

**Natural Gas Technology –
Perspectives on Research and Industrial Application,**

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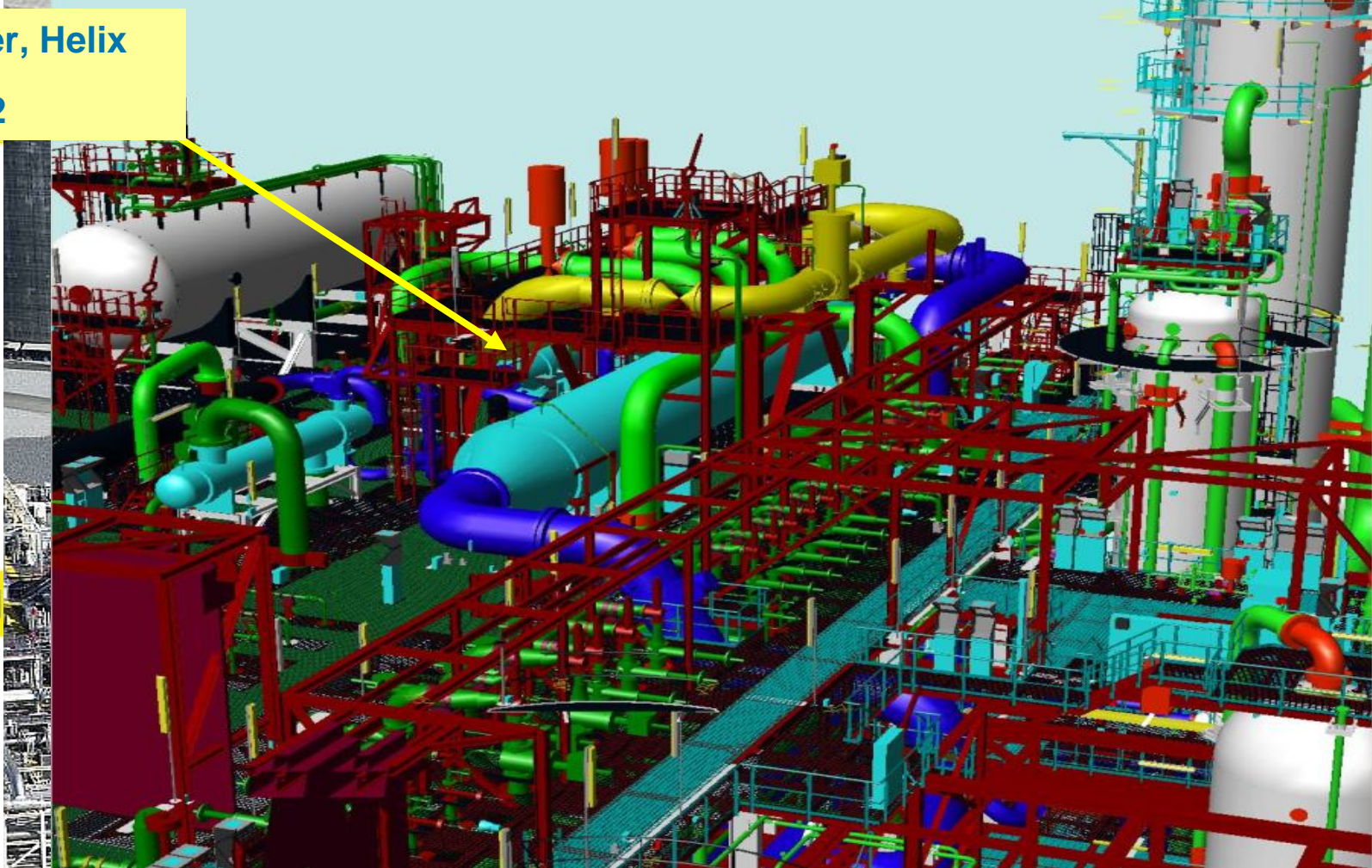
Outline

- **Technology and Snøhvit – what have we learnt?**
- Natural gas development – what is achieved?
- Gas Reserves – Is there a future?
- Gas and Climate – The problem or the solution?
- Need for technology



Condenser, Helix

25-HA-112



Cold



Root Causes

- PFHE
 - All PFHE blocks in cold-box replaced
- SWHE
 - Pressure drop devices installed in subcooler
- Condenser
 - Condenser to be replaced
- Process
 - The process parameters changed to better fit to the equipment



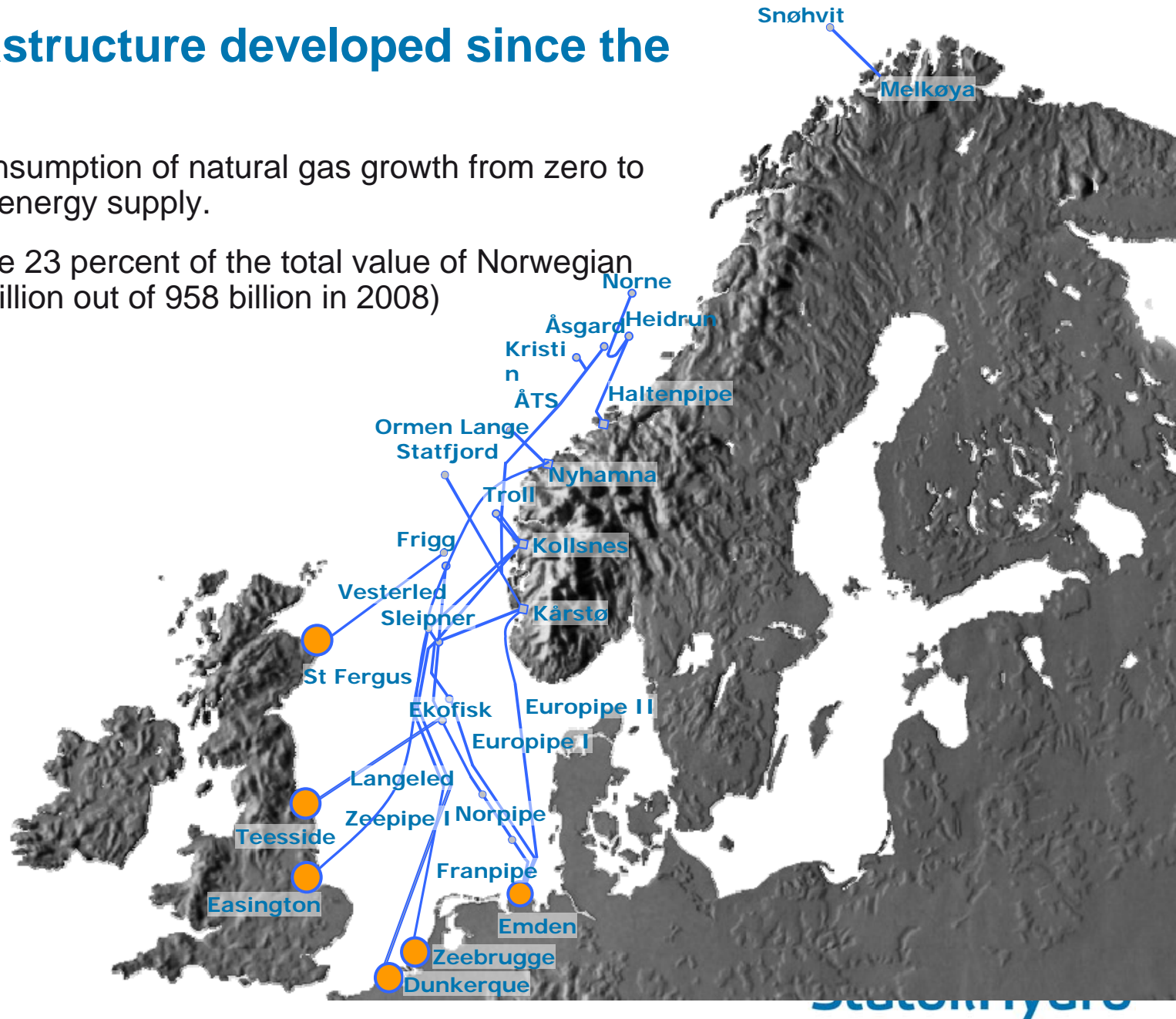
Have we learnt anything about technology from Snøhvit?

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Gas infrastructure developed since the 1960's

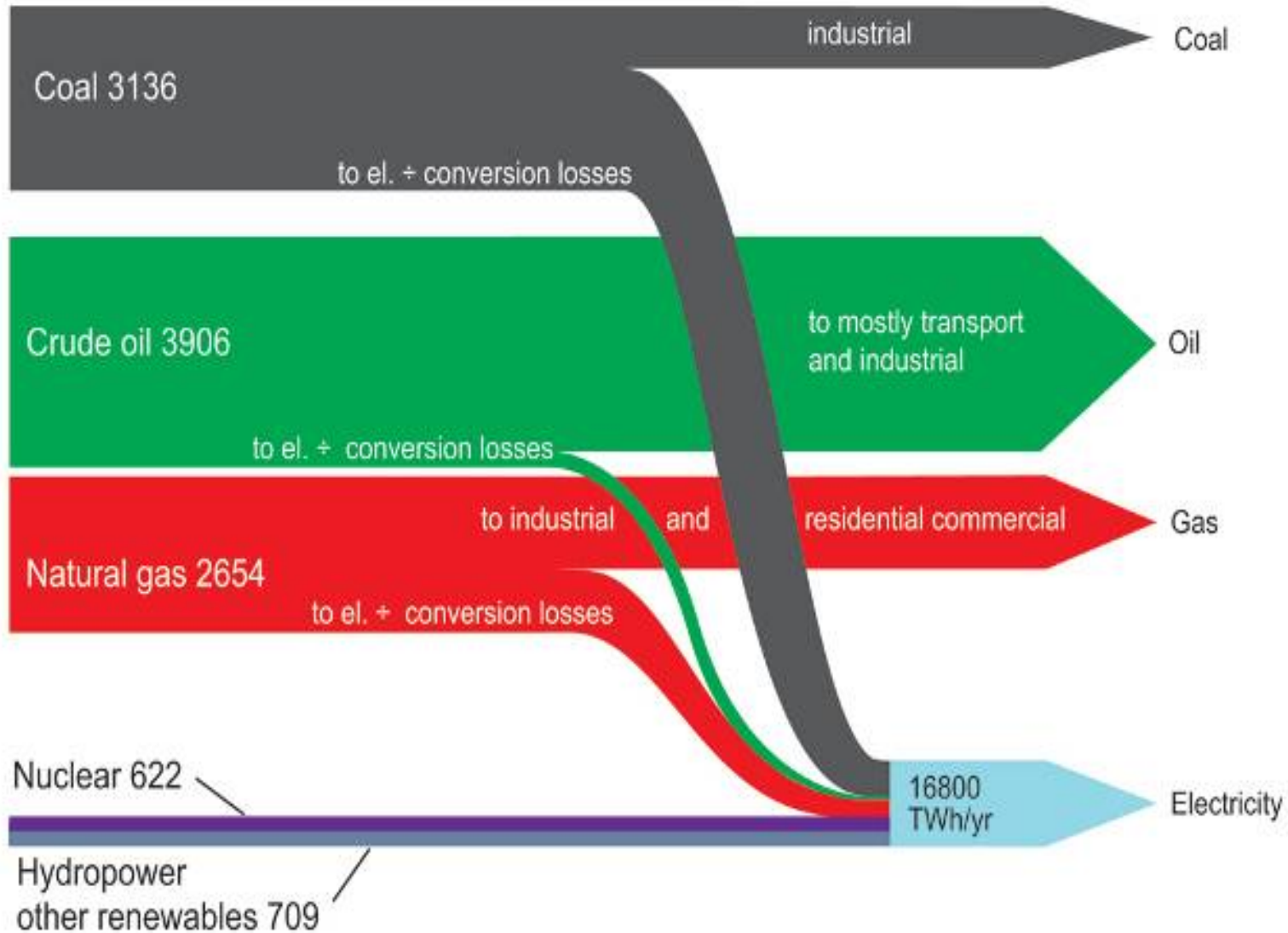
- European consumption of natural gas growth from zero to 25 % of total energy supply.
- Gas constitute 23 percent of the total value of Norwegian export (218 billion out of 958 billion in 2008)



Simplified Global Energy Flows 2007 - The role of natural gas

(million tonnes of oil equivalent per year)

Source: Olav Kårstad



Energy Efficiency in natural gas

Source: Olav Kårstad

- The average of own consumption plus losses for production and processing of natural gas amounts to about 3,5 percent of the throughput with LNG production well above this average
- The energy consumption from the transmission stage is closely connected to the transportation distance both for pipelines and LNG-shipping. For pipelines the average is about 4,5 percent of throughput, 9/10 of which is energy use

	Production	Transmission	LNG production	LNG transport	LNG regasification	Storage		Distribution
	Average	Average	Average (existing)	BAT (1000 km)	Average	Min	Max	Average
Percentage covered	54%	79%	69%	N.A.	27%	N.A.		34%
Natural gas consumption:	3,52%		10,3%					
- Energy	2,73%	4,1%	8,8%	0,21%	0,43%	0,13%	2,0%	0,16%
- Fugitive/venting	0,58%	0,4%	0,2%		0,00%	0,00%	0,10%	0,42%
- Flaring	0,48%		0,5%					
Electricity (MJ/Nm ₃)					0,042	0,047	0,205	0,003
Fuel oil (MJ/Nm ₃)				73,8				
Emissions (g/Nm ₃)								
CO ₂	62,05	132,12	280,22	9,59	8,88	3,39	10,80	0,16
CH ₄	4,01	3,35	5,90		0,03	0,16	0,75	4,32
NO _x	0,07	0,05	0,99	0,01	0,004	0,002	0,10	
SO ₂			0,003	0,01				

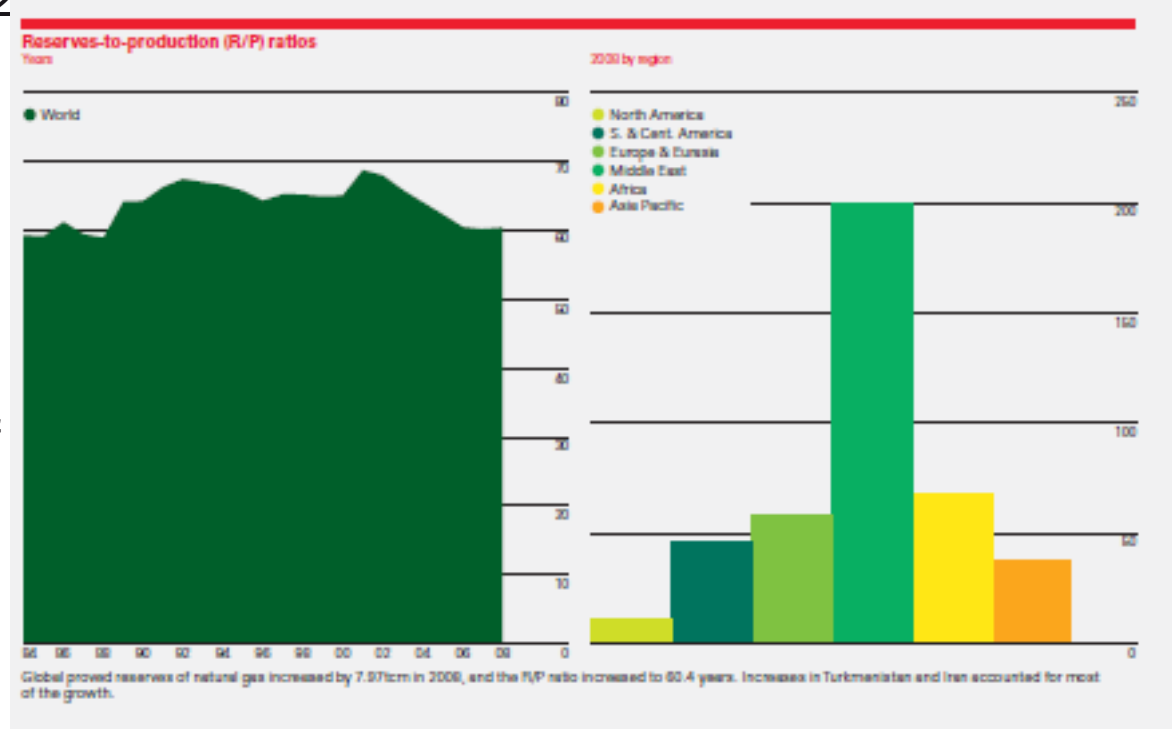
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Global gas reserves

Source: BP World Energy Review

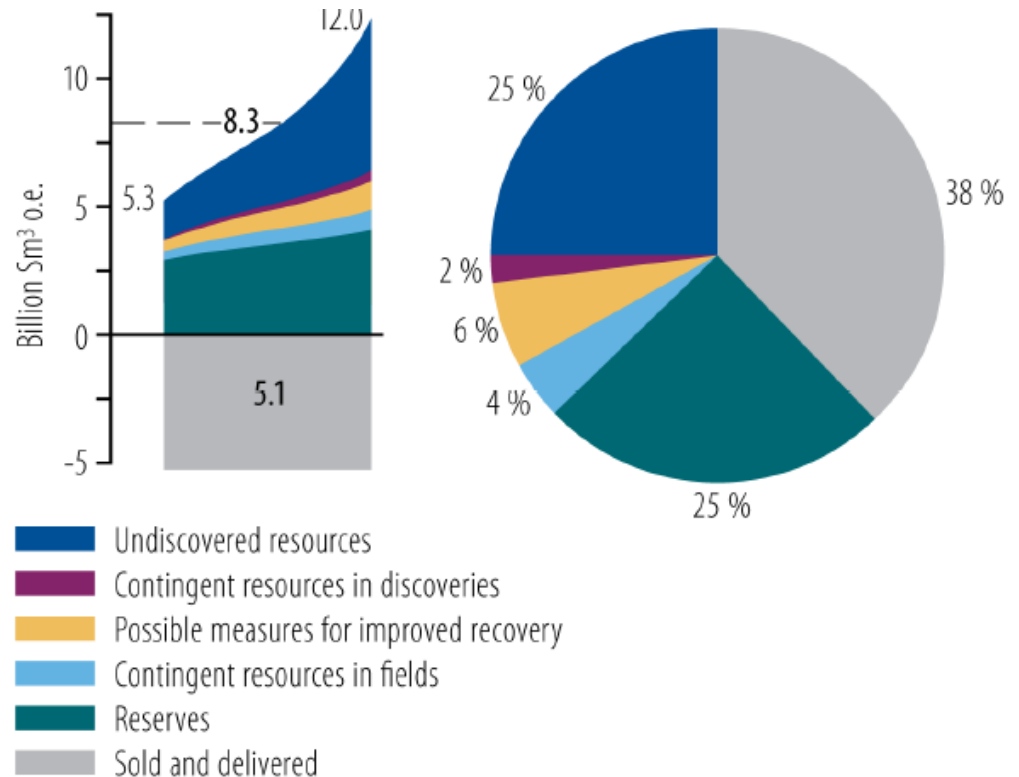
- Global proven reserves of natural gas increased by 7.97 tcm in 2008 to 185.02 trillion cubic meters and the R/P ratio increased to 63.1 years
- The world energy consumption will increase due to population growth and increased standard of living.



Gas at the Norwegian Continental Shelf (ref NPD)

Source: NPD Resource report

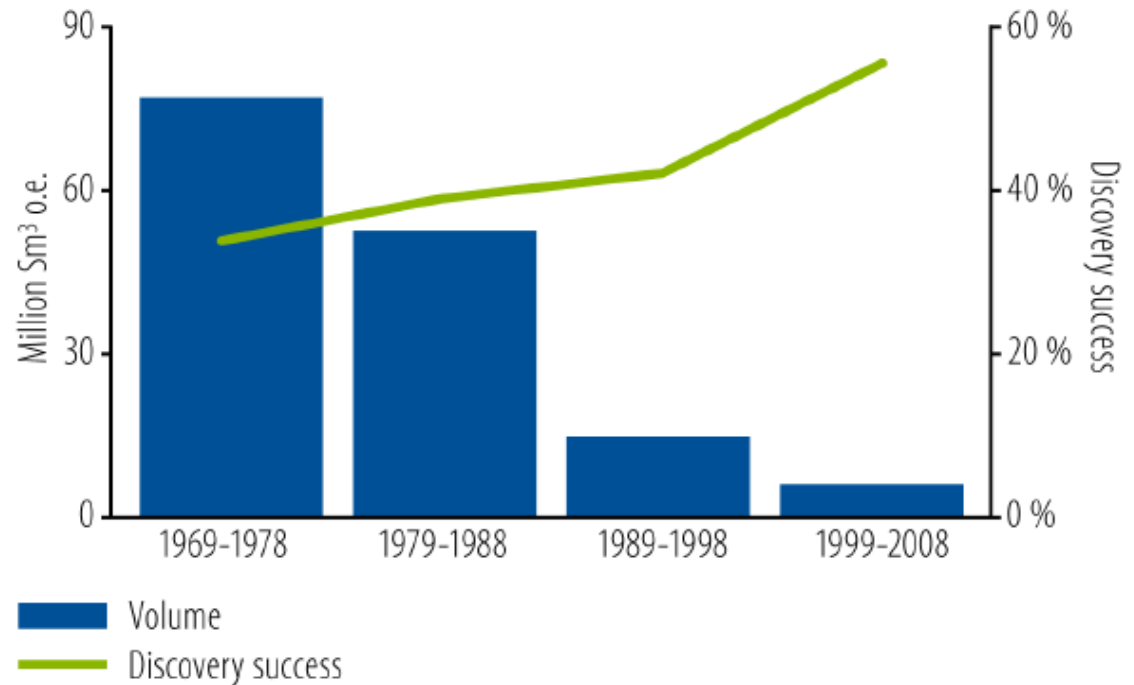
- Remaining resources at NCS estimated to 8.3 billion Sm³ o.e.
- Gas is currently 2/3 of remaining proven reserves.



Smaller and smaller discoveries

- Last large discovery at NCS was Ormen Lange in 1997.

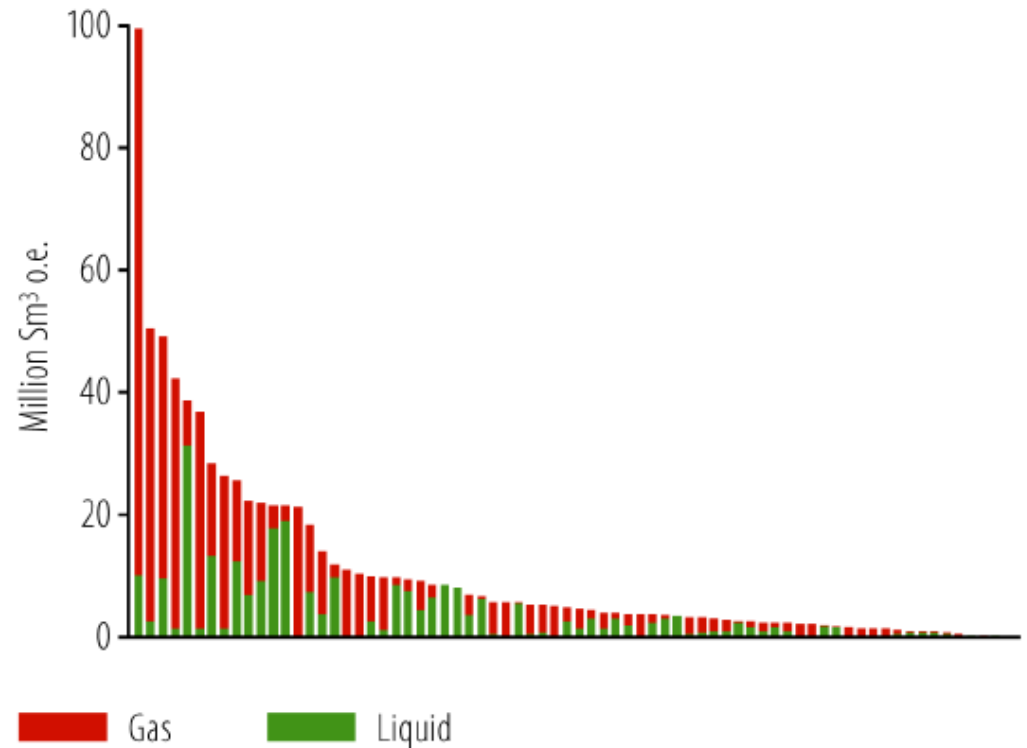
Source: NPD Resource report



Discovery portfolio

- 73 discoveries not developed constitutes about 15 percent of proven reserves.
- The production of these reserves depend highly on technology development.
- A rule of the thumb is that an LNG Train needs 160 billion Sm³
- The challenge to launch a second train at Melkøya?

Source: NPD Resource report



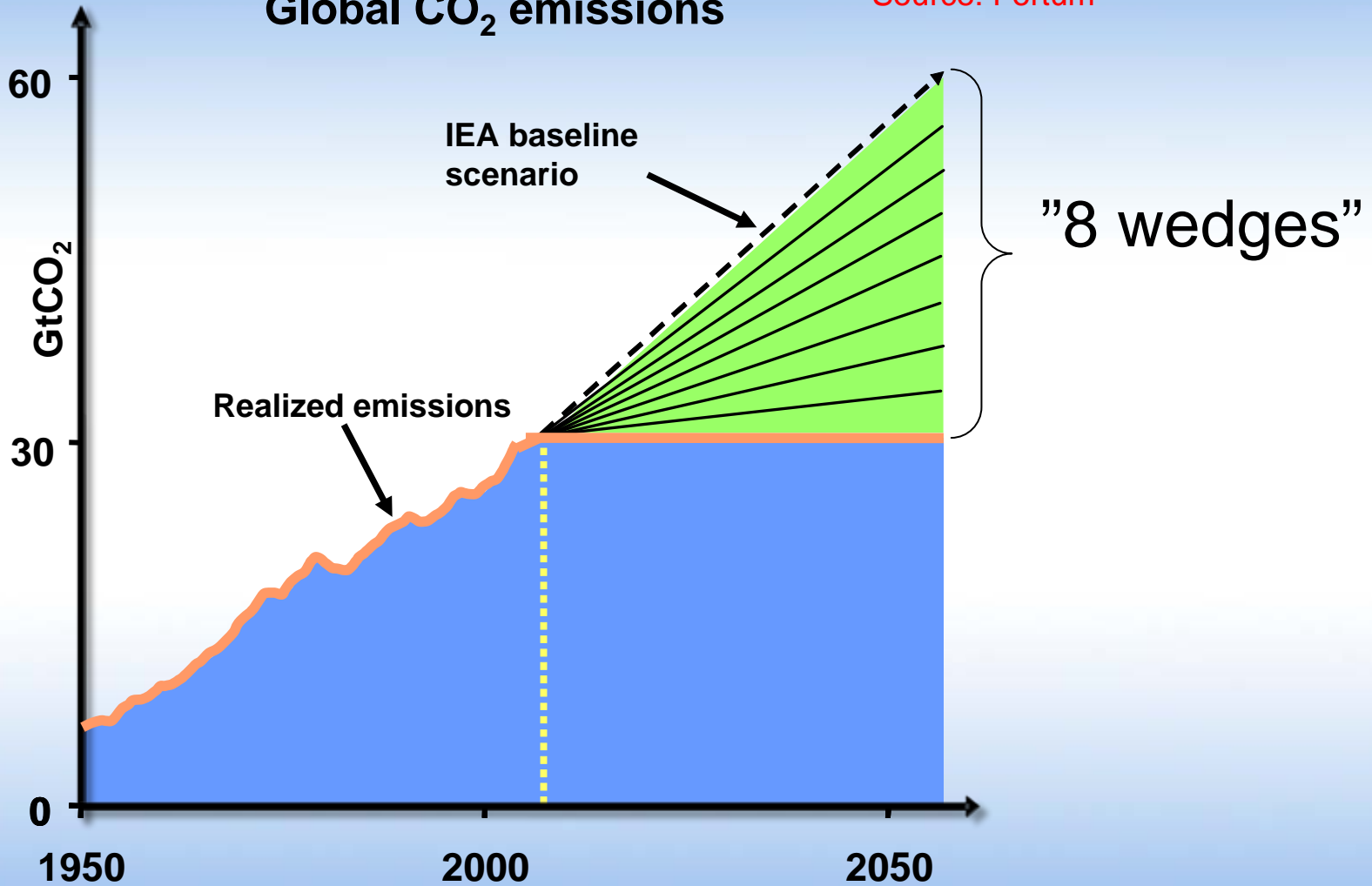
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How to limit global CO₂ emissions?

Global CO₂ emissions

Source: Fortum



"8 wedges"

Each single wedge equals for example...

Source: Fortum

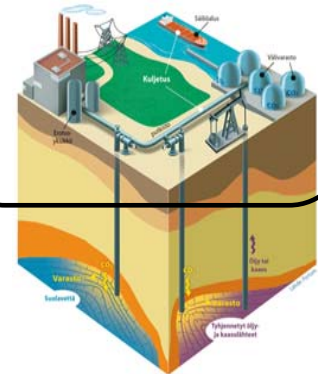
2 million 1 MW wind power plants



Replacing all world's coal-fired power plants with gas.



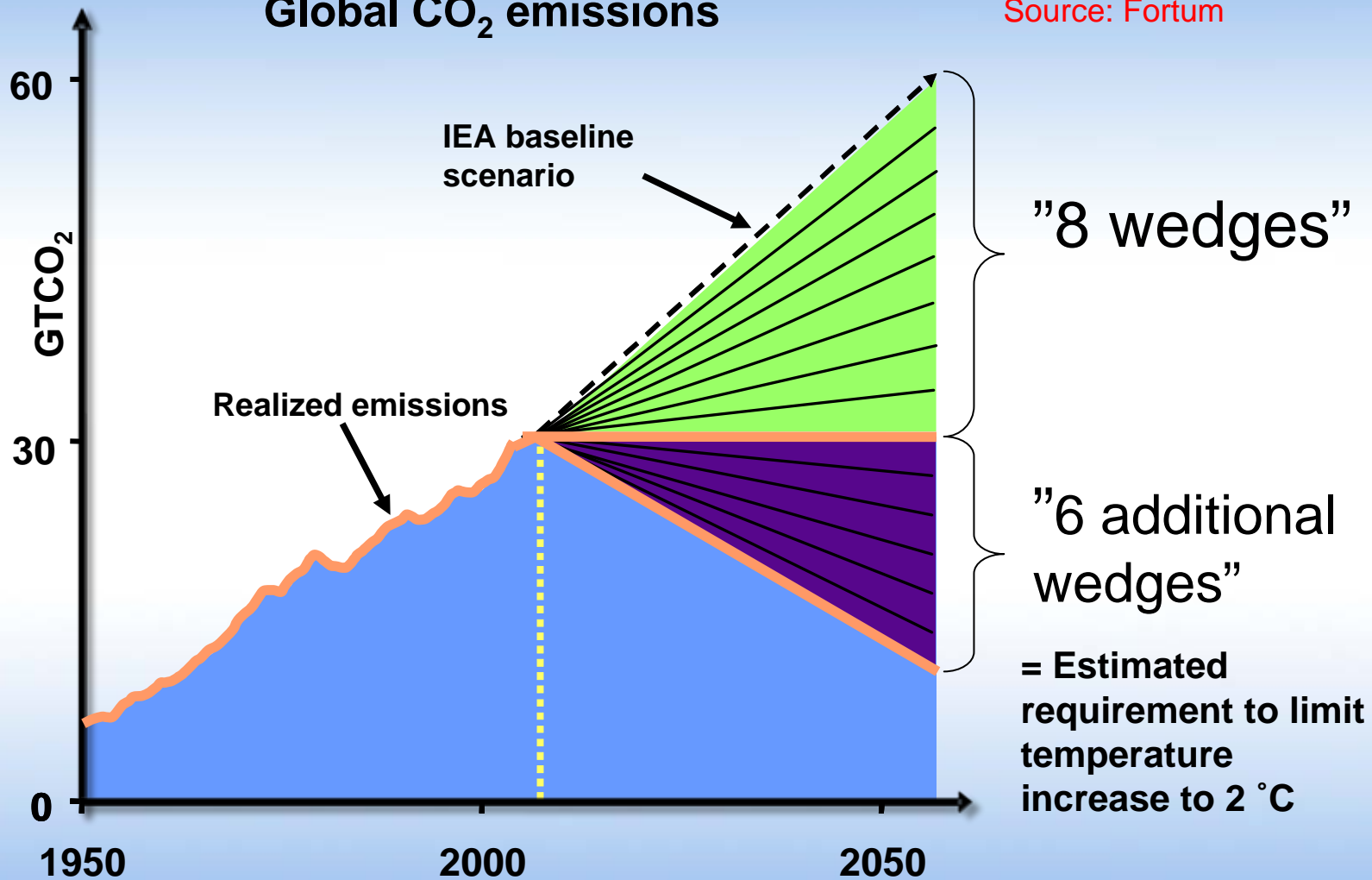
CCS in 800 large coal-fired power plants



And 8 wedges just isn't quite enough...

Global CO₂ emissions

Source: Fortum



Natural gas – part of the climate solution

- Climate actions in the gas industry are typically:
 - Energy efficiency improvement
 - Cutting flaring and venting emissions
 - The use of renewables in own operations
 - Geological storage of CO₂
- Natural gas will be a bridge to a less carbon intensive society (Norwegian Gas export may reduce CO₂ emission by 220 million tonns if used to substitute coal fired power).

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Major issues

- Globally
 - Development of profitable gas value chains. Create Gas corridors to the big gas markets.
 - Access to reserves: Unconventional gas and deep water?
- Nationally:
 - Need access to more gas at NCS – new acreage
 - Technology for profitable production of small and difficult reservoirs.
 - Compliance with climate goals

Likely developments?

- Electrification
 - Have we seen the last new development with local energy production?
 - What technology is needed?
 - Will Melkøya be electrified?
 - Challenge?
- CCS
 - Storage of captured CO₂ a reality – also for Gorgon (10 years after Snøhvit).
 - Will we see CCS on power production in LNG plants?
- Production of gas from small and tight reservoirs?

Electrification of new developments in Norskehavet

Luva



Victoria



Åsgard MF

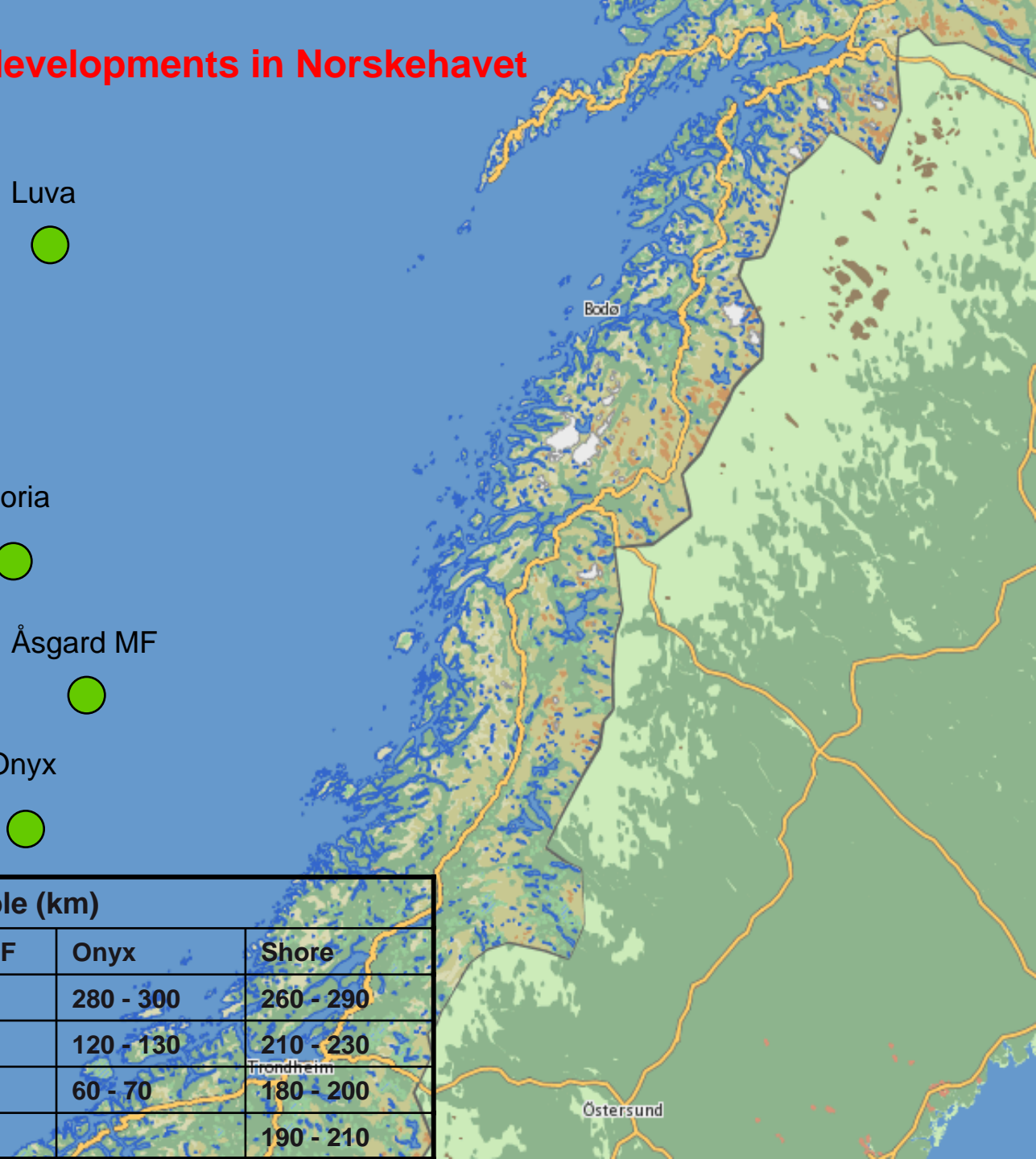


Onyx



Distance table (km)

	Victoria	Åsgard MF	Onyx	Shore
Luva	170 -180	210 - 220	280 - 300	260 - 290
Victoria		60 - 70	120 - 130	210 - 230
Åsgard MF			60 - 70	180 - 200
Onyx				190 - 210



Technologies for CO₂ abatement (expectations from 2002 – what is happened since?)

CO₂ abatement cost NOK/ton

