Energy efficiency and CO_2 emissions in LNG chains

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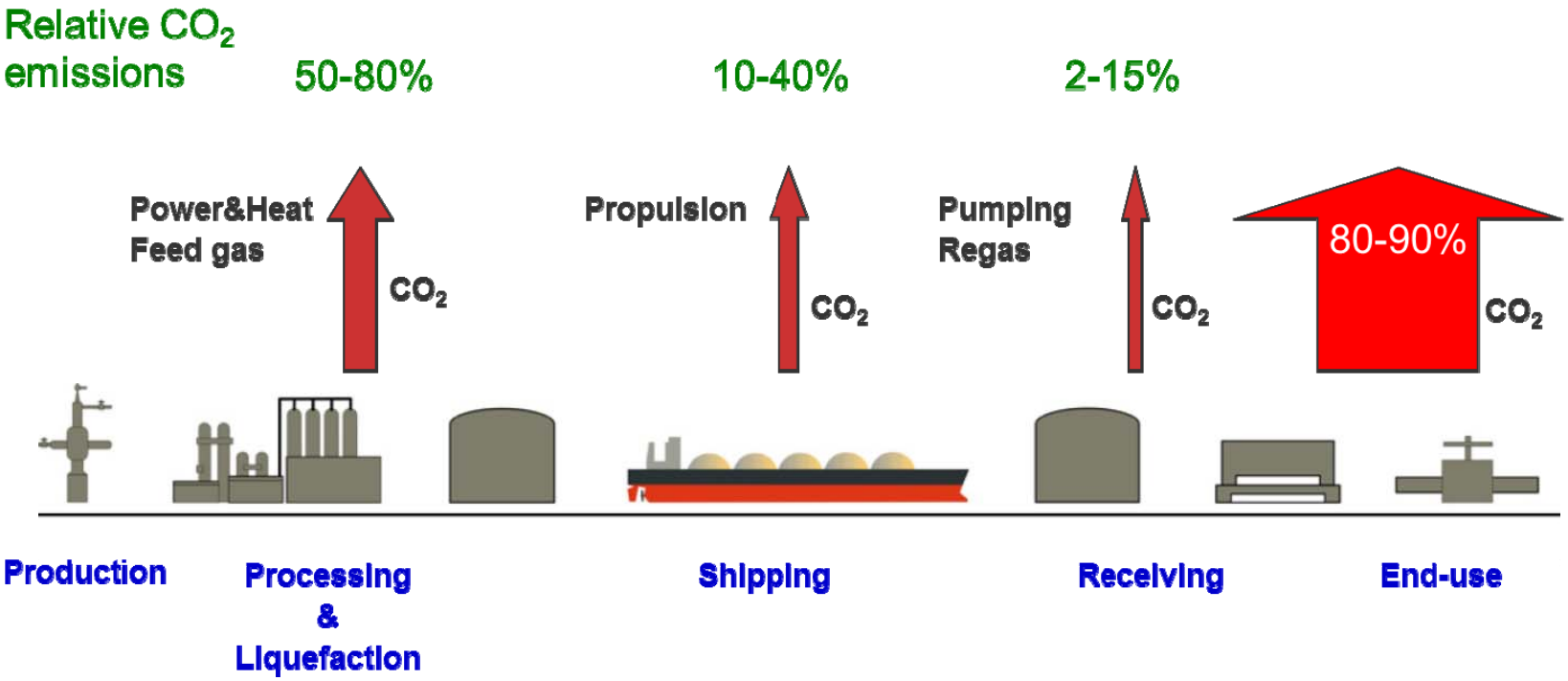
Typical distribution of CO_2 emissions



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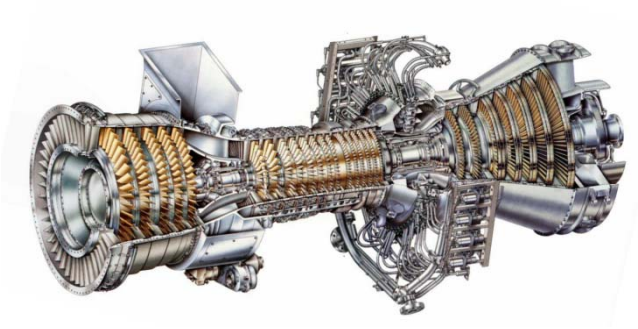
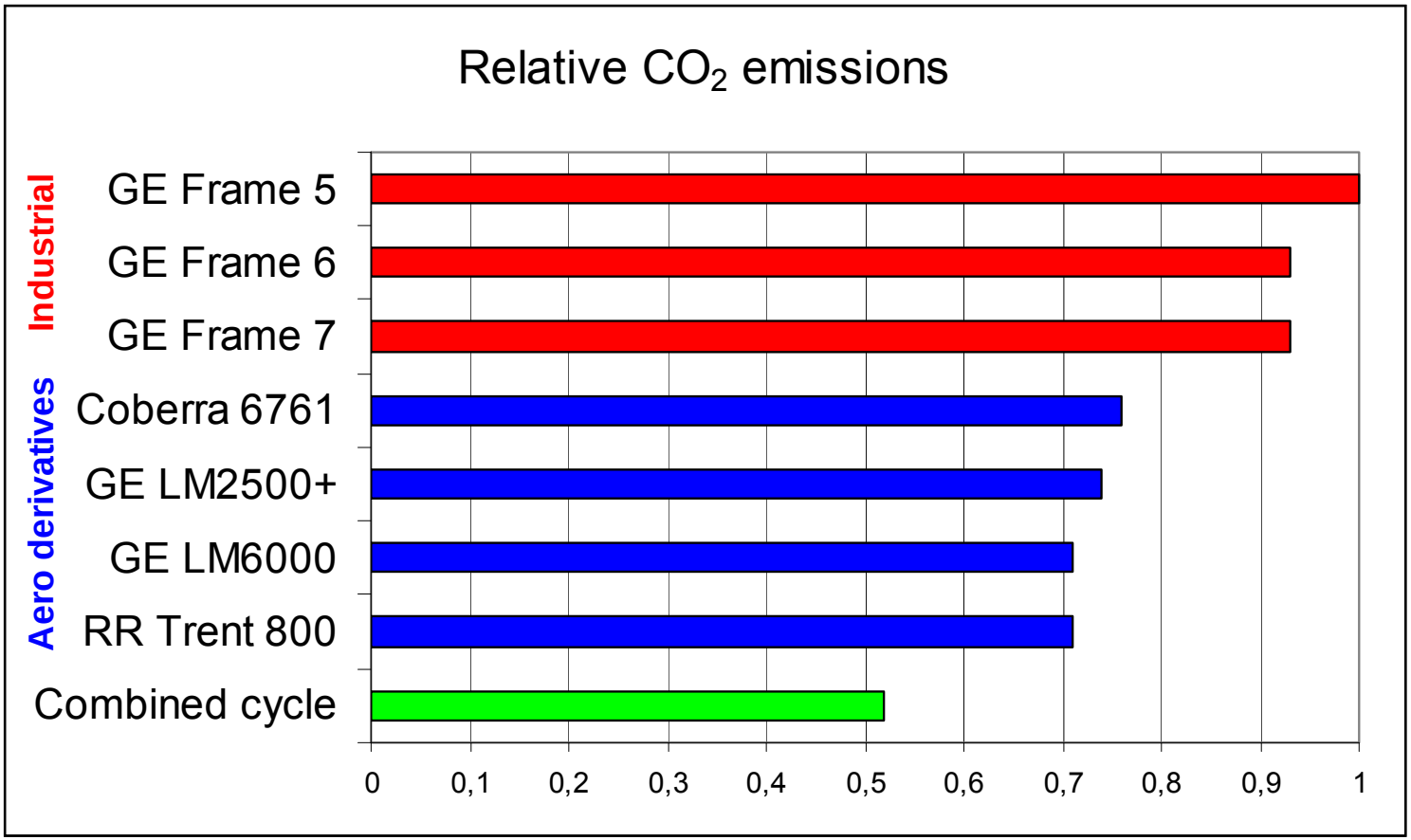
Efficiency in power generation





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Efficiency in ship propulsion

Type	NO_x (g/kWh)	SO_x (g/kWh)	Particulates (g/kWh)	**CO_2 (g/kWh)**	Relative CO_2 emissions
Low speed diesel	17	12.9	0.5	**580**	
Medium speed diesel	12	13.6	0.4	**612**	
Dual fuel diesel electric	1.3	0.05	0.05	**420**	
Steam turbine	1	11.0	2.5	**850***	
Gas turbine	2.5	0	0.01	**480**	

*using 50% boil-off gas and 50% heavy fuel oil for steam generation

Source: Wayne, Hodgson, *The options and evaluation of propulsion systems for the next generation LNG carriers*, WGC 2006.

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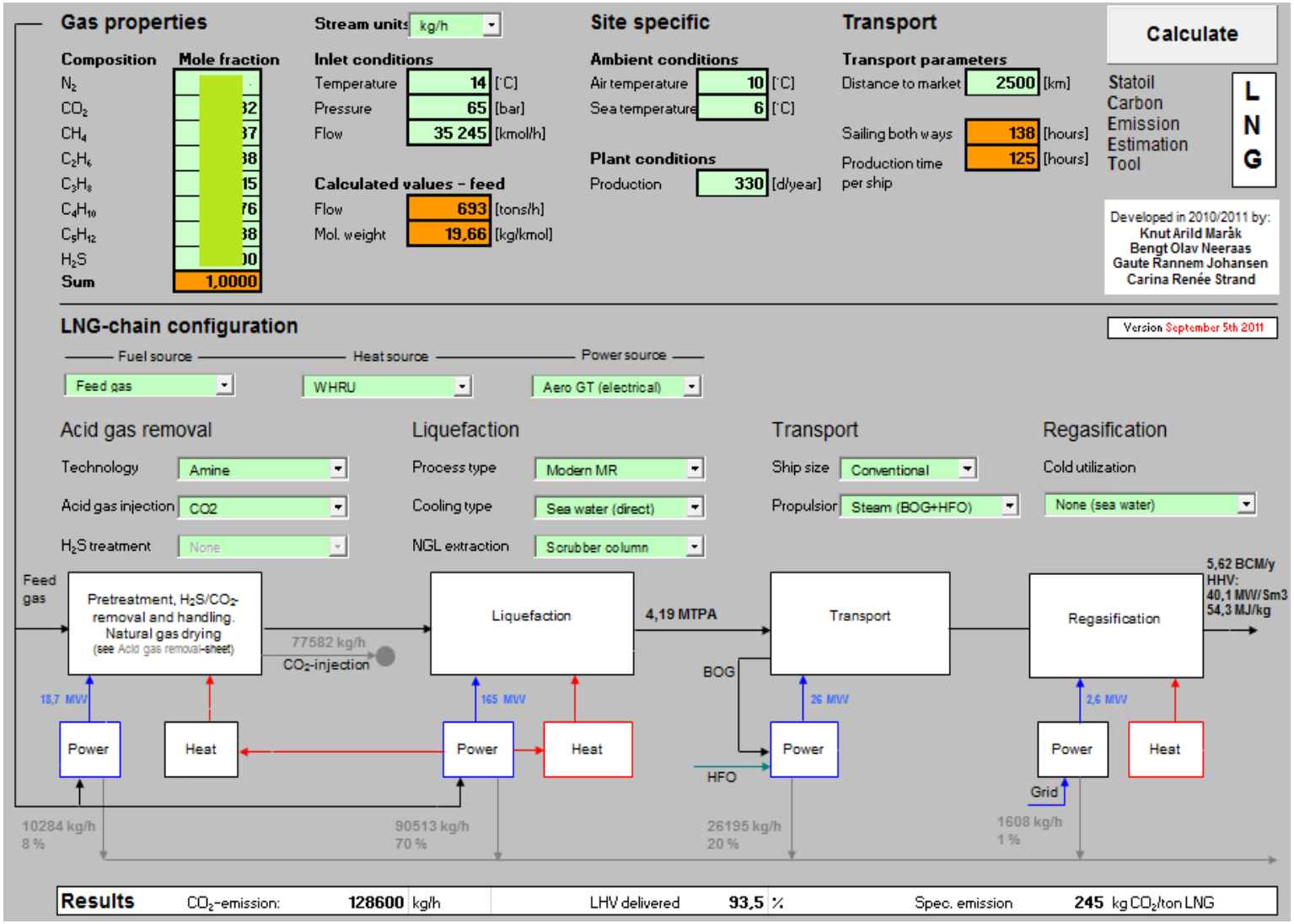
SCEET-LNG



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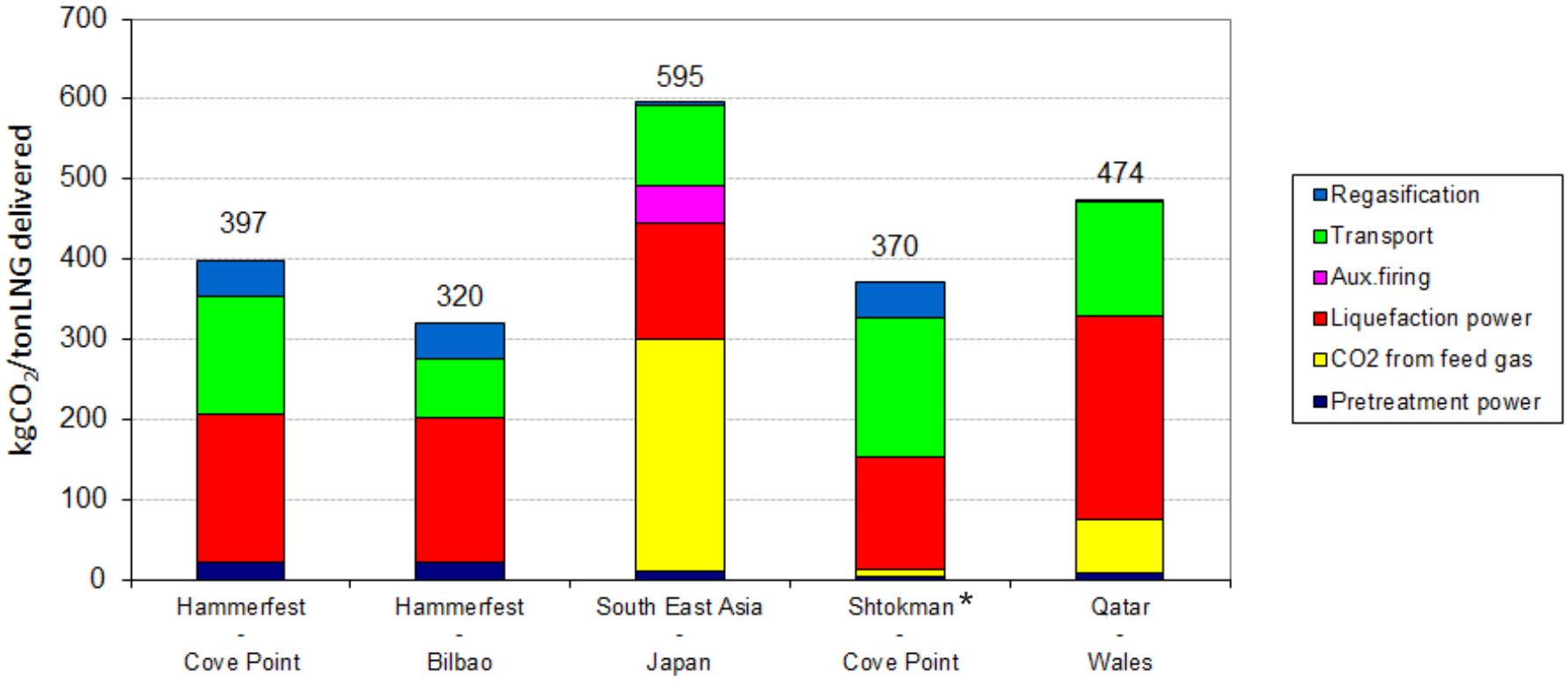
Estimated CO_2 emissions from different LNG chains



*Combined cycle power generation applied for Shtokman case

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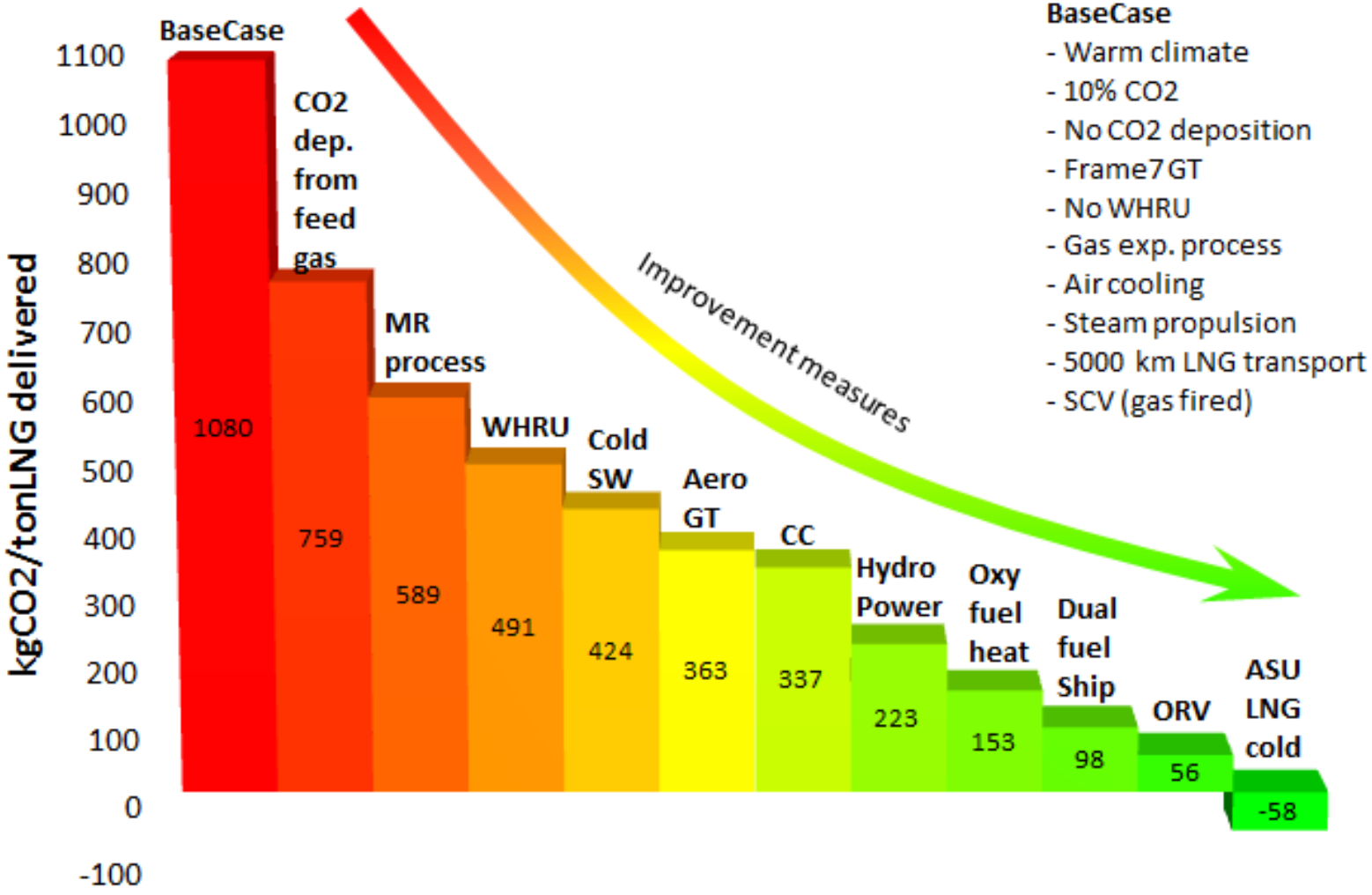
CO_2 reduction stair



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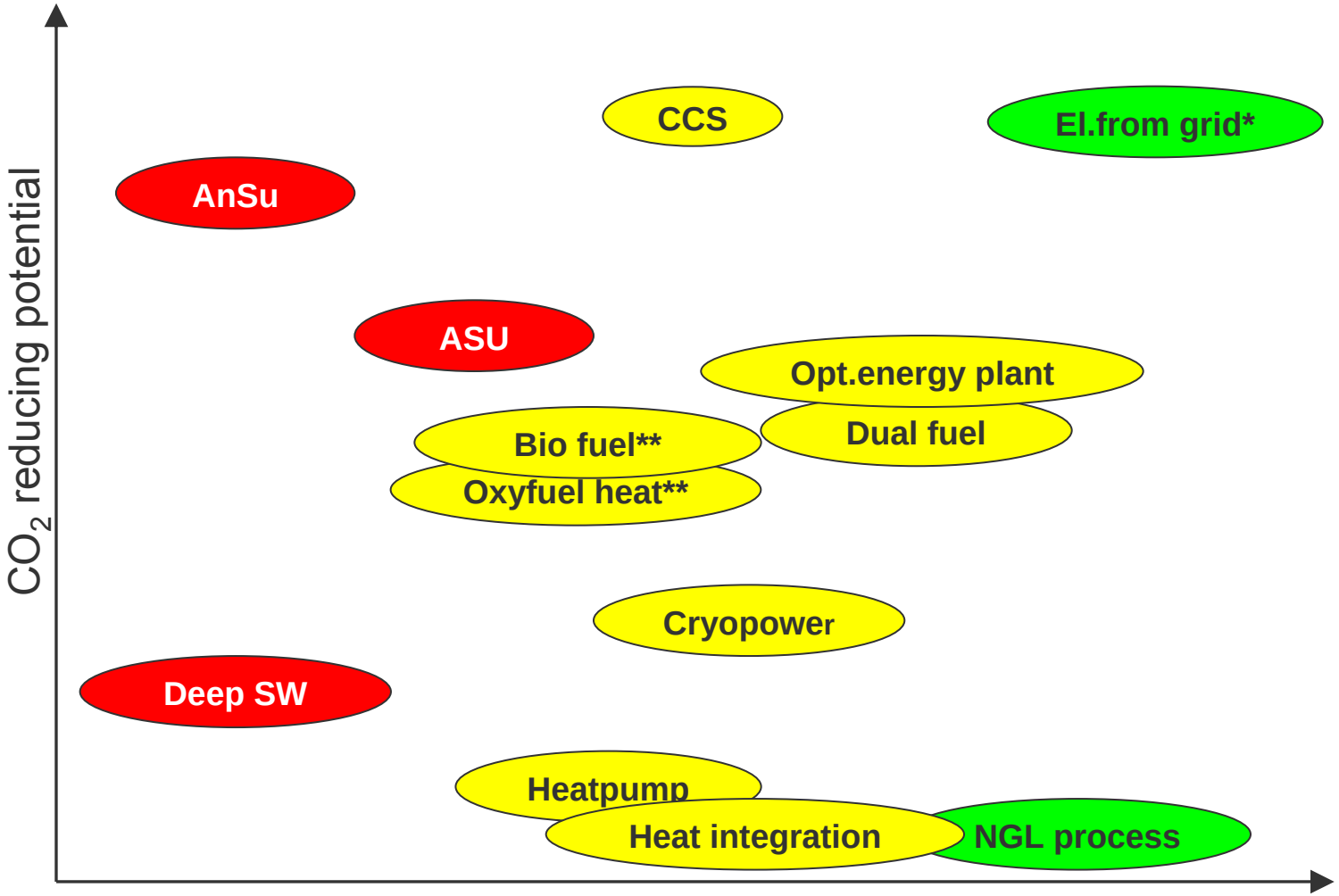
CO_2 reducing measures & potentials



*renewable energy, **@ el.from grid

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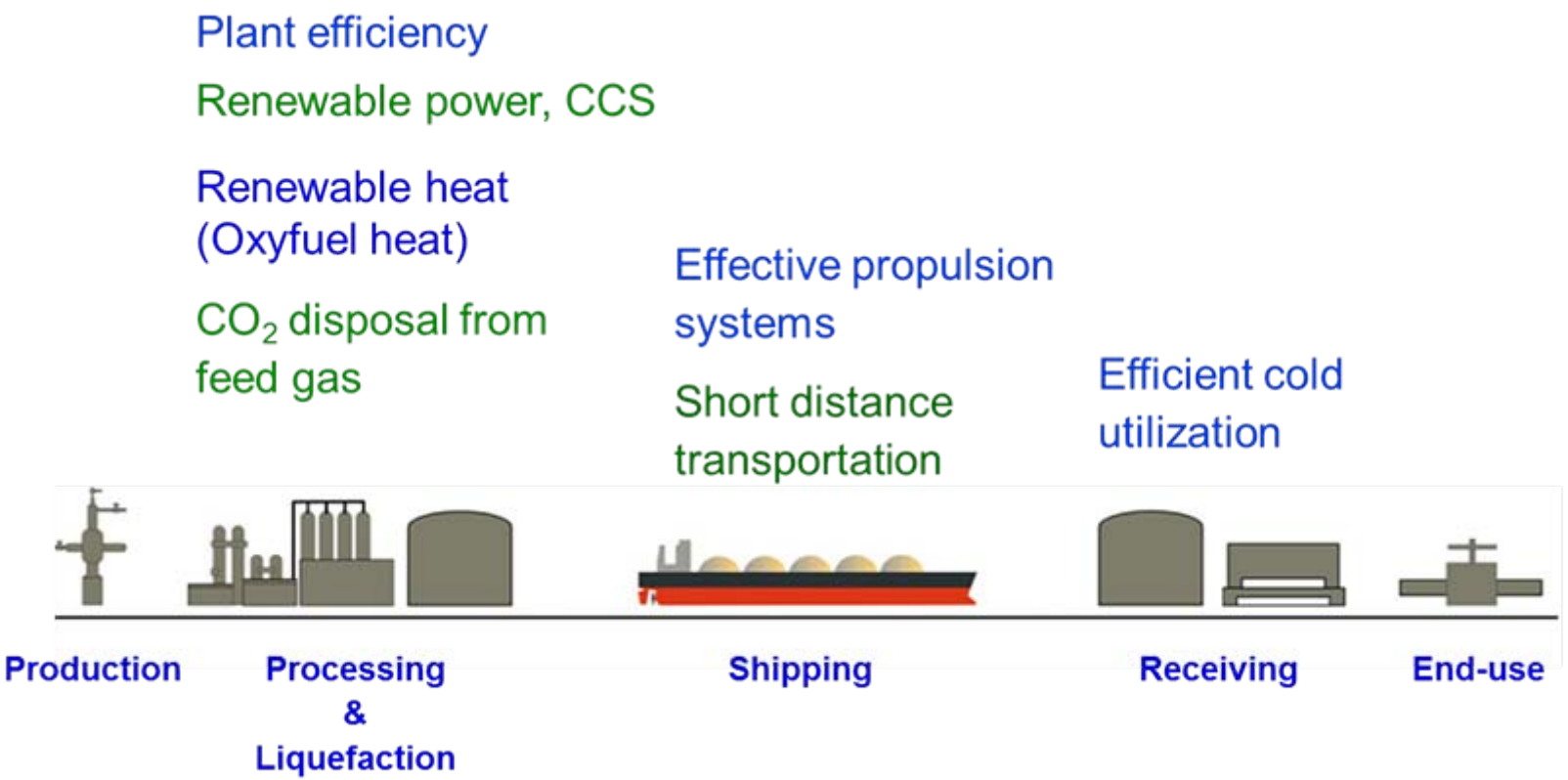
Towards ”zero emission LNG chain”



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Case study – LNG vs PIPELINE
Applied tools: SCEET-LNG & SCEET-PIPELINE

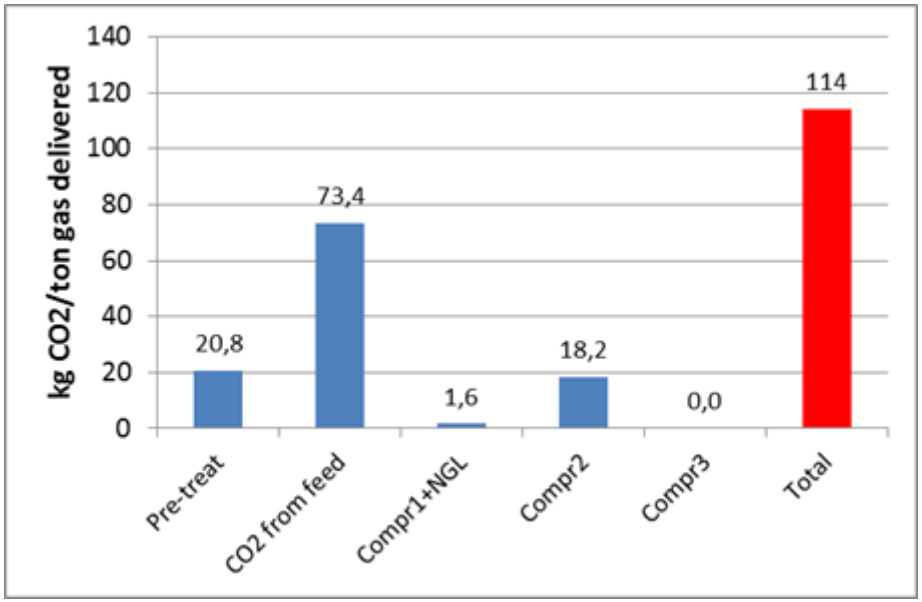
Hammerfest-Europe, 2500 km

- NG feed 20 mill Sm^3/d (~4.3 mtpa LNG)
- CO_2 disposal for LNG (Removal to 50 ppm for LNG and 2.5% for PIPELINE)
- LNG Case (Calculations with SCEET-LNG)
  - Hydropower, Gas fired heaters, Dual fuel ship propulsion, SW regas
- PIPELINE Case (Calculations with SCEET-PIPELINE)
  - Hammerfest-Norne (800 km, Hydropower)
  - Norne-Kårstø (700 km, Gas turbine power)
  - Kårstø-Europe (1000 km, Hydropower)

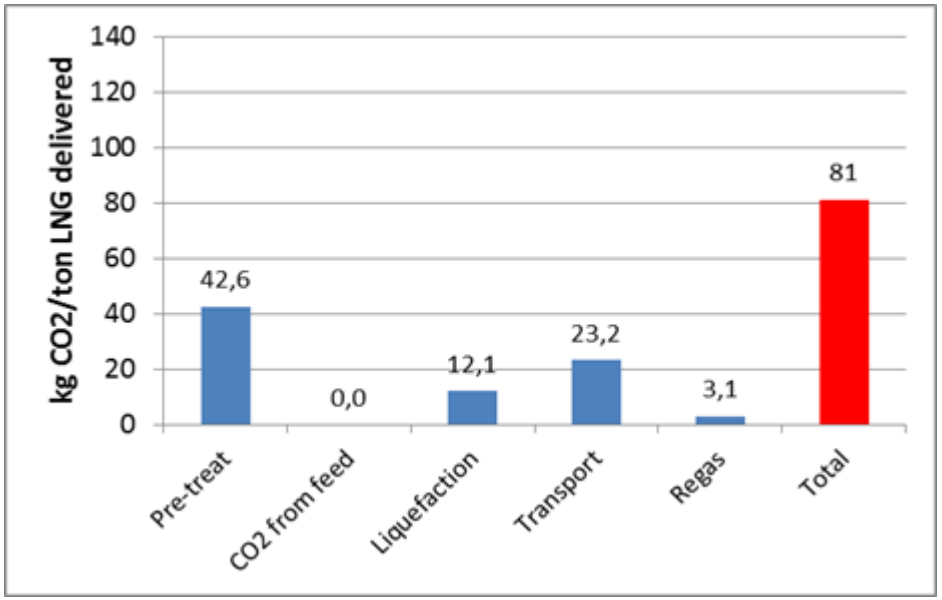
Case study – LNG vs PIPELINE

Hammerfest-Europe, 2500 km

PIPELINE Case



LNG Case



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Summary & Conclusions

- It is possible to reduce CO_2 emission from all parts of the LNG chain by using best available technology
- Efficient power and heat generation is necessary to lower CO_2 emissions
- Efficient propulsion for transportation is an important factor to reduce CO_2 emissions
- Use of LNG cold at the receiving terminal for cryogenic cooling/processes has significant potential regarding reduction of CO_2 emissions
- The “near zero emissions LNG” is possible if renewable energy is used for the liquefaction plant in combination with efficient ship propulsion and LNG cold utilization
- In a global perspective the best solution may be to use natural gas in an optimal way at the production site to produce power & heat

Thank you !

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