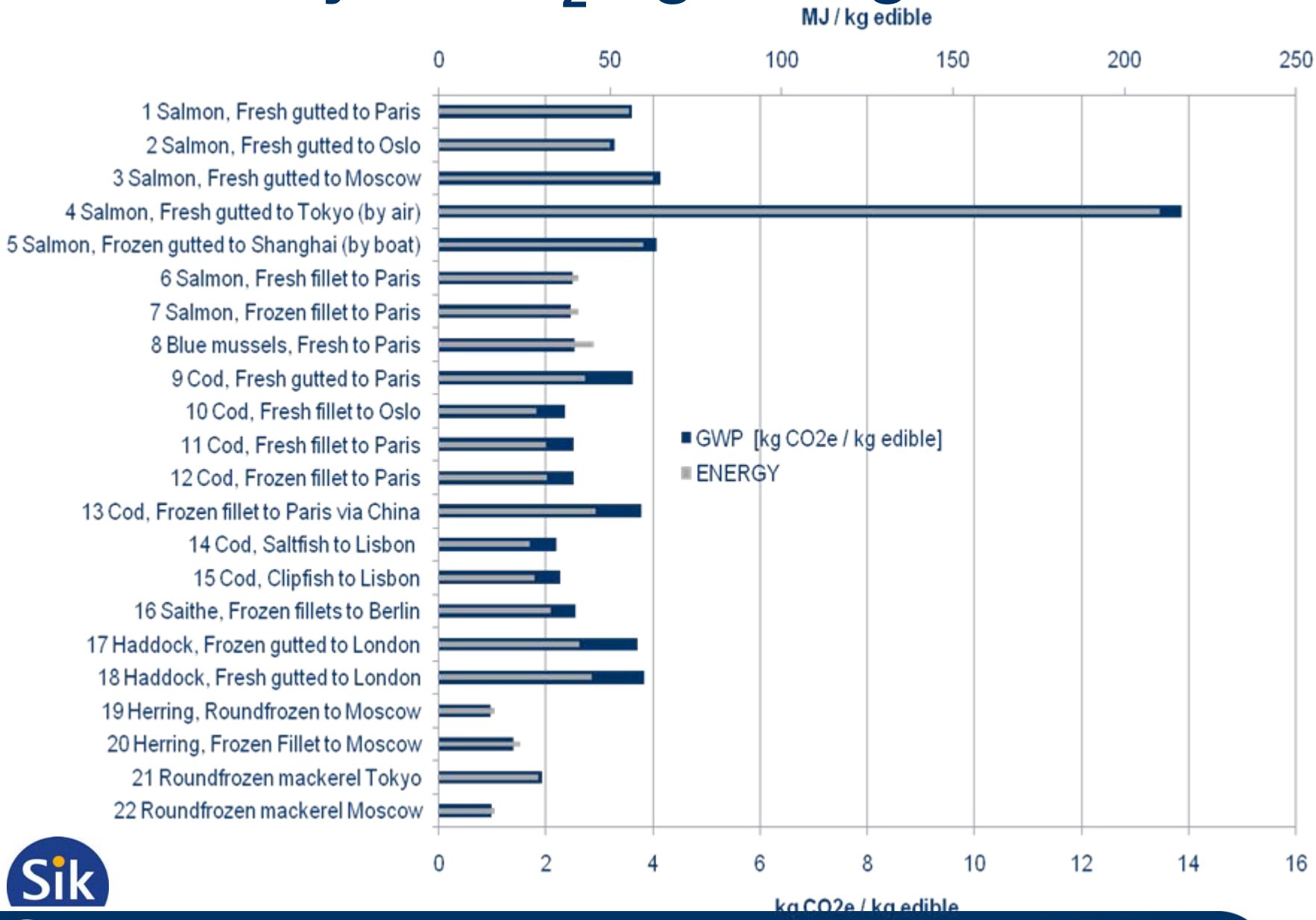
# Carbon footprint - havbruk



# Carbon footprint - fiskerier



# Korrelasjon $CO_2$ og energibruk



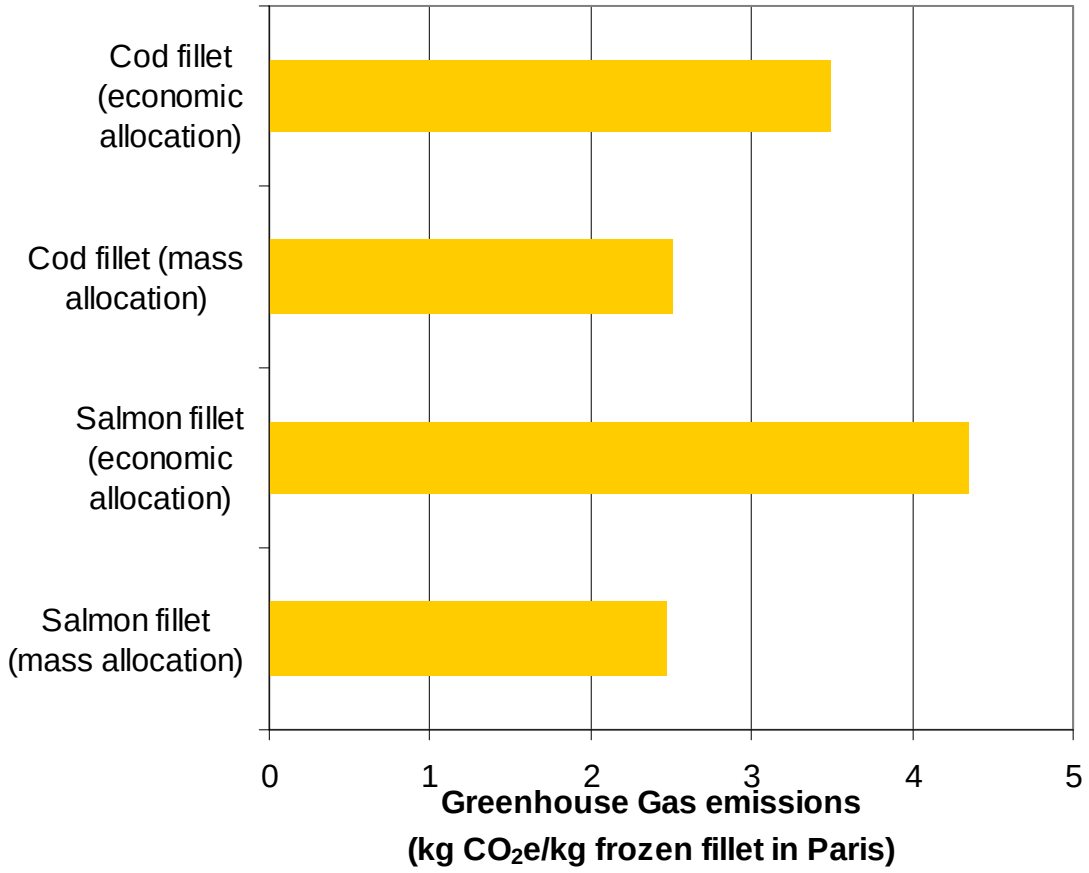
# Sensitivity analysis

- Replace Nordic electricity mix by Norwegian average grid
- Product waste
  - Product waste at processing plant 2 % (as opposed to no product waste)
  - Product waste at processing plant 2 % and product waste at wholesaler 5% (as opposed to no product waste neither at processing plant nor wholesaler)
- Increase in edible yield when processing cod in Norway (from 62 % yield to 70 %)
- Economic allocation (as opposed to mass allocation) in the case of
  - Frozen cod fillets transported to Paris
  - Frozen salmon fillets transported to Paris

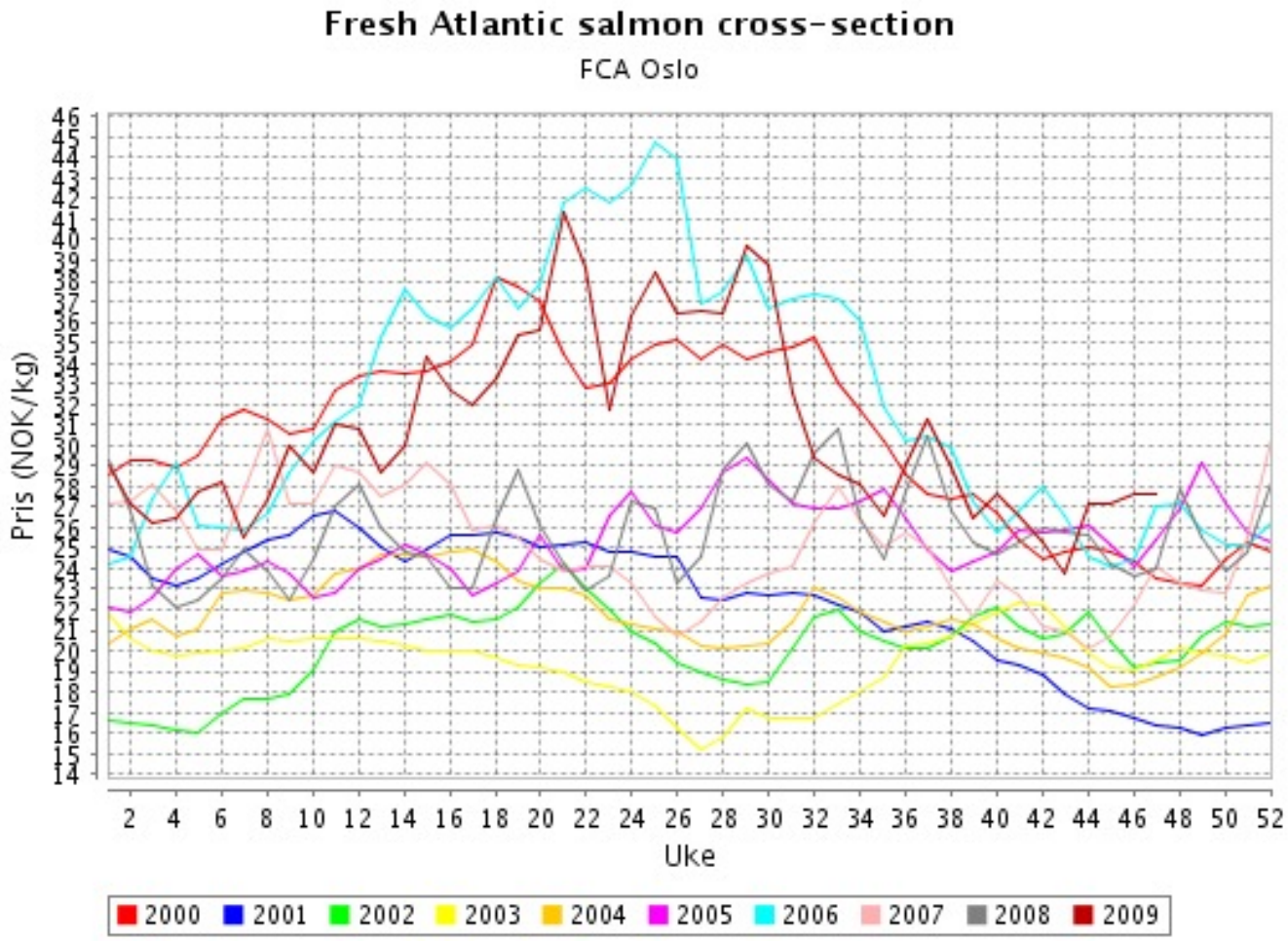
# Sensitivity analysis, continued.

- Use of by-products from processing
  - By-products of salmon and cod are used abroad to the same extent as in Norway
  - By-products of salmon and cod are fully used both in Norway and abroad
  - By-products of salmon and cod are not used at all
- Feed Conversion Ratio in salmon farming and smolt production 1.0 (instead of 1.2)
- Lower proportion of marine inputs in salmon feed (30 % instead of 60 %)
- Only Anchoveta as marine input in salmon feed (as opposed to 28 % of marine inputs imported from South and North America)
- Optimised mussel production (higher edible yield, less fuel used, use of by-products)
- Replace all on-board refrigerants with carbon neutral ones

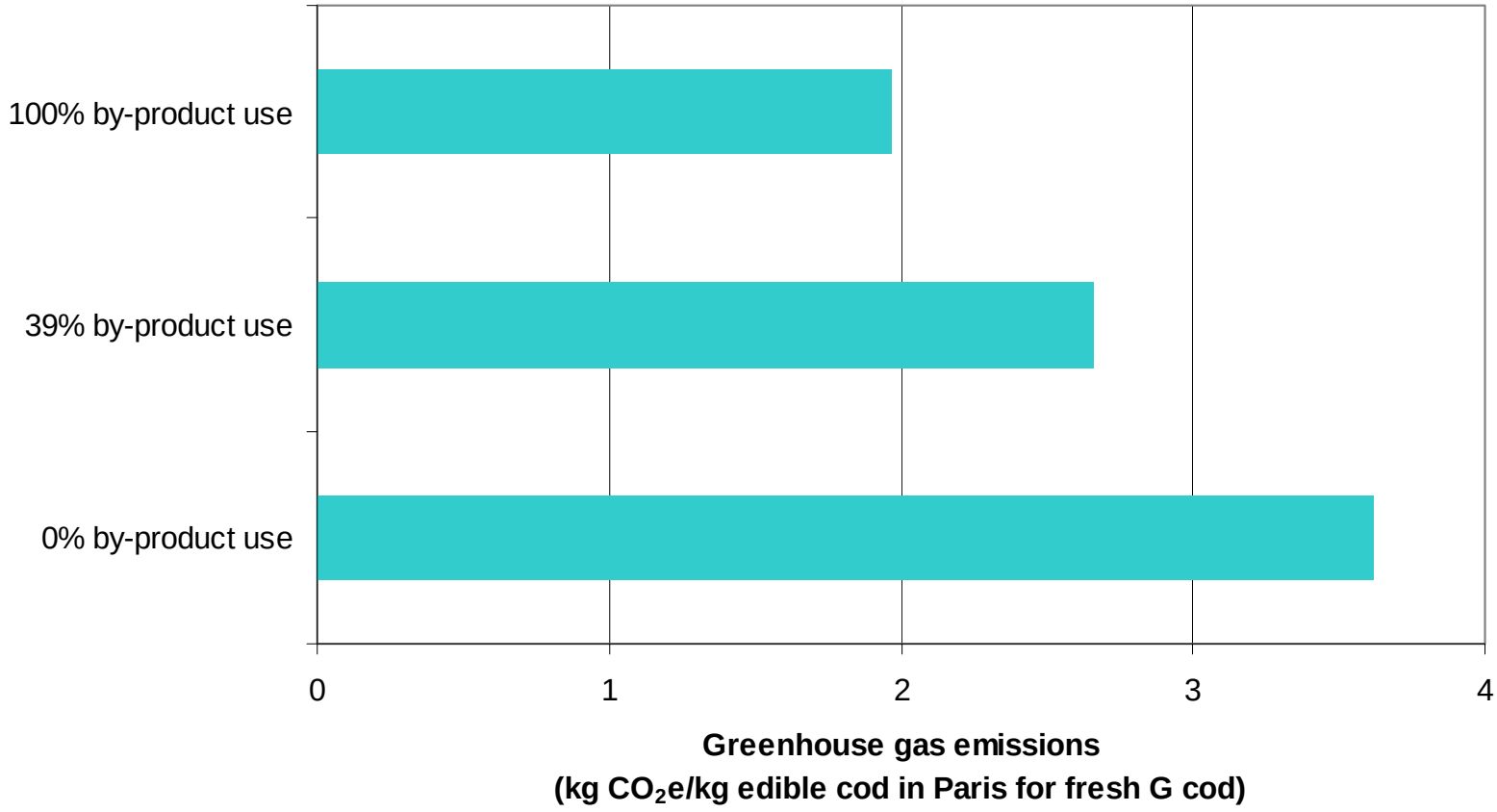
# Economic allocation



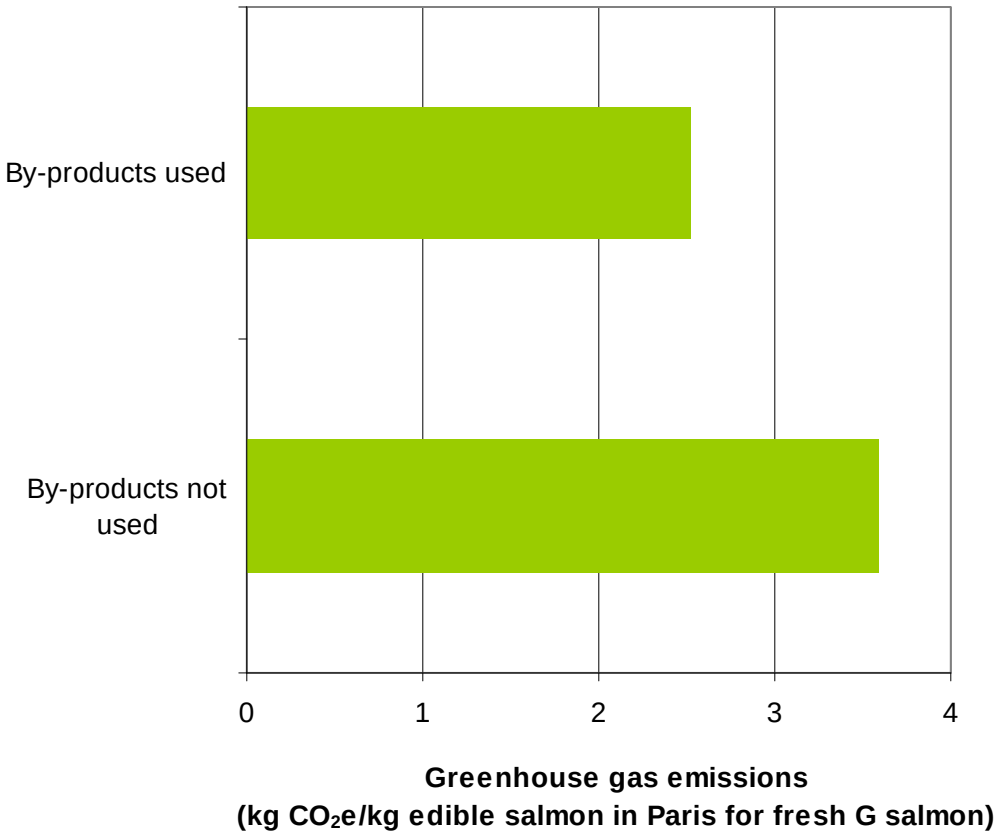
# Salmon price development 2000-2009



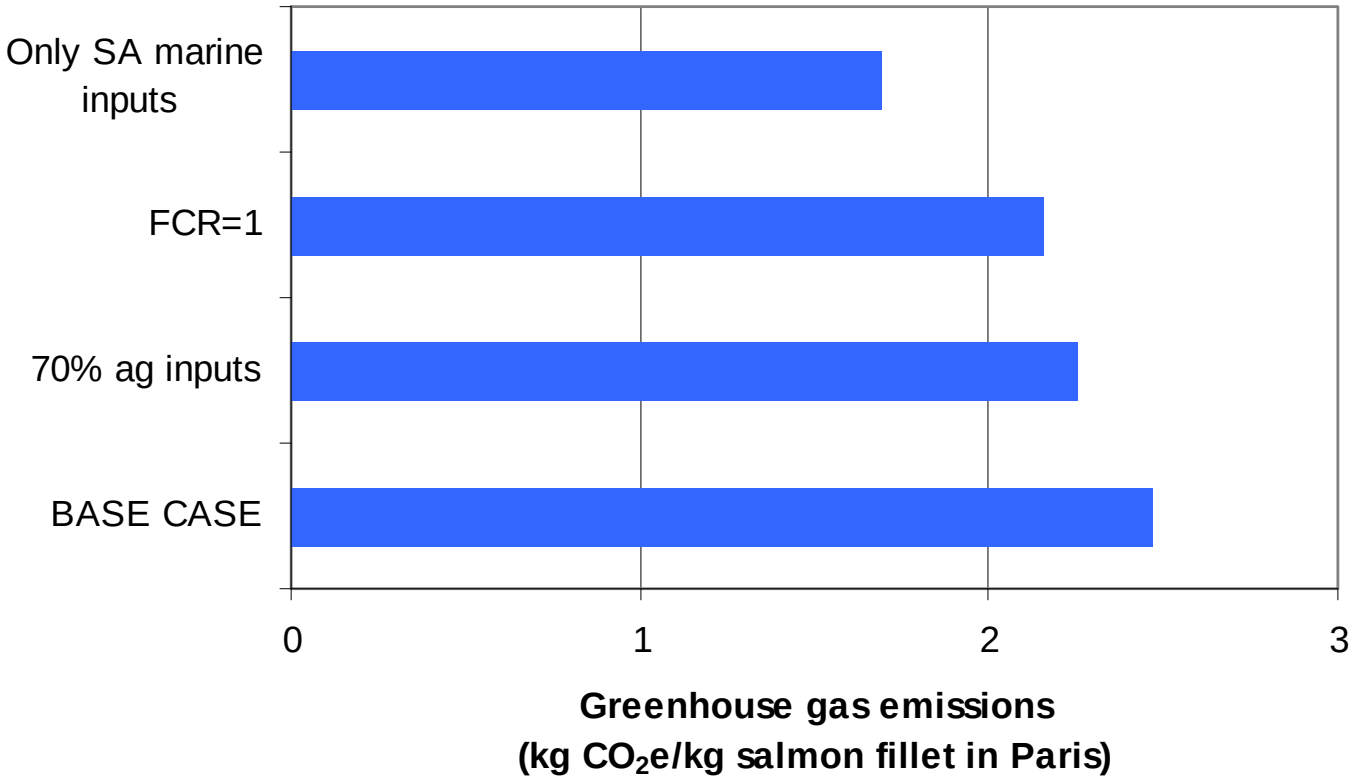
# By-product use, gutted cod Paris



# By-product use, gutted salmon Paris



# Changes in salmon feed



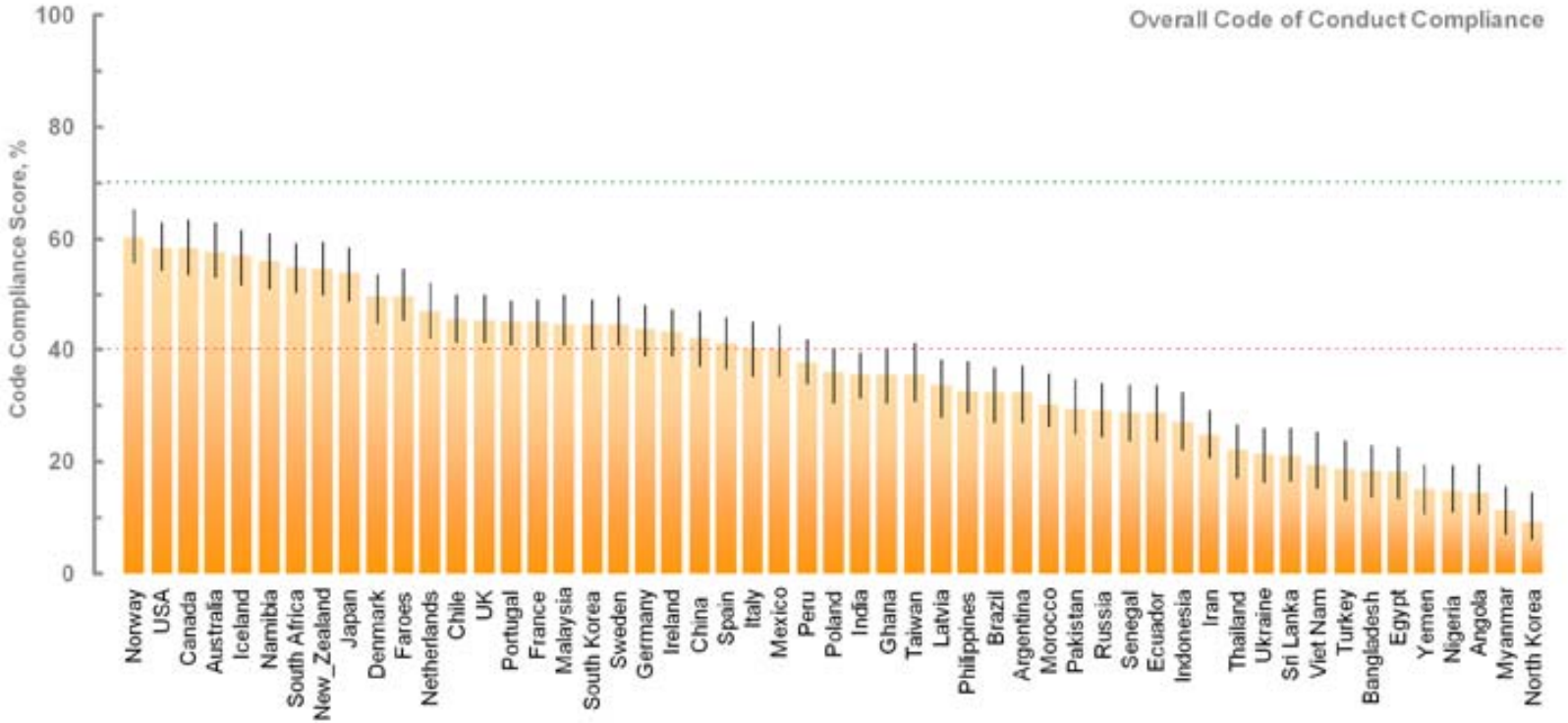
# Gear specific results

| Fishing equipment | Fuel use [l / kg]* | Standard deviation | coefficient of variation** |
|---|---|---|---|
| Other long lines (Andre liner) | 0.15 | 0.069 | 0.5 |
| Long-line (Autoline) | 0.31 | 0.12 | 0.4 |
| Bottom trawl (Bunntrål) | 0.43 | 0.24 | 0.6 |
| Trolling line (Dorg/harp/snik) | 0.14 | 0.14 | 1.0 |
| Pelagic line (Flyteline) | 0.10 | 0.051 | 0.5 |
| Pelagic trawl (Flytetrål) | 0.098 | 0.12 | 1.2 |
| Pelagic pair trawl (Flytetrål par) | 0.093 | 0.022 | 0.2 |
| Hand line/ jig (Juksa/pilk) | 0.15 | 0.19 | 1.3 |
| Gillnet (Settegarn) | 0.15 | 0.18 | 1.2 |
| Purse seine (Snurpenot/ringnot) | 0.089 | 0.03 | 0.3 |
| Danish seine (Snurrevad/Rundfisktrål/Flyndretrål) | 0.12 | 0.20 | 1.7 |
| Undefined gillnet (Udefinert garn) | 0.25 | 0.26 | 1.0 |
| Undefined seine (Udefinert not) | 0.083 | 0.16 | 1.9 |
| *liters fuel per kilo landed catch in round weight<br>** coefficient of variation= standard deviation / average value | | | |

# Species specific results

| | Fuel factors [liter fuel / kg landed round weight] | Standard deviation |
|---|---|---|
| Cod | 0.24 | 0.096 |
| Haddock | 0.29 | 0.11 |
| Saithe | 0.29 | 0.13 |
| Herring | 0.091 | 0.029 |
| Mackerel | 0.094 | 0.031 |

# Norway has the best fisheries management system in the world



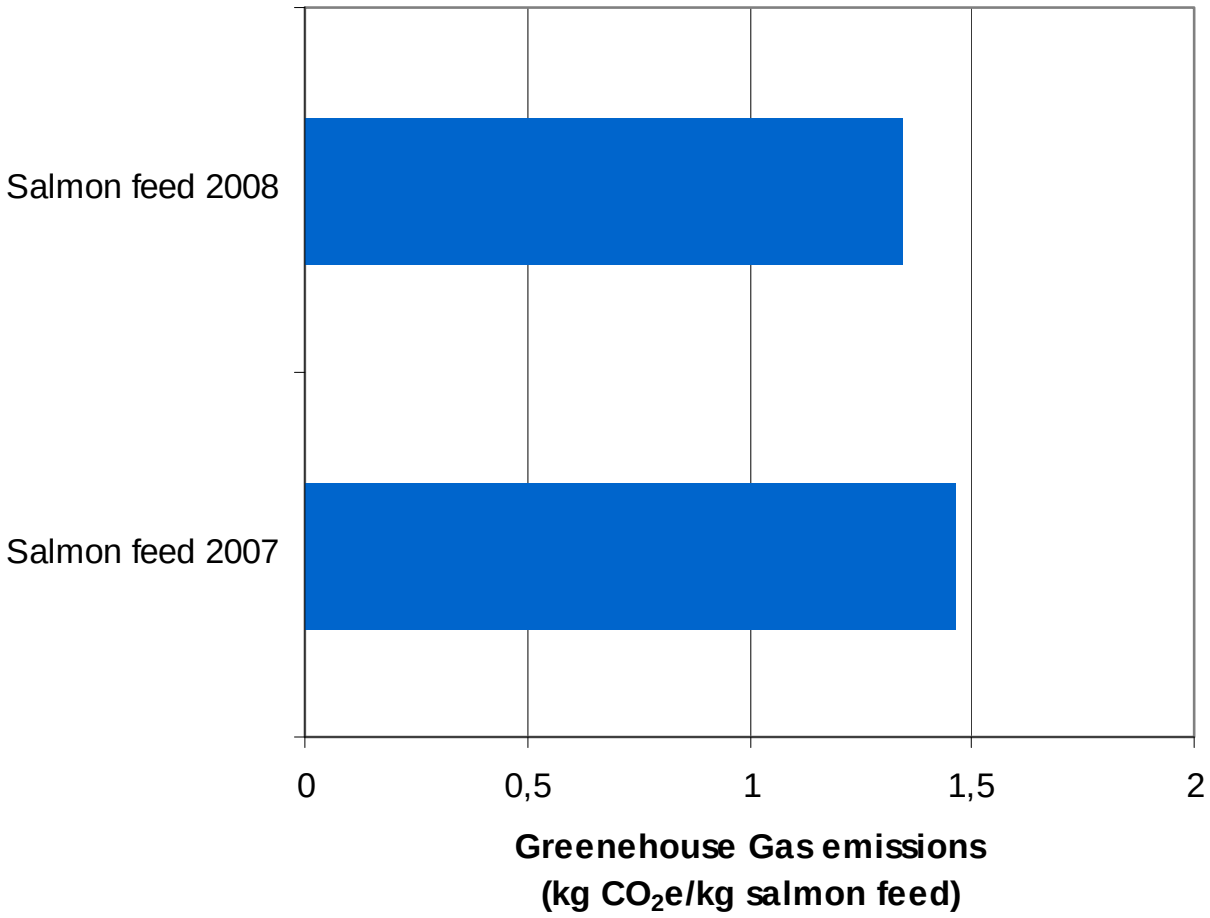
# But…needs to replace refrigerants!

| Refrigerant | Name | Ozone depletion potential (kg CFC11e/kg) | Global warming potential (kg $CO_2$e/kg) |
|---|---|---|---|
| $CO_2$ | Carbon dioxide | 0 | 1 |
| $NH_3$ | Ammonia | 0 | 0 |
| HCFC-22 | R22 | 0.055 | 1810 |
| HFC-404 | R404a | 0 | 3750 |
| HFC-507 | R507 | 0 | 3300 |
| HFC-134a | R134a | 0 | 1300 |
| HFC-410a | R410a | 0 | 1890 |

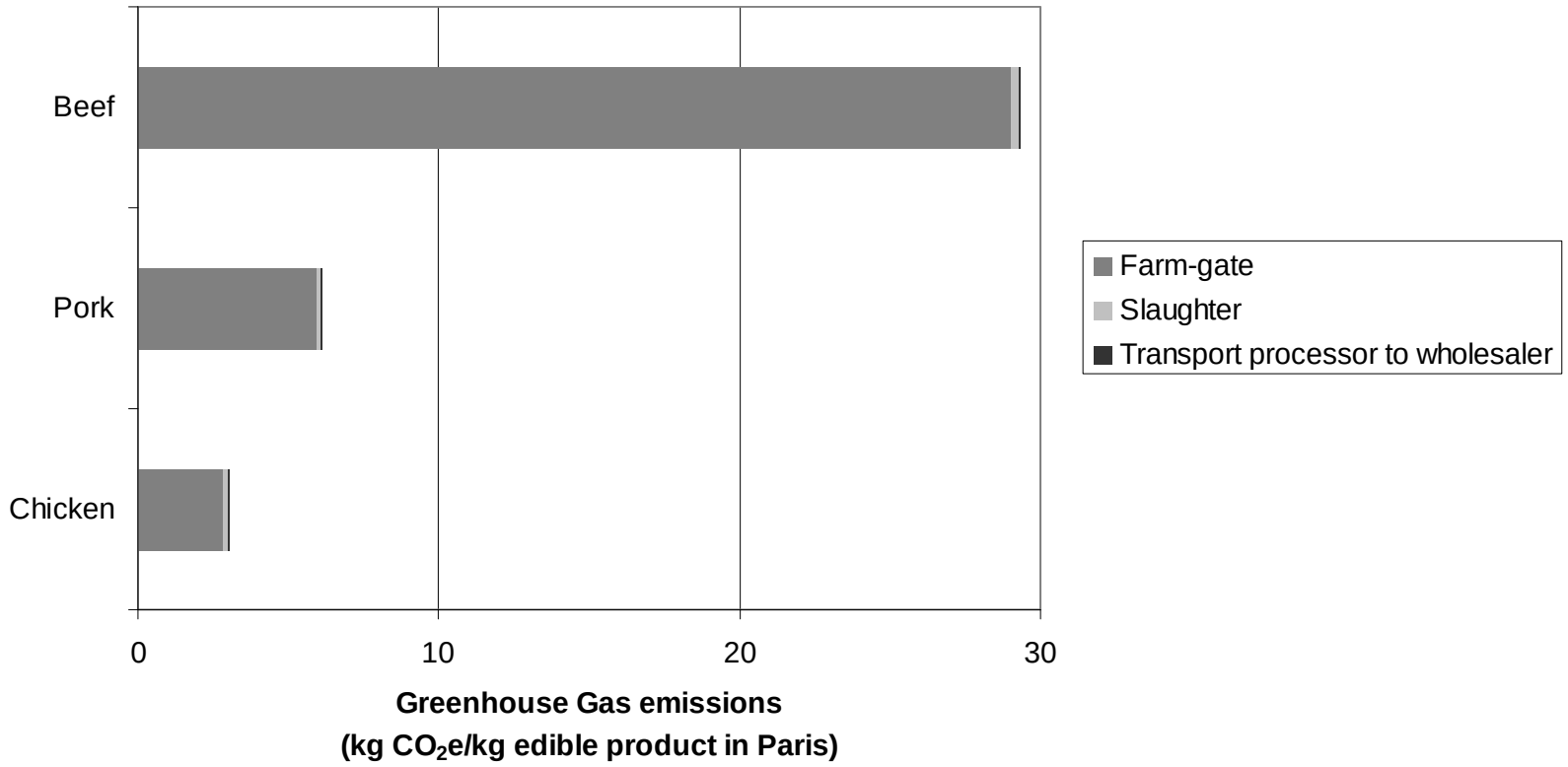
# Refrigerants in Norwegian fishing fleet

- 200 tons R22 = 362000 tons of $CO_2e$
- Used by approximately 1700,
  probably less than 1500 vessels
- 117 kg R22 per vessel
- 212 tons $CO_2e$ per vessel due to leakage of R22

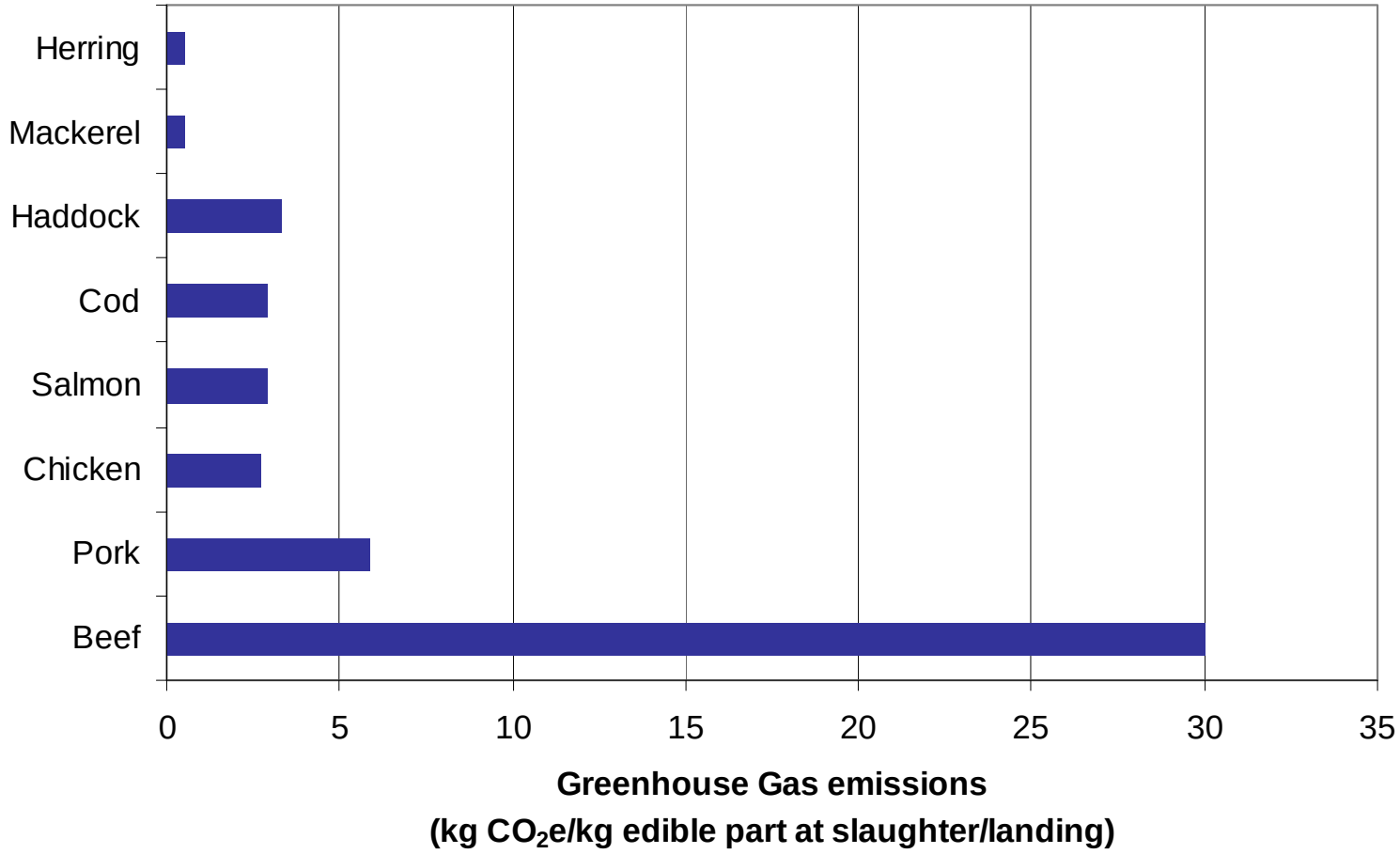
# Variation in feed composition



# Meat products



# Seafood in perspective



# Improvement options

- Replace refrigerant by climate and ozone neutral ones
- Improve energy efficiency in fishery further
- Optimise salmon feed regarding climate impact
- Process more fish before export
- More frozen and super-cooled, less fresh
- Increase edible yield and use of by-products
- Improve data availability
- Incorporate carbon footprinting methods into fisheries management system