



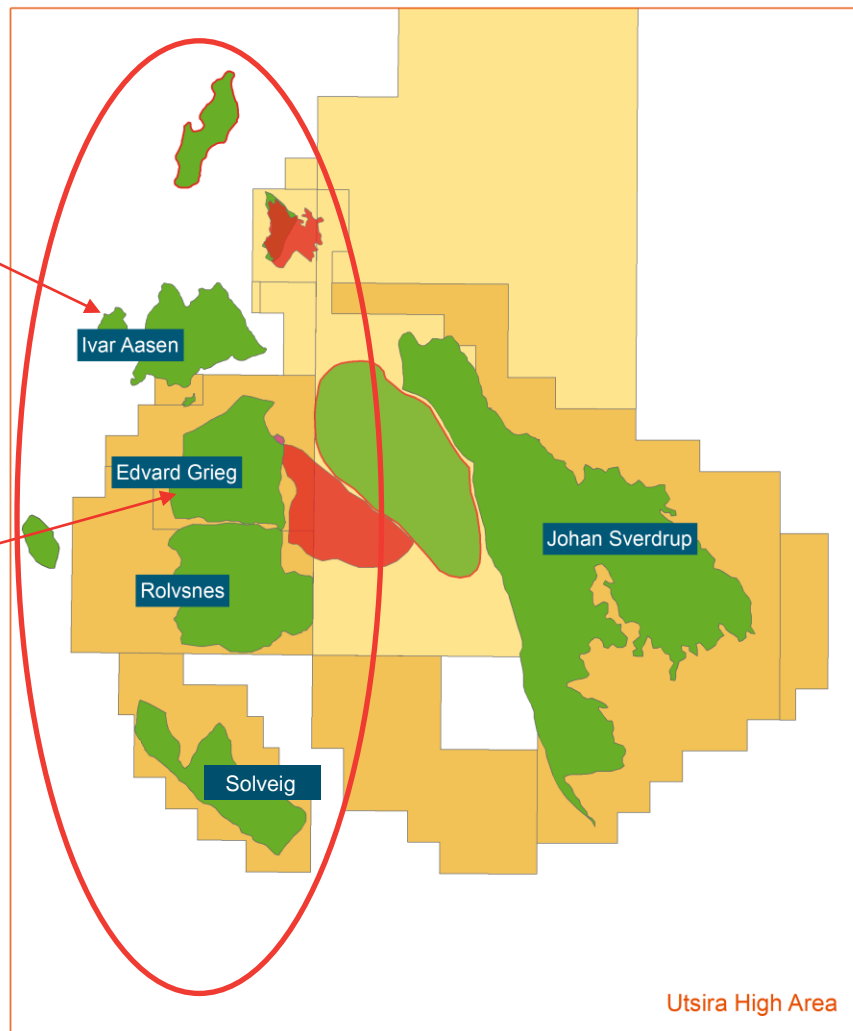
Allocation of Emissions & Taxes
- Including Energy Consumption
On Edvard Grieg Field Hub

Eystein Westgaard
Hydrocarbon Management Workshop 2022

Content

- Edvard Grieg area overview
- Emission sources
- Allocation of
 - emissions
 - power use
 - emission taxes & CO2 quotas cost
- Power from shore
 - allocation
 - costs and emissions

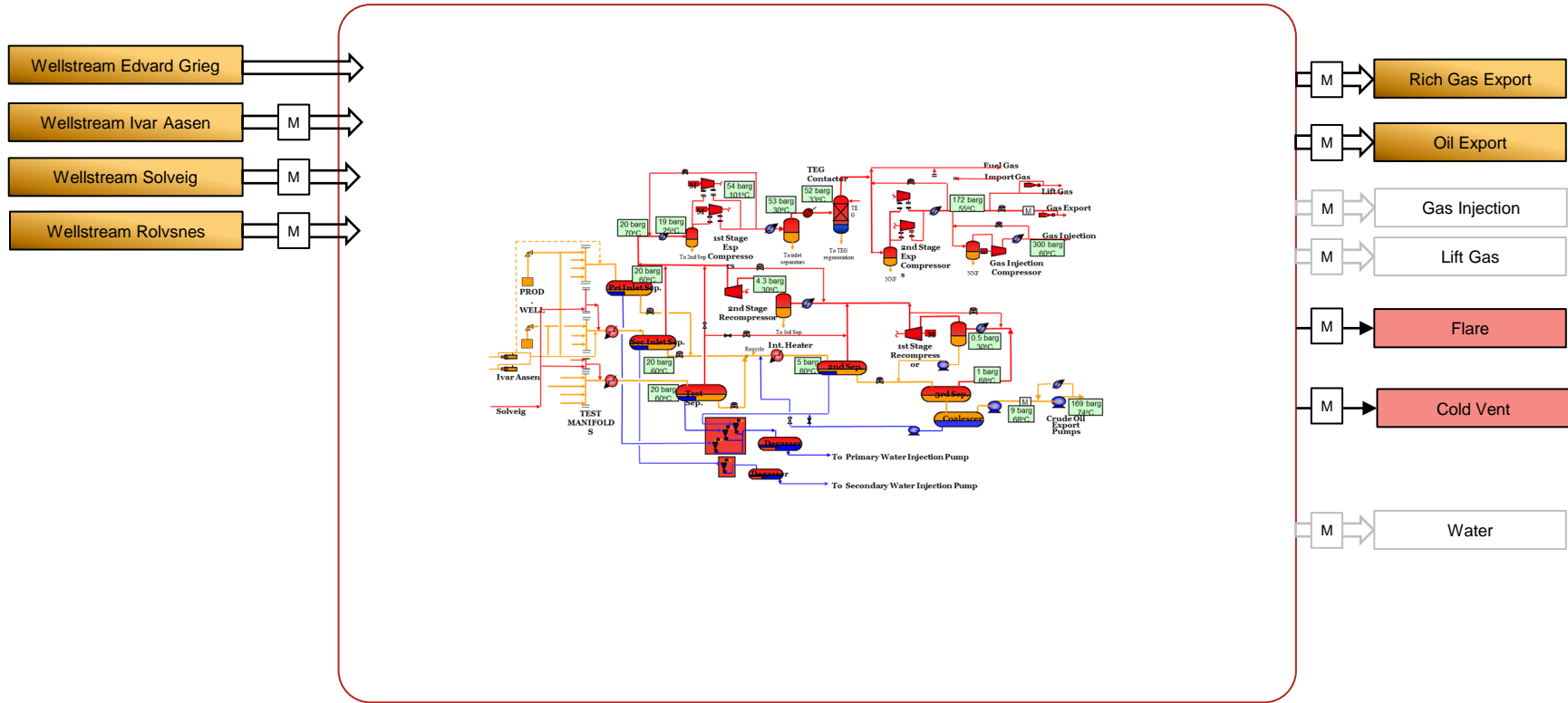
Edvard Grieg area overview



Utsira High Area

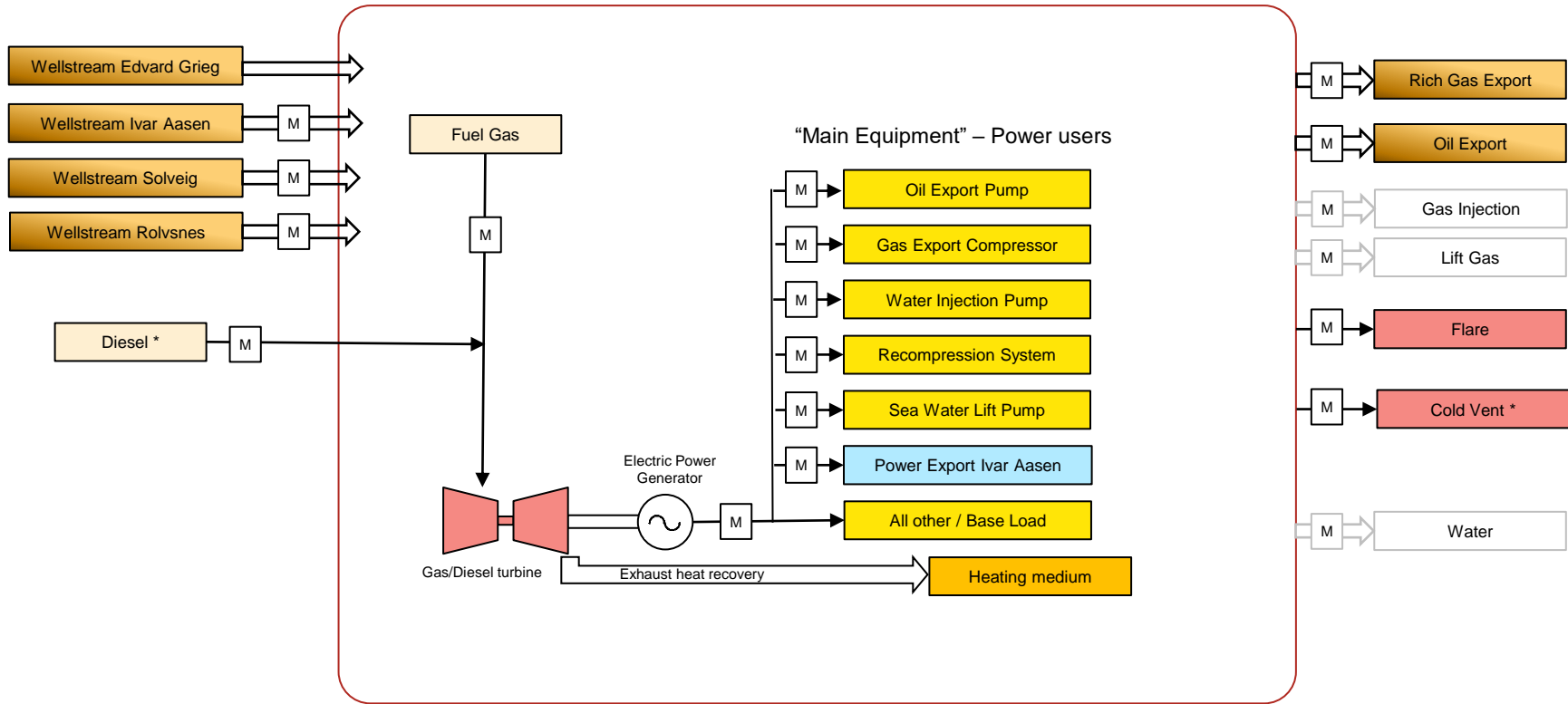
Edvard Grieg field hub

Edvard Grieg Platform Processing



Edvard Grieg field hub

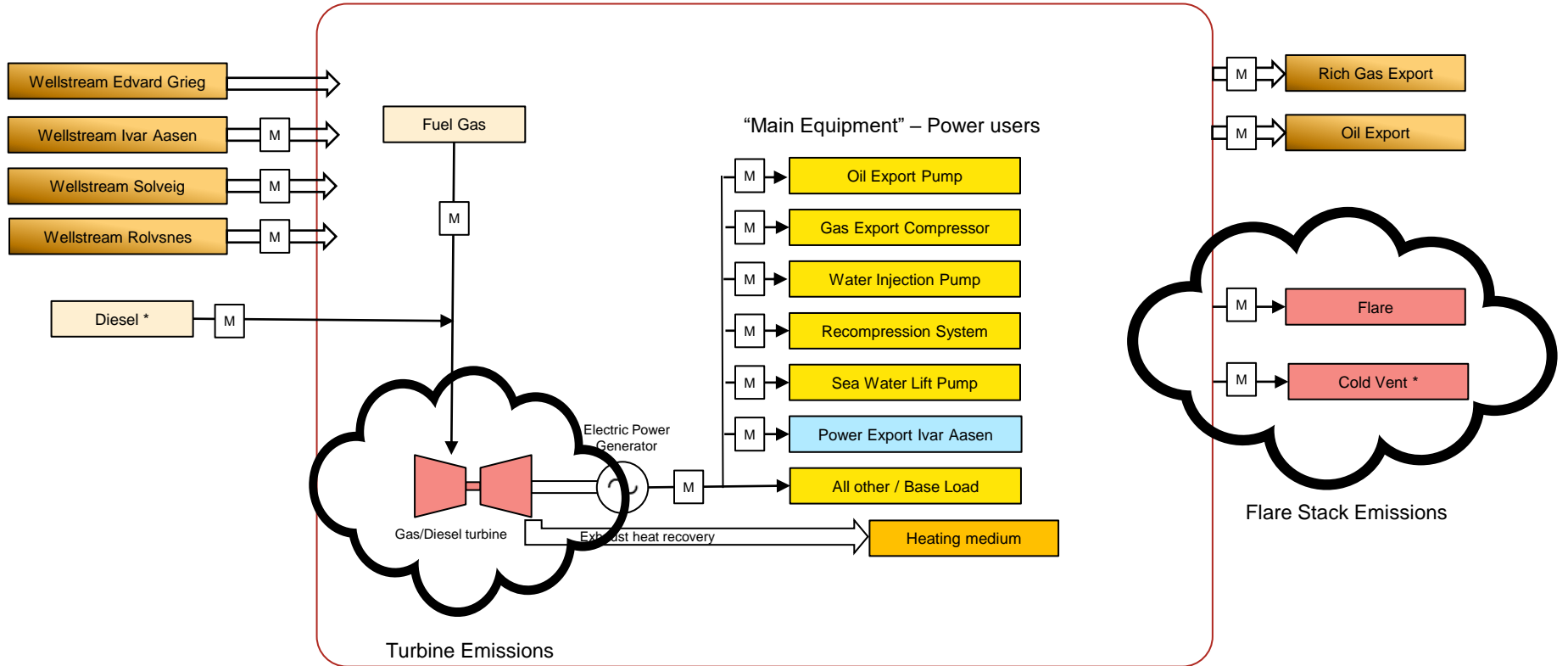
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* Not included in HC allocation procedure

Emission sources

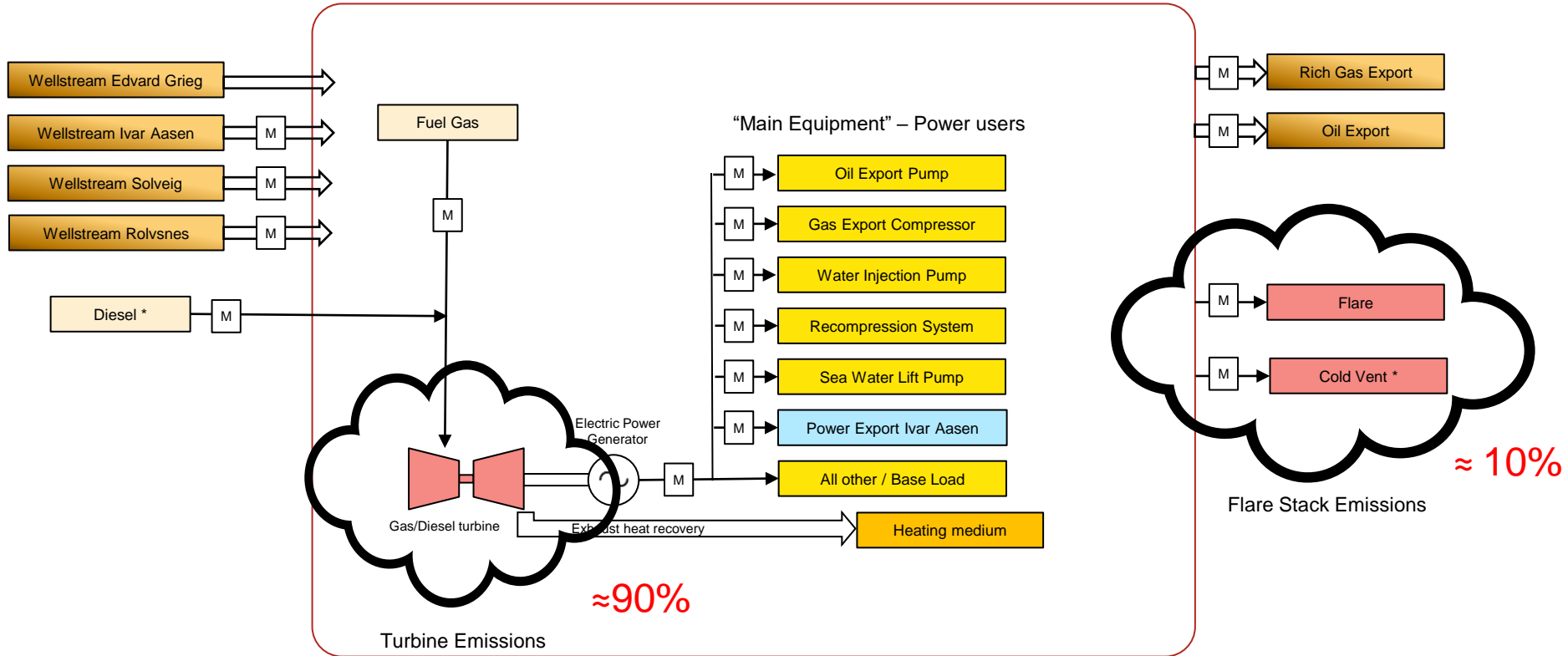
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Emission sources

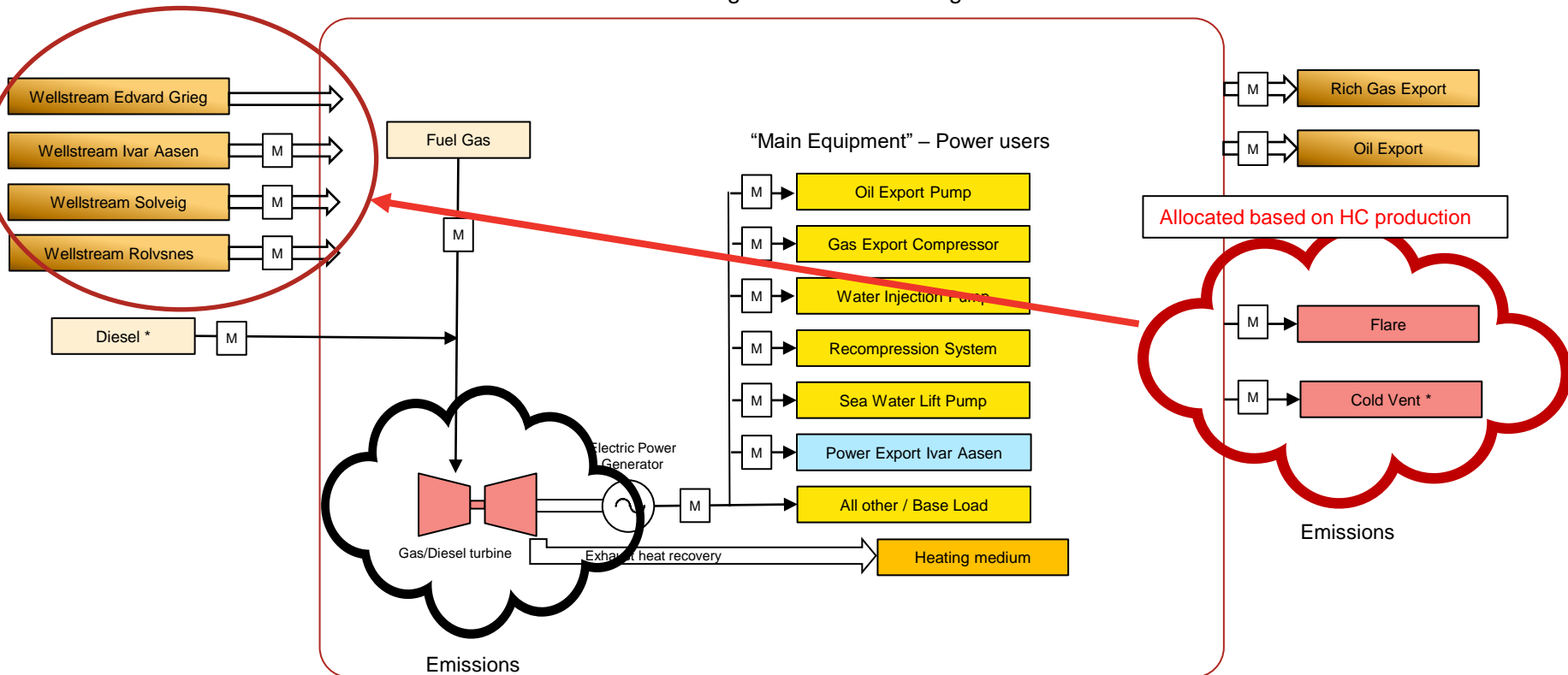
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* Not included in HC allocation procedure

Allocation of Flare & Vent

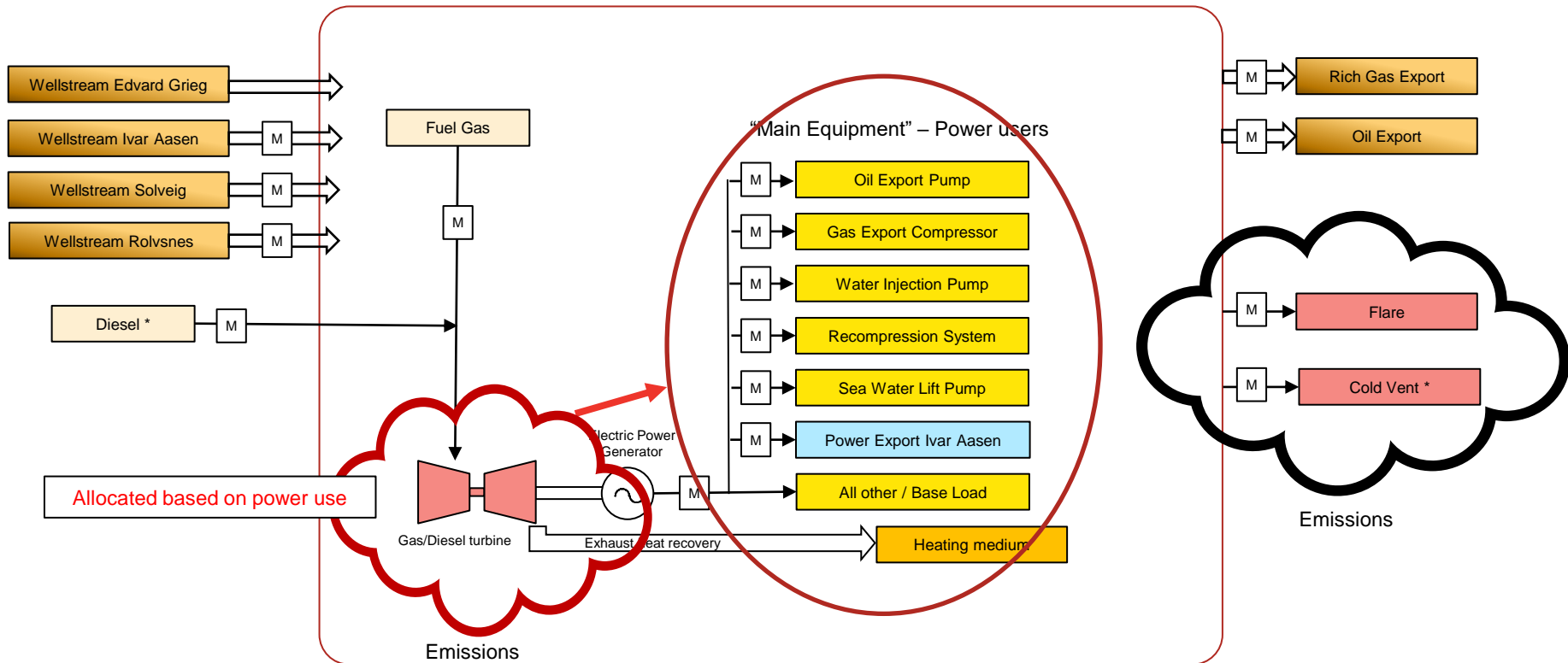
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* Not included in HC allocation procedure

Allocation of emissions from Turbine

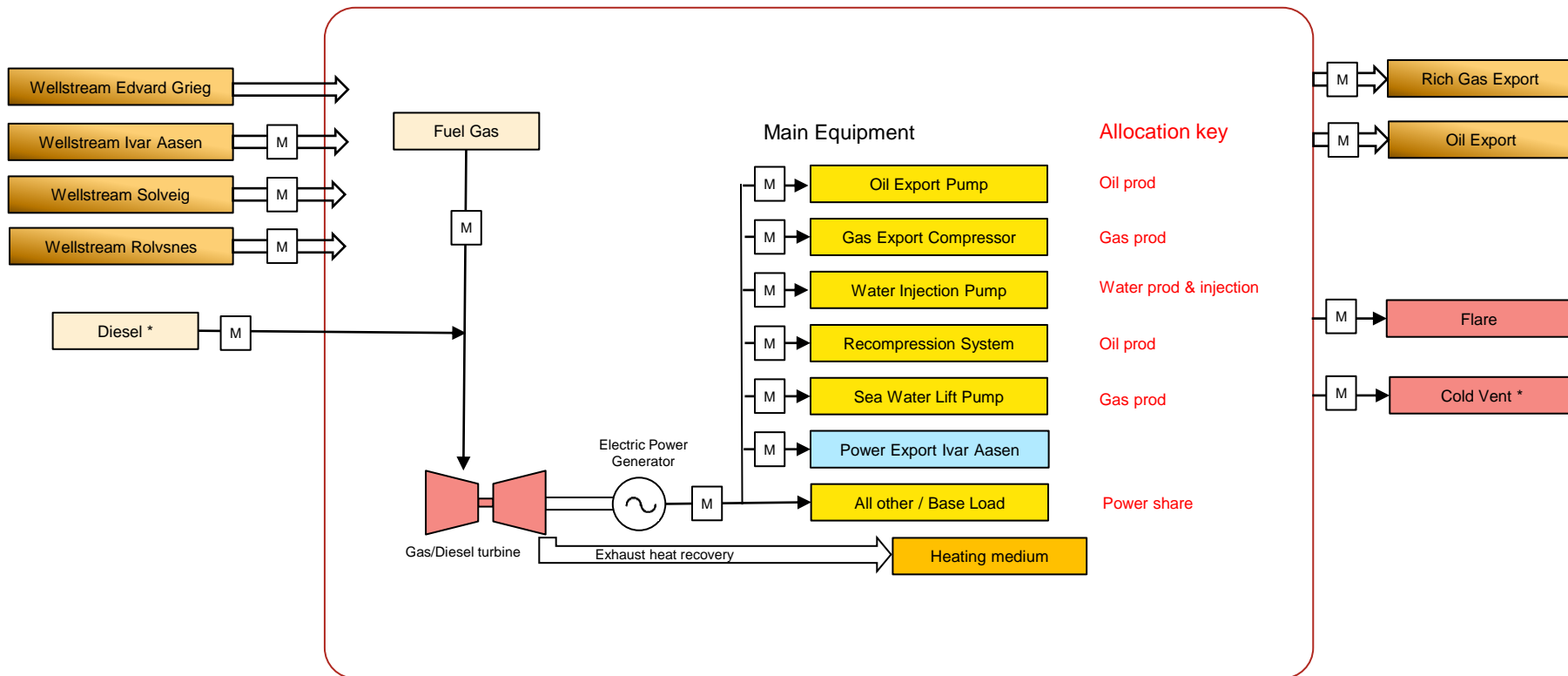
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* Not included in HC allocation procedure

Power use - Allocation keys

Edvard Grieg Platform Processing



* Not included in HC allocation procedure

Power use - Monthly Allocation

- Power allocation is defined in Allocation Procedure
- Monthly power share of equipment x related to field f

	Equipment	Allocation key	Measured/ By difference GWh	Share					Allocated				
				EG	IA	SO	RN	total	GWh EG	GWh IA	GWh SO	GWh RN	GWh total
Main Equipment	Oil Export Pump	Oil prod	2.2	71 %	24 %	4 %	2 %	100 %	1.5	0.5	0.1	0.0	2.2
	Gas Export Compressor	Gas prod	11.5	53 %	37 %	8 %	2 %	100 %	6.1	4.2	1.0	0.2	11.5
	Water Injection Pump	Water Injection	5.0	80 %	10 %	5 %	5 %	100 %	4.0	0.5	0.3	0.3	5.0
	Recompression System	Oil prod	1.4	71 %	24 %	4 %	2 %	100 %	1.0	0.3	0.1	0.0	1.4
	Sea Water Lift Pump	Gas prod	0.7	53 %	37 %	8 %	2 %	100 %	0.4	0.3	0.1	0.0	0.7
By difference	Power Export Ivar Aasen		13.0							13.0			13.0
	All Other/Base Load - Type 1	10% EG only	0.2						0.2				0.2
	All Other/Base Load - Type 2	90% Power share Main Eq.	1.9	63 %	28 %	7 %	3 %	100 %	1.2	0.5	0.1	0.0	1.9
	Total Power EG hub		36.0						14.5	19.4	1.5	0.6	36.0

Power share	40 %	54 %	4 %	2 %	100 %
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HC allocation:

HC allocation	EG Tonnes	IA Tonnes	SO Tonnes	RN Tonnes	EG Hub Tonnes
Oil	415	140	23	9	587
Gas	58	40	9	2	109
Total HC	473	180	32	11	696

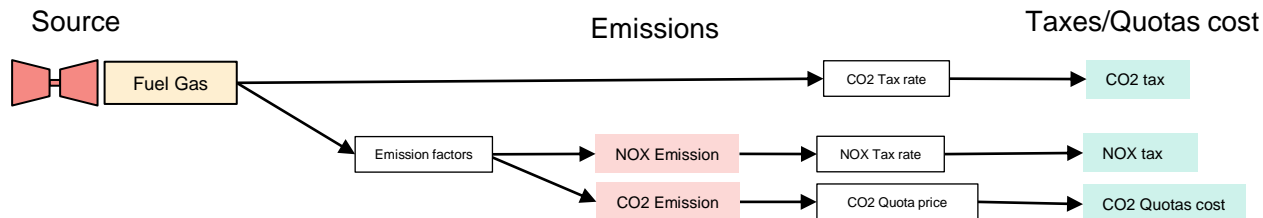
HC allocation	EG Share	IA Share	SO Share	RN Share	EG Hub Share
Oil	71 %	24 %	4 %	2 %	100 %
Gas	53 %	37 %	8 %	2 %	100 %
Total HC	68 %	26 %	5 %	2 %	100 %

All figures for illustration purposes only

Emissions: Taxes & Quotas

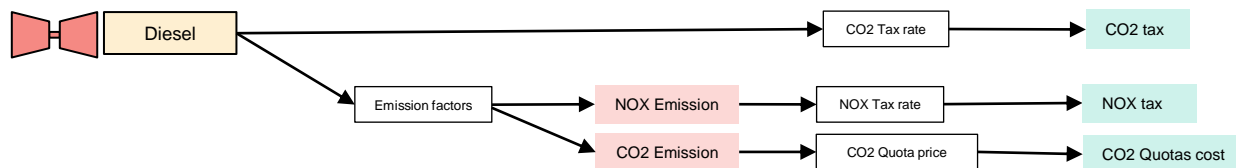
Fuel gas:

- Measured
- Field allocation: Share of power consumption
- Included in Allocation Procedure



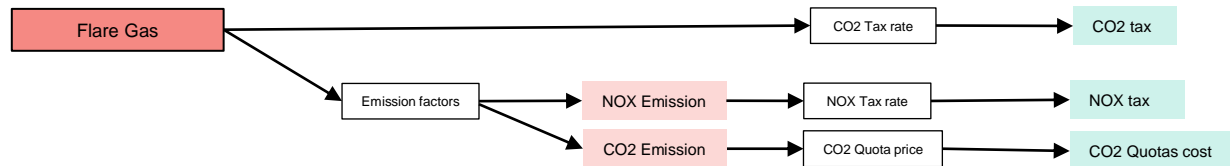
Diesel:

- Measured
- Field allocation: Same as fuel gas



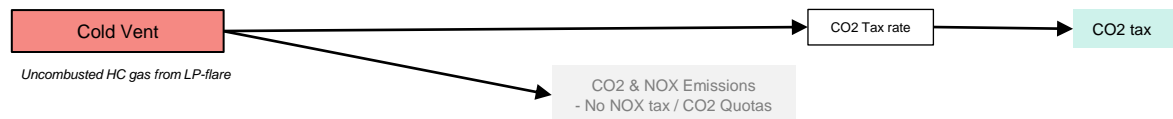
Flare gas:

- Measured
- Field allocation: HC production
 - less Fuel Gas & Lift Gas
- Included in Allocation Procedure



Cold Vent:

- Measured/Calculated (field specific method)
- Field allocation: Same as flare gas



Taxes/Quota costs – Field Allocation

Density Diesel	0.87 kg/l
FX	10 NOK/EUR

Source	Consumption kSm3	Emission factors	Emissions Tonnes	Tax rates	Taxes kNOK	Field Allocation	EG Share	IA Share	SO Share	RN Share	EG kNOK	IA kNOK	SO kNOK	RN kNOK	EG Hub kNOK			
Fuel gas	5,000.0			1.65 NOK/Sm3	8,250	CO2 tax	Power alloc	40%	54%	4%	2%	3,329	4,437	352	133	8,250	CO2 tax	
		NOX	0.0018 kg/Sm3	9	16.5 NOK/kg	149	NOX tax	Power alloc	40%	54%	4%	2%	60	80	6	2	149	NOX tax
		CO2	2.71 kg/Sm3	13,550	75 EUR/t	10,163	CO2 Quota	Power alloc	40%	54%	4%	2%	4,100	5,465	433	164	10,163	CO2 Quota
Diesel	0.6			1.65 NOK/L	861	CO2 tax	Power alloc	40%	54%	4%	2%	348	463	37	14	861	CO2 tax	
		NOX	0.025 kg/kg	13	16.5 NOK/kg	215	NOX tax	Power alloc	40%	54%	4%	2%	87	116	9	3	215	NOX tax
		CO2	3.17 kg/kg	1,655	75 EUR/t	1,241	CO2 Quota	Power alloc	40%	54%	4%	2%	501	667	53	20	1,241	CO2 Quota
Flare Gas	500.0			1.65 NOK/Sm3	825	CO2 tax	HC alloc	68%	26%	5%	2%	561	213	38	13	825	CO2 tax	
		NOX	0.0014 kg/Sm3	1	16.5 NOK/kg	12	NOX tax	HC alloc	68%	26%	5%	2%	8	3	1	0	12	NOX tax
		CO2	3.5 kg/Sm3	1,750	75 EUR/t	1,313	CO2 Quota	HC alloc	68%	26%	5%	2%	892	339	60	21	1,313	CO2 Quota
Cold Vent	20.0			10.66 NOK/Sm3	213	CO2 tax	HC alloc	68%	26%	5%	2%	145	55	10	3	213	CO2 tax	
		NOX	0 kg/Sm3	-	0 NOK/kg	-	NOX tax											
		CO2	0 kg/Sm3	-	0 EUR/t	-	CO2 Quota											
Total					10,150	CO2 tax					4,382	5,168	436	164	10,150	CO2 tax		
					375	NOX tax					155	199	16	6	375	NOX tax		
					12,716	CO2 Quota					5,493	6,472	546	205	12,716	CO2 Quota		

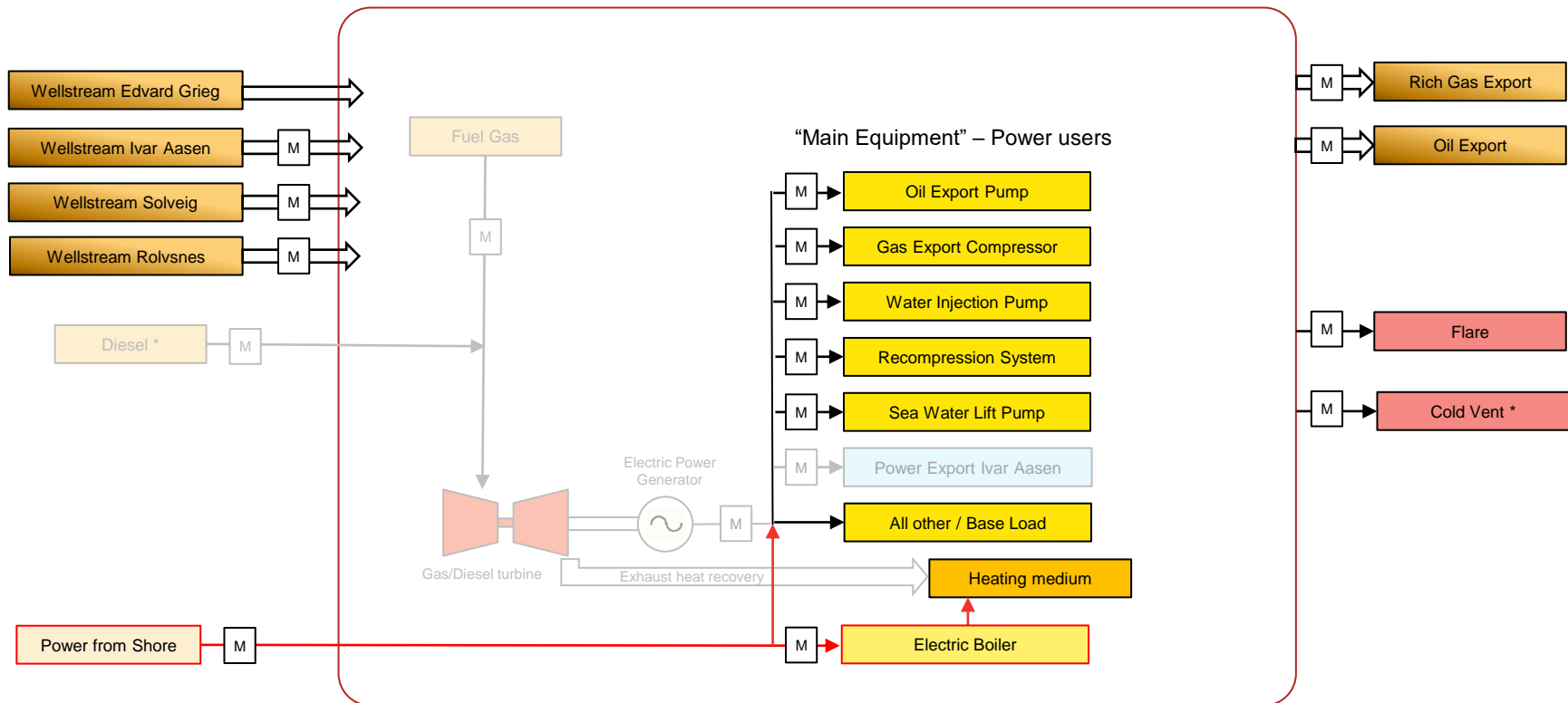
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Oil	415	140	23	9	587
Gas	58	40	9	2	109
Total HC	473	180	32	11	696

	EG Share	IA Share	SO Share	RN Share	EG Hub Share
HC allocation					
Oil	71 %	24 %	4 %	2 %	100 %
Gas	53 %	37 %	8 %	2 %	100 %
Total HC	68 %	26 %	5 %	2 %	100 %

Power share	40 %	54 %	4 %	2 %	100 %
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Power from Shore (PfS) – From Q4 2022

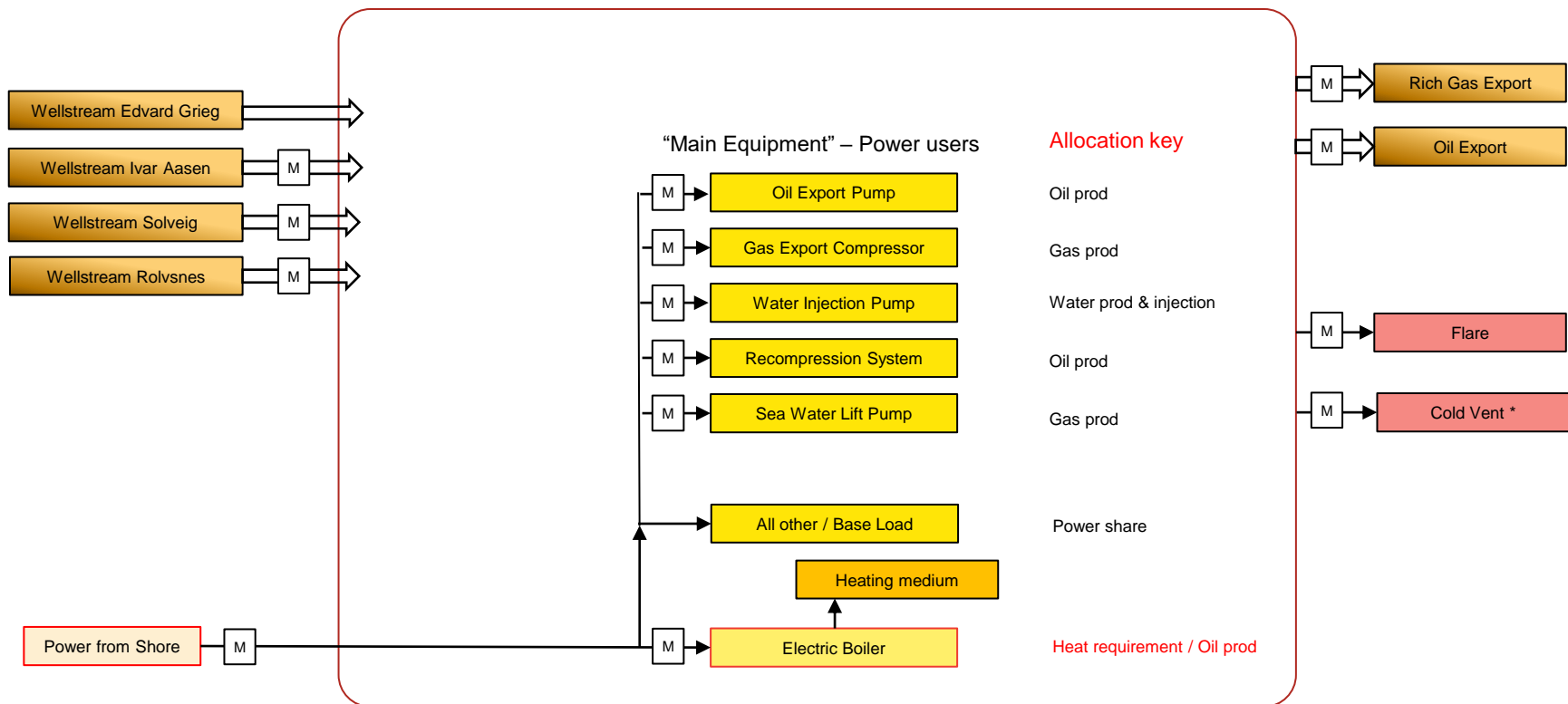
Edvard Grieg Platform Processing



* Not included in HC allocation procedure

Power from Shore – Allocation key

Edvard Grieg Platform Processing



* Not included in HC allocation procedure

Power from Shore – Allocation of heat

- Total power for heating is measured

- Heating is separated into 3 categories:
 1. Pre-heat wellstream secondary inlet separator
 - Heat capacities per field/per phase is defined in the procedure

 2. Pre-heat wellstream test (“3rd party”) separator
 - Heat capacities per field/per phase is defined in the procedure

 3. Heating all other (2nd stage separator, TEG, fuel, baseload, loss, etc.)
 - Defined “by difference”: Total less cat. 1 & 2.
 - Allocated to all fields based on oil production

- Power used in category 1&2 will be derived/calculated using heat capacities
 - Heat requirement for each field X:
 [(Oil mass * heat capacity oil) + (Gas mass * heat capacity gas) + (Water mass * heat capacity water)] * Delta temperature

Table 6: Deemed oil, gas and water heat capacities for all fields.

Edvard Grieg	Ivar Aasen	Solveig	Rolvnes
$C_{p,EG,oil} = 2.17 \frac{kJ}{kg \cdot ^\circ C}$	$C_{p,IA,oil} = 2.17 \frac{kJ}{kg \cdot ^\circ C}$	$C_{p,SO,oil} = 2.08 \frac{kJ}{kg \cdot ^\circ C}$	$C_{p,RN,oil} = 2.04 \frac{kJ}{kg \cdot ^\circ C}$
$C_{p,EG,gas} = 2.22 \frac{kJ}{kg \cdot ^\circ C}$	$C_{p,IA,gas} = 2.22 \frac{kJ}{kg \cdot ^\circ C}$	$C_{p,SO,gas} = 2.20 \frac{kJ}{kg \cdot ^\circ C}$	$C_{p,RN,gas} = 2.22 \frac{kJ}{kg \cdot ^\circ C}$
$C_{p,EG,water} = 4.18 \frac{kJ}{kg \cdot ^\circ C}$	$C_{p,IA,water} = 4.18 \frac{kJ}{kg \cdot ^\circ C}$	$C_{p,SO,water} = 4.18 \frac{kJ}{kg \cdot ^\circ C}$	$C_{p,RN,water} = 4.18 \frac{kJ}{kg \cdot ^\circ C}$

Power allocation – Including Power from Shore

- Power allocation is defined in Allocation Procedure
- Monthly power share of equipment x related to field f

	Equipment	Allcoation key	Measured/ By difference GWh	Share	Share	Share	Share	Share	Allocated	Allocated	Allocated	Allocated	Allocated
				EG	IA	SO	RN	total	GWh EG	GWh IA	GWh SO	GWh RN	GWh total
Main Equipment	Electric Boiler/Heat, Cat 1&2	Heating requirement	4.3	0 %	35 %	45 %	20 %	100 %	0.0	1.5	1.9	0.9	4.3
	Electric Boiler/Heat, Cat 3	Oil prod	7.6	71 %	24 %	4 %	2 %	100 %	5.3	1.8	0.3	0.1	7.6
	Oil Export Pump	Oil prod	2.2	71 %	24 %	4 %	2 %	100 %	1.5	0.5	0.1	0.0	2.2
	Gas Export Compressor	Gas prod	11.5	53 %	37 %	8 %	2 %	100 %	6.1	4.2	1.0	0.2	11.5
	Water Injection Pump	Water Injection	5.0	80 %	10 %	5 %	5 %	100 %	4.0	0.5	0.3	0.3	5.0
	Recompression System	Oil prod	1.4	71 %	24 %	4 %	2 %	100 %	1.0	0.3	0.1	0.0	1.4
	Sea Water Lift Pump	Gas prod	0.7	53 %	37 %	8 %	2 %	100 %	0.4	0.3	0.1	0.0	0.7
By difference	Power Export Ivar Aasen												
	All Other/Base Load - Type 1	10% EG only	0.2						0.2				0.2
	All Other/Base Load - Type 2	90% Power share Main Eq.	1.6	63 %	28 %	7 %	3 %	100 %	1.0	0.5	0.1	0.0	1.6
	Total Power EG hub		34.6						19.6	9.6	3.8	1.6	34.6
Power share									57 %	28 %	11 %	4 %	100 %

All figures for illustration purposes only

Power from Shore – A Step Change

- Cost of power is material
 - Power costs: Electricity costs + grid fee
 - Allocated to fields based on power share
- NVE* standard emission factors for power production
 - Not taxed, but defined as “Scope 2 emissions”
 - Location based, Norway: 11gram CO2e/kWh (“*klimadeklarasjon*” 2021)
- Electrification:
 - Reduces CO2 emissions on Edvard Grieg hub by approx. 90%

CO2 Emissions (t)	Before PfS	After PfS
Turbine	300,000	-
Flare Stack	35,000	35,000
Total EG hub	335,000	35,000
Reduction		-90 %
<hr/>		
Power from Shore		4,620

* The Norwegian Water Resources and Energy Directorate

All figures for illustration purposes only

Takeaway point

- This Edvard Grieg hub case is an example of a detailed allocation of energy use and emissions
- There is no correct level of details in allocation of energy consumption
- Must be assessed on a case by case basis
 - The more similar wellstreams ➡ Simple allocation keys, e.g. BOE
 - The more differentiated wellstreams ➡ Detailed allocation keys, e.g. power use