Getting into hot water: An opportunity for the Petroleum Industry

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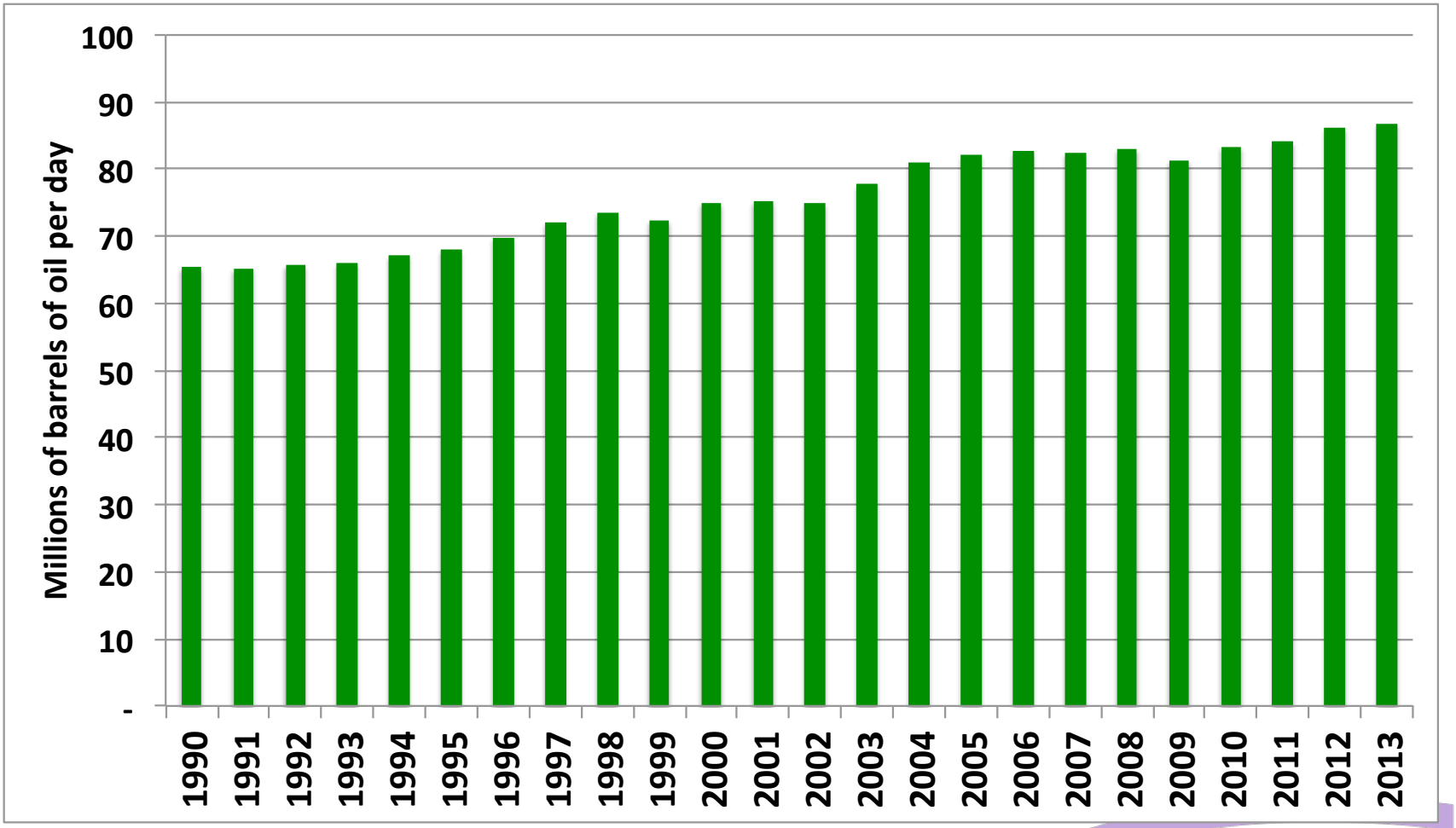
CeREES

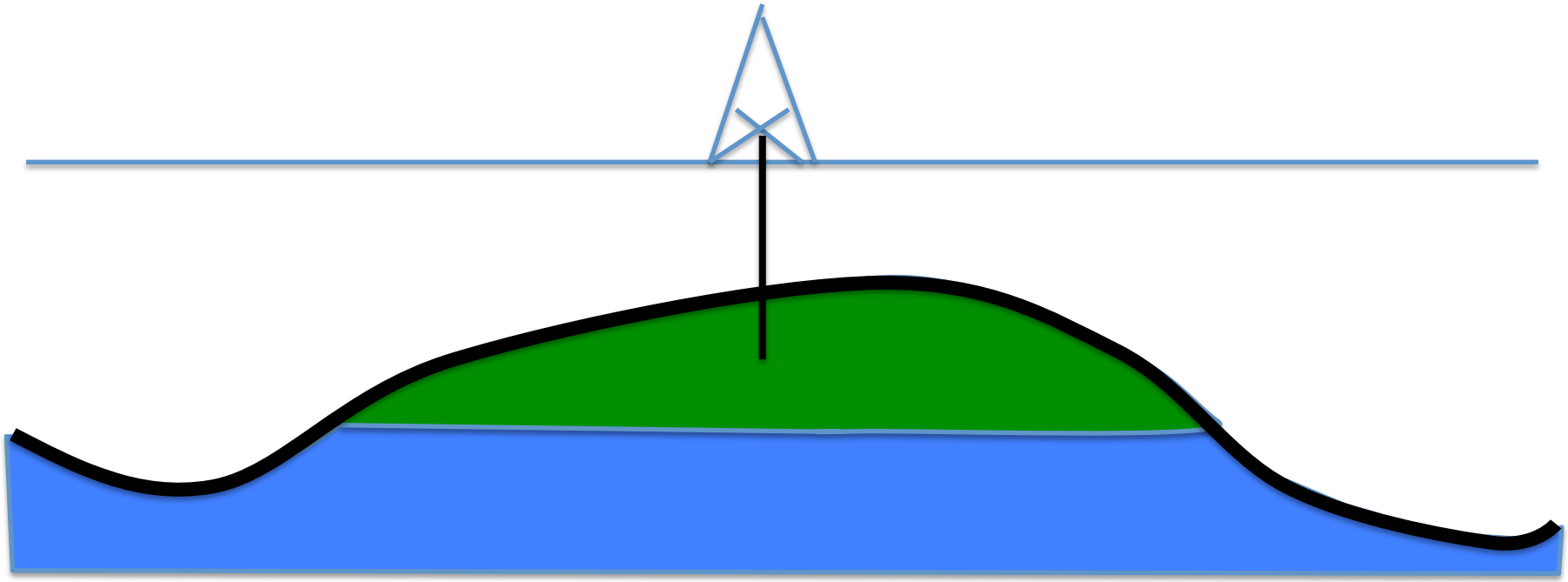
Outline

- Global oil production
- Co-produced water
- Examples of co-produced water N Sea fields
- Southampton District Energy Scheme & Wytch Farm
- Power generation
- UK co-produced water
- Global co-produced water
- The global geothermal industry
- Global potential for power generation from co-produced water

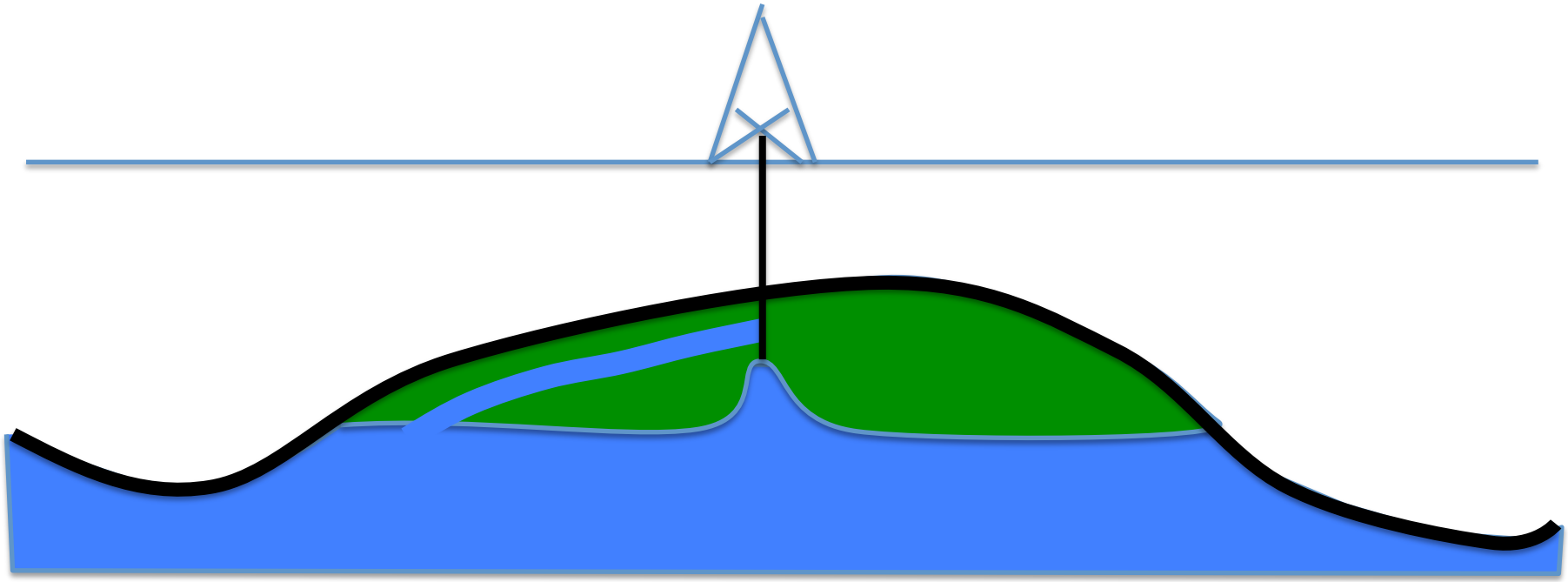
Global Oil Production



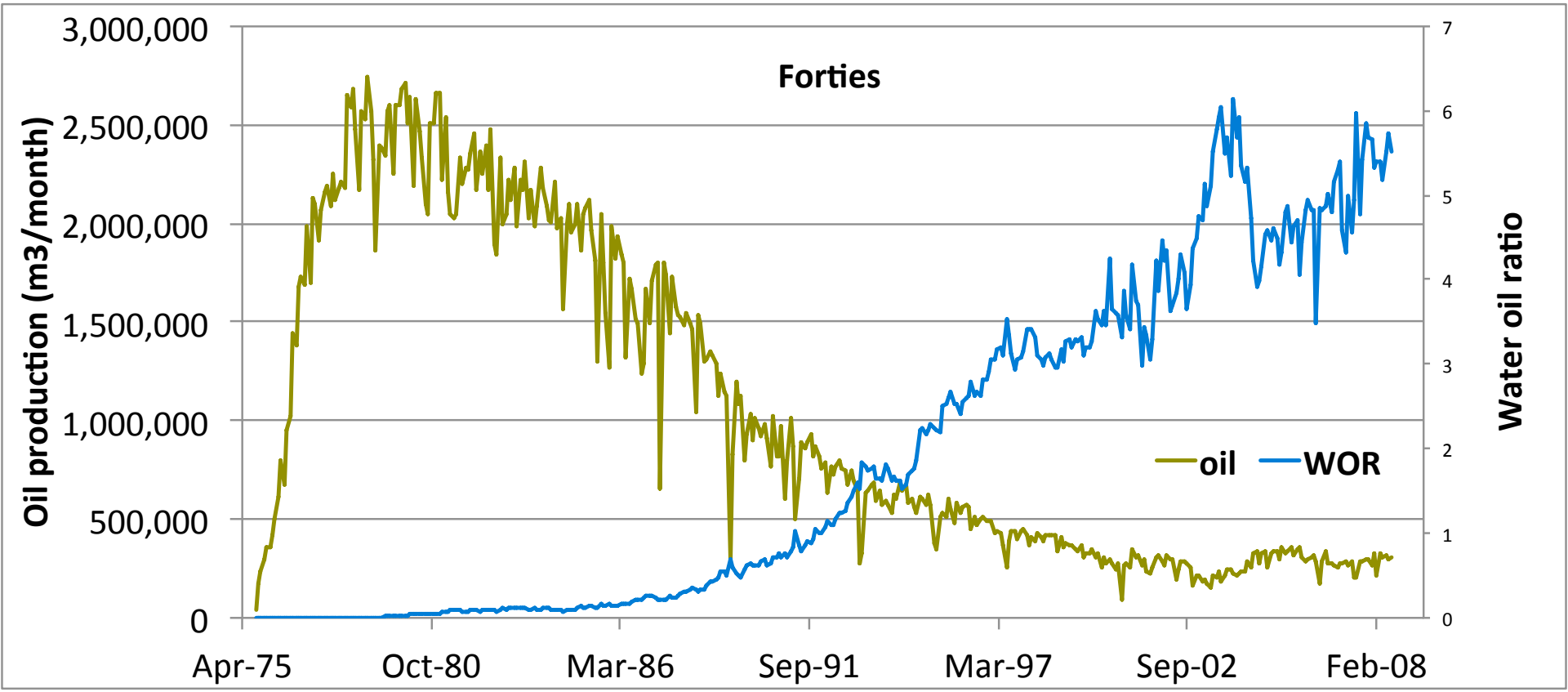
Initial Water Free Production



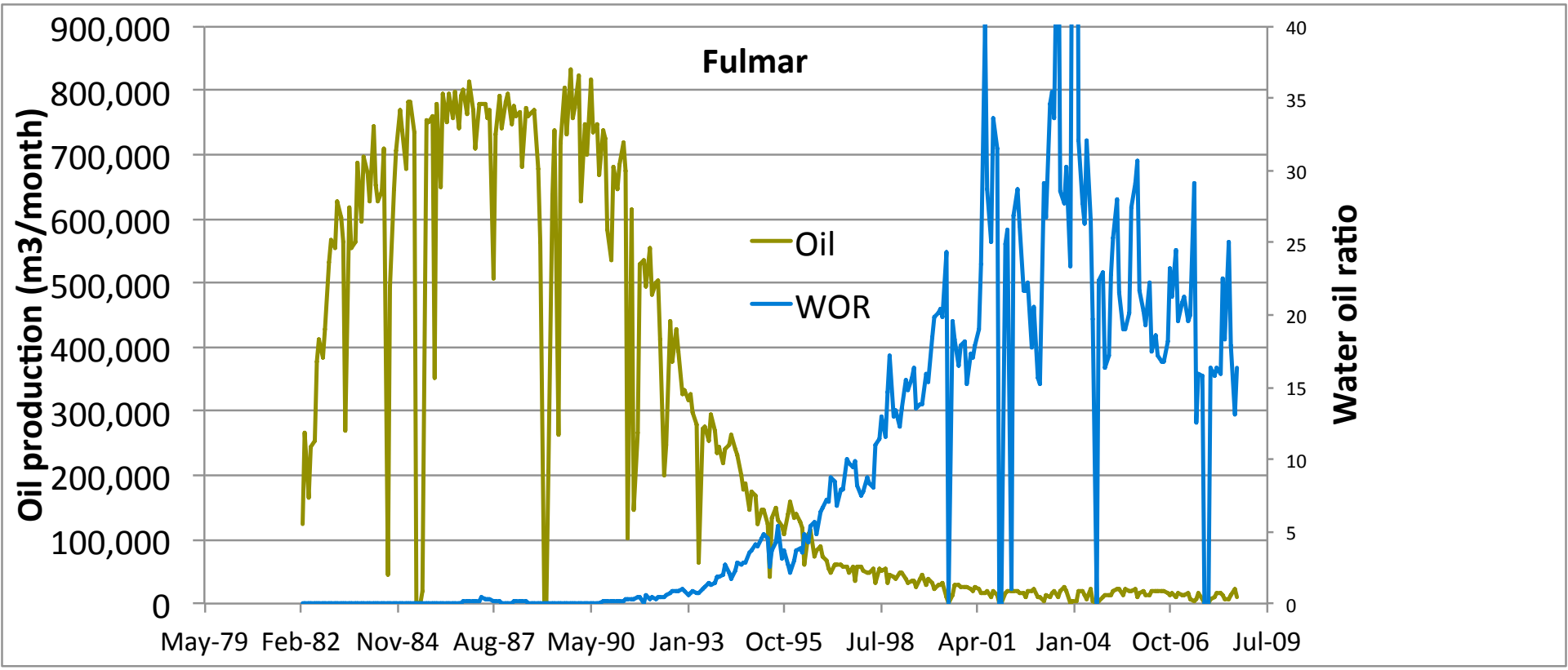
Co-produced Water



UK Forties Oil + Water Production



UK Fulmar Oil + Water Production



Southampton District Energy Scheme

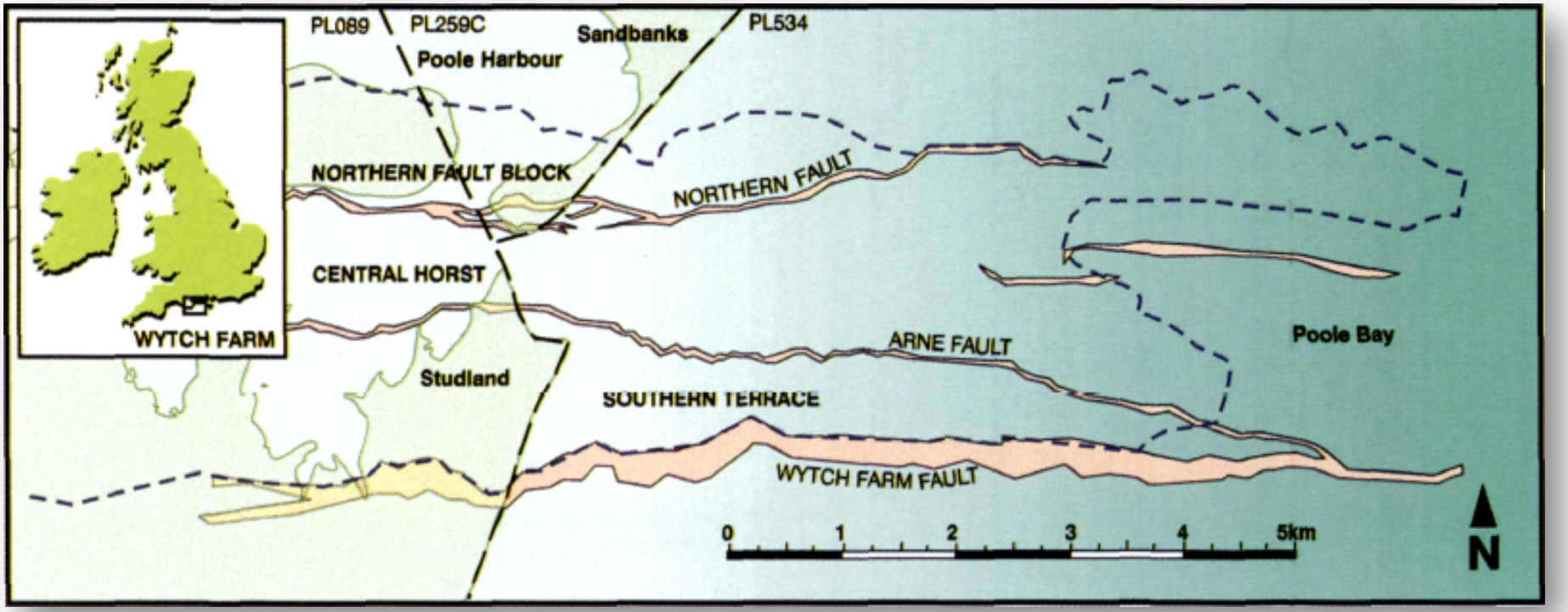
- Single borehole
  - Start-up 1986
  - Rate 15-20 $lsec^{-1}$ (≡ 39,500-52,600 m^3month^{-1} or 8,200-11,000 bwpd)
  - Power ~ 1.7MW

Triassic Sherwood Sandstone - Outcrop

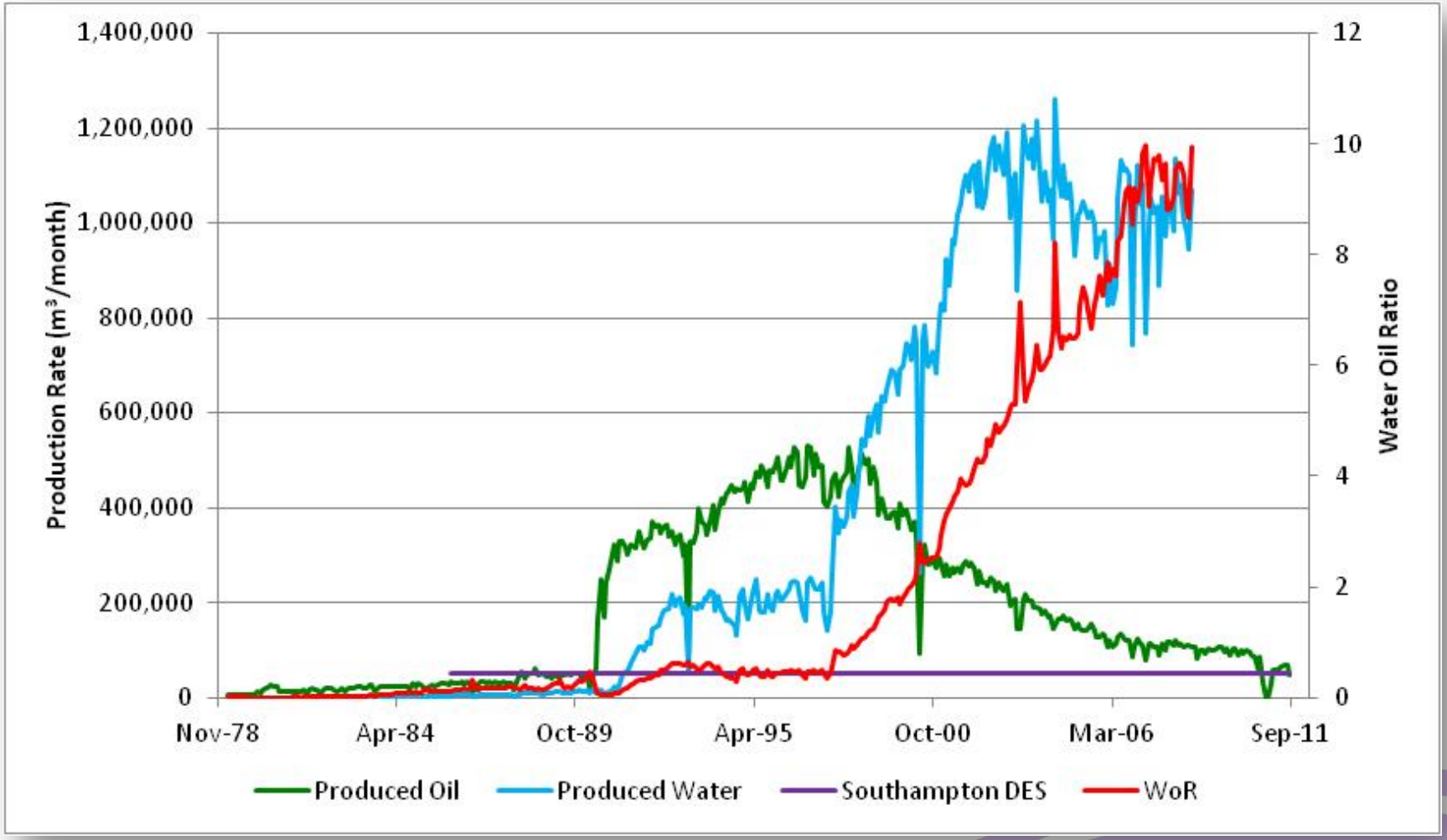
- High net to gross reservoir
- High porosity
- High permeability
- High kv/kh

Sherwood Sandstone Ladram Bay, Devon, October 2011

Triassic Sherwood Sandstone – Wytch Farm Field

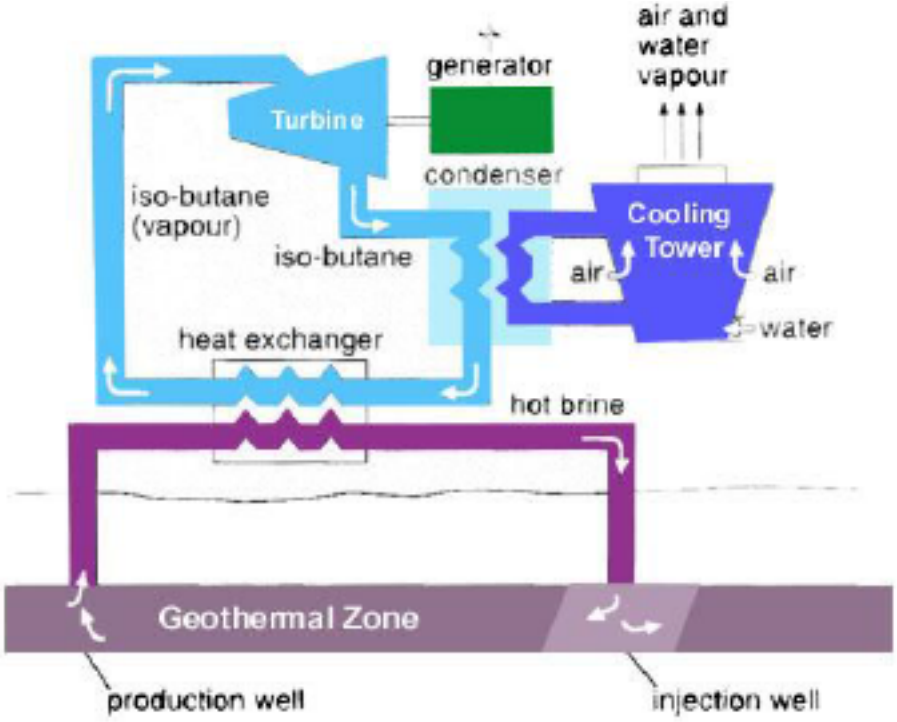


Production Performance
Wytch Farm & Southampton DES



Power Production

- The Organic Rankine Cycle (Binary power plant)
- Typically 1-20 MW
- Size ‘sea container’ & 150+ tonnes

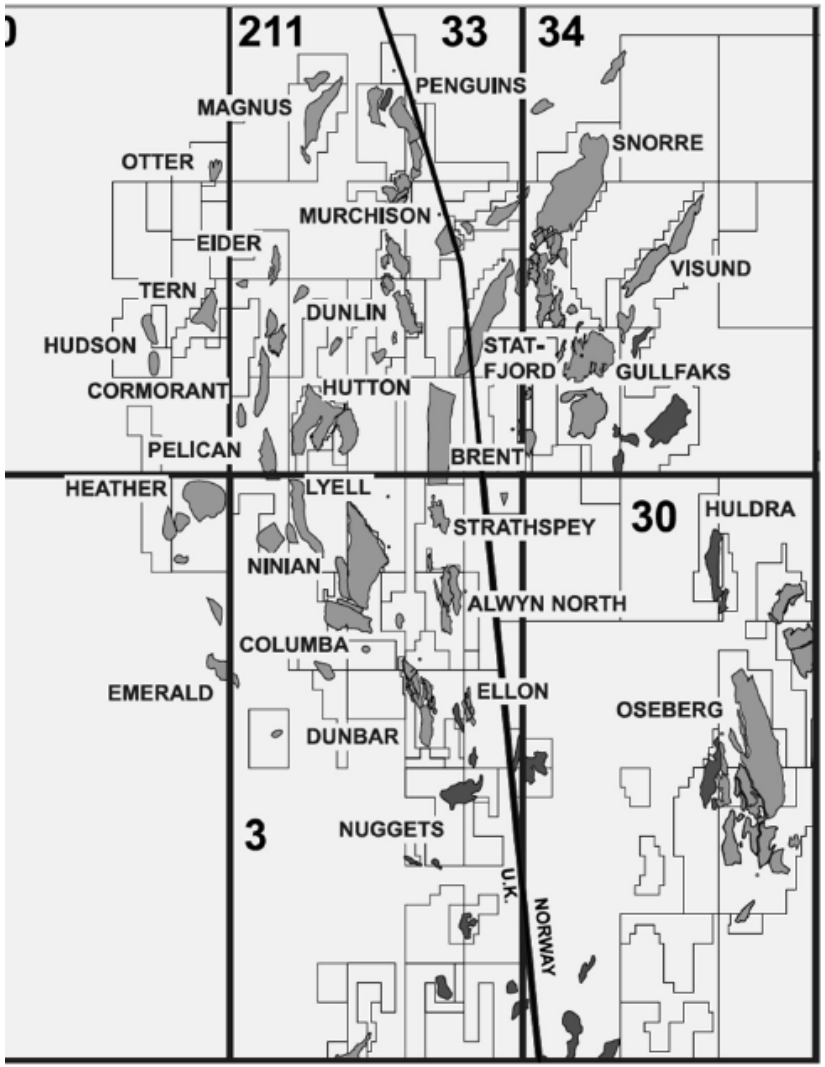


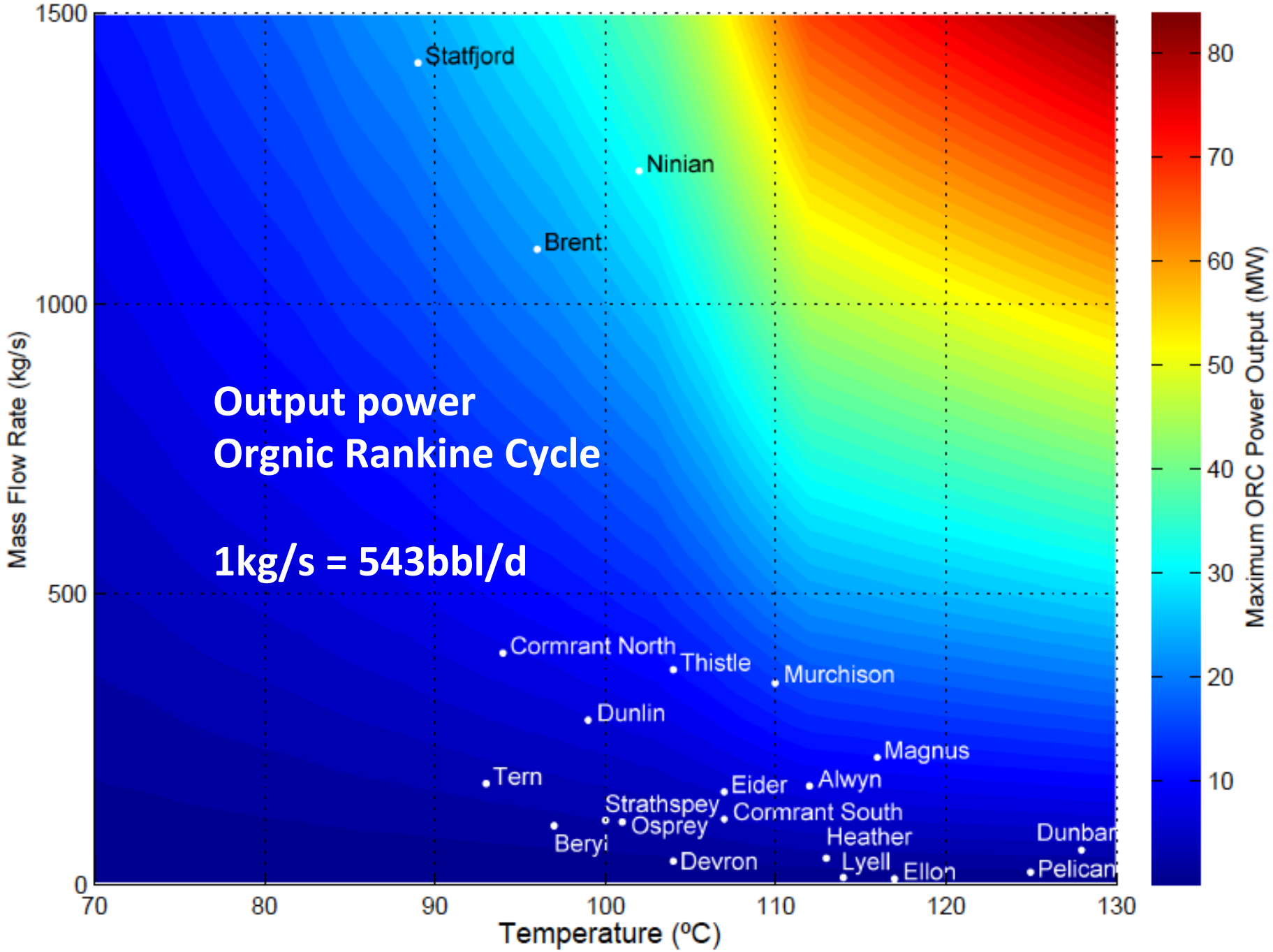
Pratt & Whitney PreCycle 250kW

The North Viking Graben, UKCS

Late Life Production Chokes

- Water handling
- Water/oil separation & discharge
- Scaling
- Injectivity
- Aging infrastructure
- Power generation & hence water injection/pressure maintenance




Output power
Orgnic Rankine Cycle
1kg/s = 543bbl/d
Statfjord
Ninian
Brent
Cormrant North
Thistle
Murchison
Dunlin
Magnus
Tern
Eider
Alwyn
Strathspey
Osprey
Cormrant South
Heather
Dunbar
Beryl
Devron
Lyell
Ellon
Pelican
Mass Flow Rate (kg/s)
Temperature (ºC)
Maximum ORC Power Output (MW)
0
500
1000
1500
70
80
90
100
110
120
130
10
20
30
40
50
60
70
80

Name	Mass Flow Rate (kg/s)	Temperature (°C)	Max. Power Output (MW)
Ellon	9.29	117	0.45
Lyell	11.25	114	0.52
Pelican	20.51	125	1.09
Devron	39.54	104	1.09
Heather	44.88	113	2.05
Dunbar	58.43	128	3.2
Beryl	100.88	97	2.1
Osprey	107.15	101	2.66
Strathspey	110.29	100	2.59
Cormorant South	111.94	107	3.67
Eider	159.22	107	5.22
Alwyn North (East)	168.71	112	7.58
Tern	173.17	93	3.15
Magnus	218.65	116	10.36
Dunlin	282.72	99	6.39
Murchison	346.46	110	14.1
Thistle	369.93	104	10.19
Cormorant North	398.72	94	7.57
Brent	1096.62	96	22.28
Ninian	1231.1	102	31.01
Statfjord	1417.43	89	22.56

Power Generation (from co-produced water)

UK Oil + Water Production

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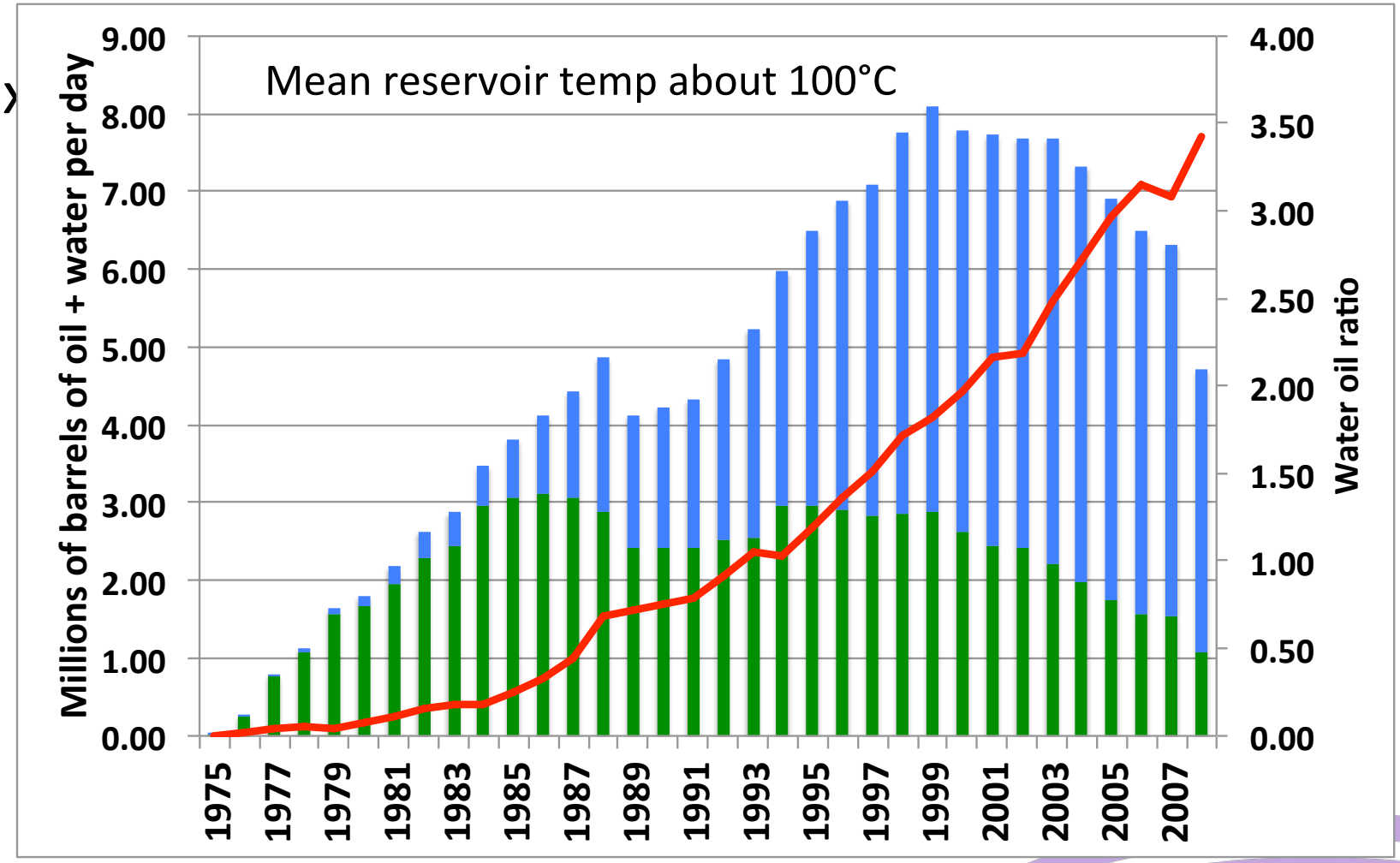
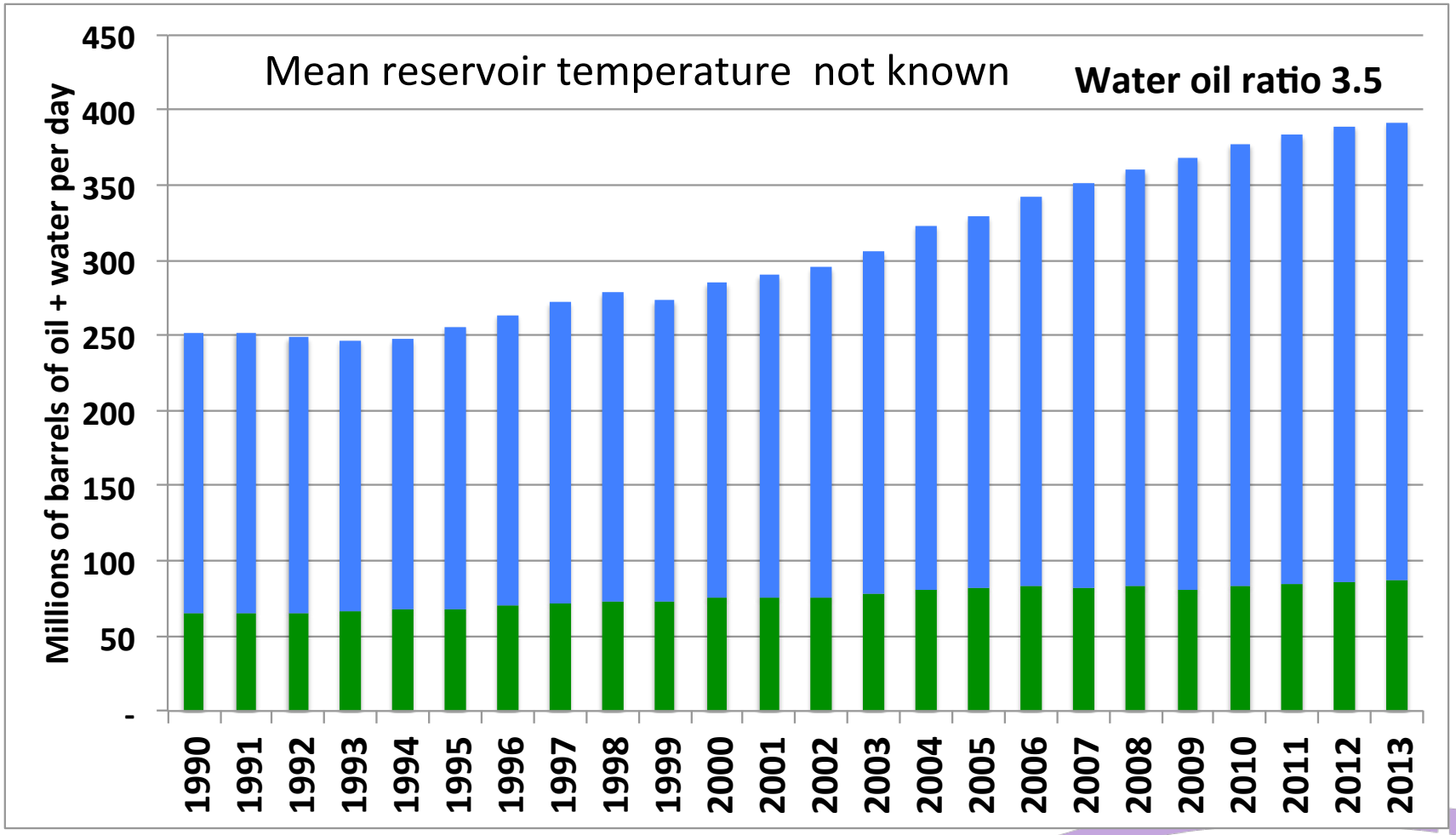


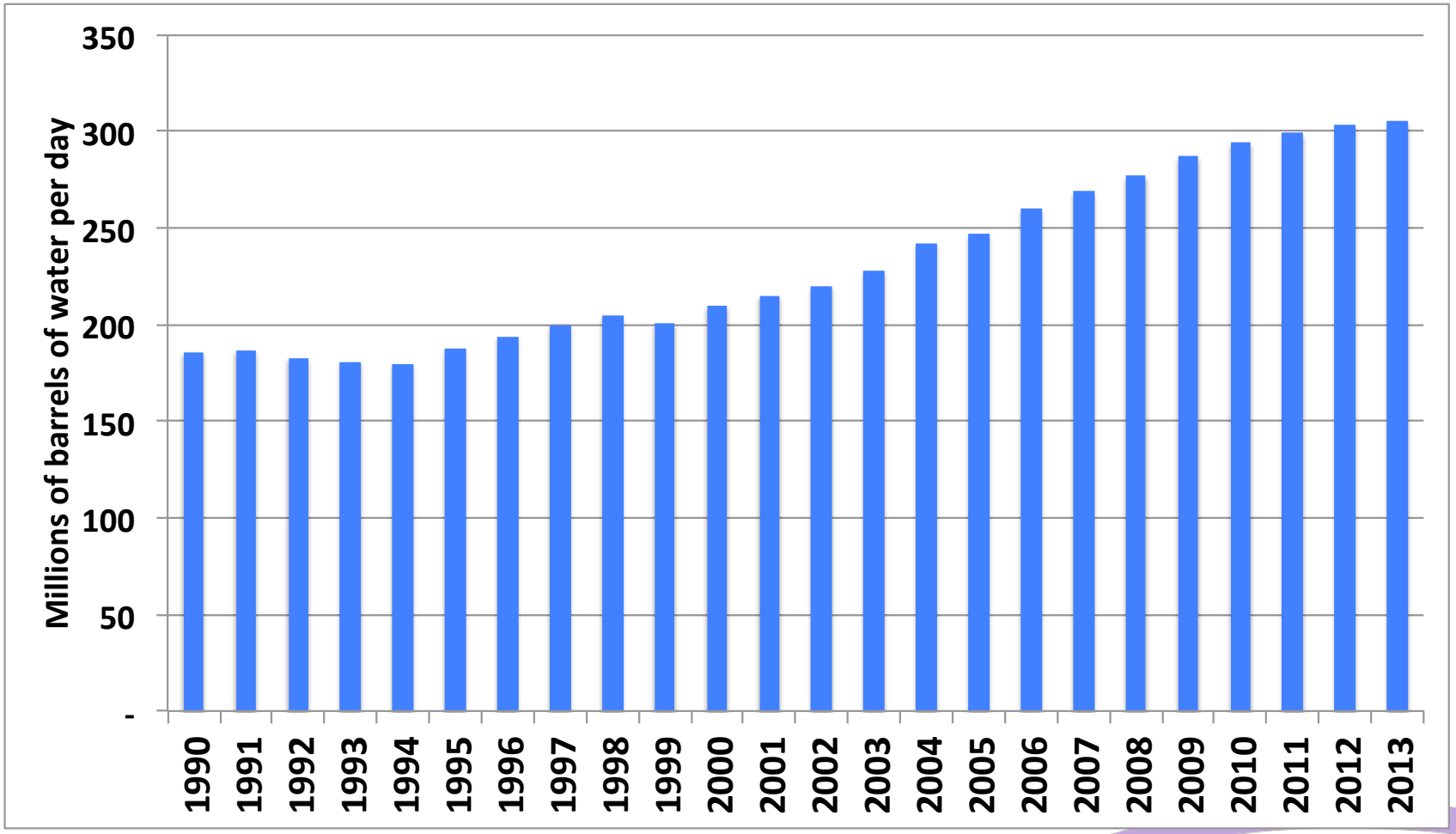
5 million bbl/d @ av 100°C = 250 MW

Global Oil + Water Production

- 

300 million bbl/d @ av ?°C = 15,000 MW

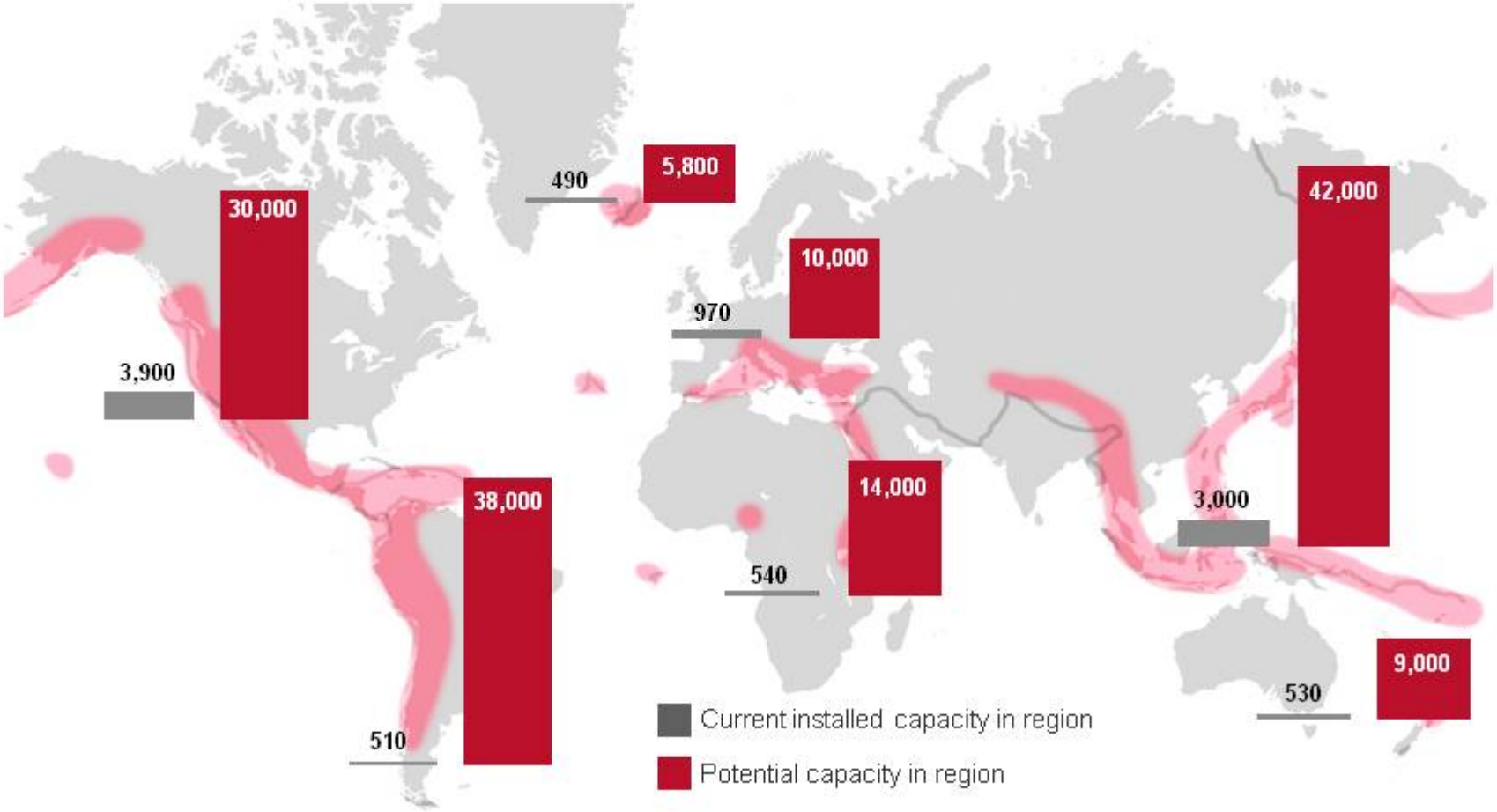
Global Water Production



About 70% of water production is onshore

World geothermal energy potential

Production about 12.000 MW & Potential 150.000 MW



Source:

Glitnir Research, 2008 US Market Report

Conclusions – Global Power Production

- Dedicated geothermal plants produce about 12,000 MW
- TODAY the oil industry could generate >15,000 MW at a water oil ratio of about 3.
- The most mature of oil fields produce >>10x more water than oil and this would rise if the co-produced water had value rather than being a cost.

- The oil industry could be a globally significant geothermal power producer & the waste heat recovery potential is substantially higher