Energy Return on Investment for Norwegian Oil and Gas in 1991-2008

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What is EROI?

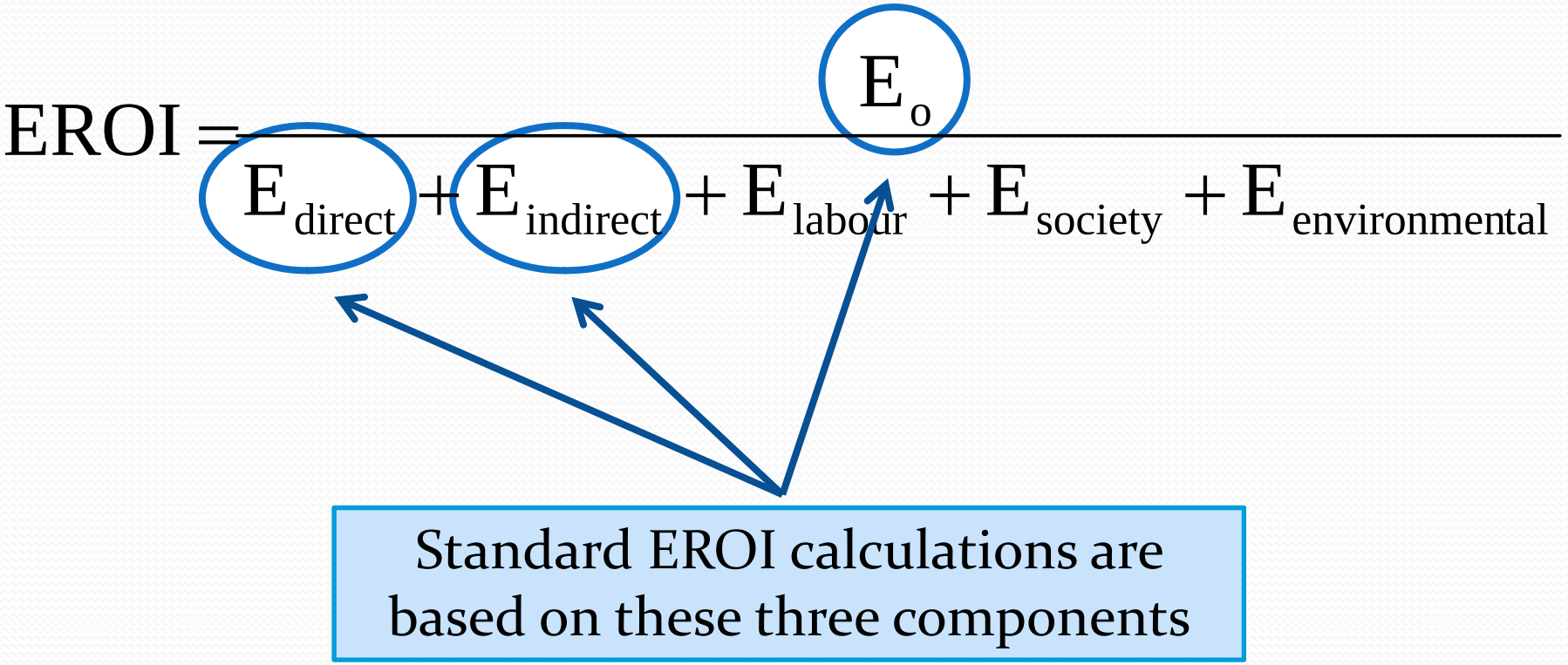
EROI = Energy Return on Energy Invested

$$\text{EROI} = \frac{\text{Energy returned to society}}{\text{Energy required to get that energy}}$$

$$\text{EROI} = \frac{E_o}{E_i}$$

- A rolling average for each year has been used

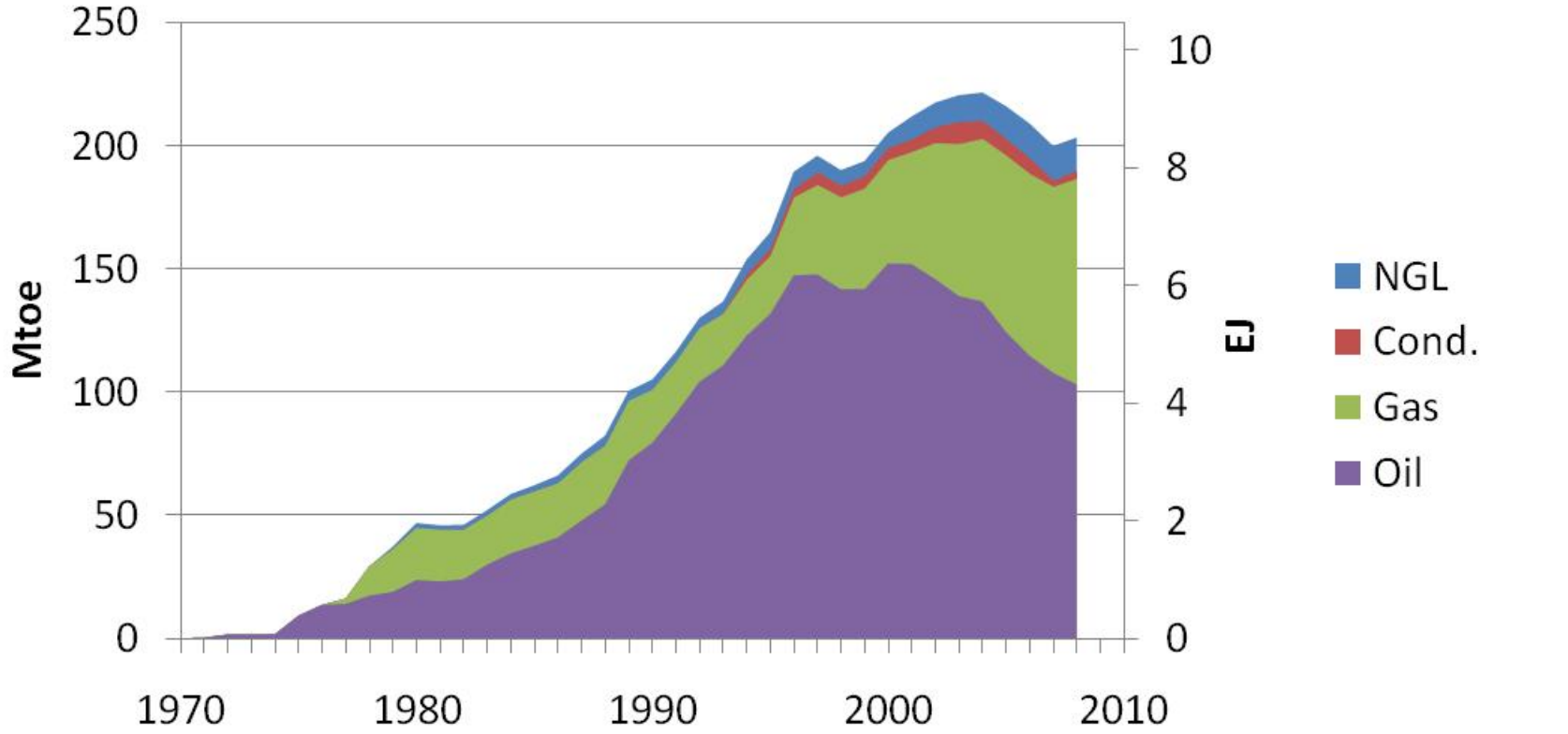
Boundaries of Calculation



Energy Output

- Energy output :
  - Oil, gas, NGL and condensate
- For aggregation we use the heating values of respective energy components
- Data source:
  - Norwegian Petroleum Directorate
- Border fields (Statfjord, Frigg and Murchison):
  - Only the Norwegian share of production is computed

Energy Output



In 2008:

- Norwegian share of European crude oil production ~50 %
- …and of natural gas production ~33 %

Energy Input:
Direct Energy Component

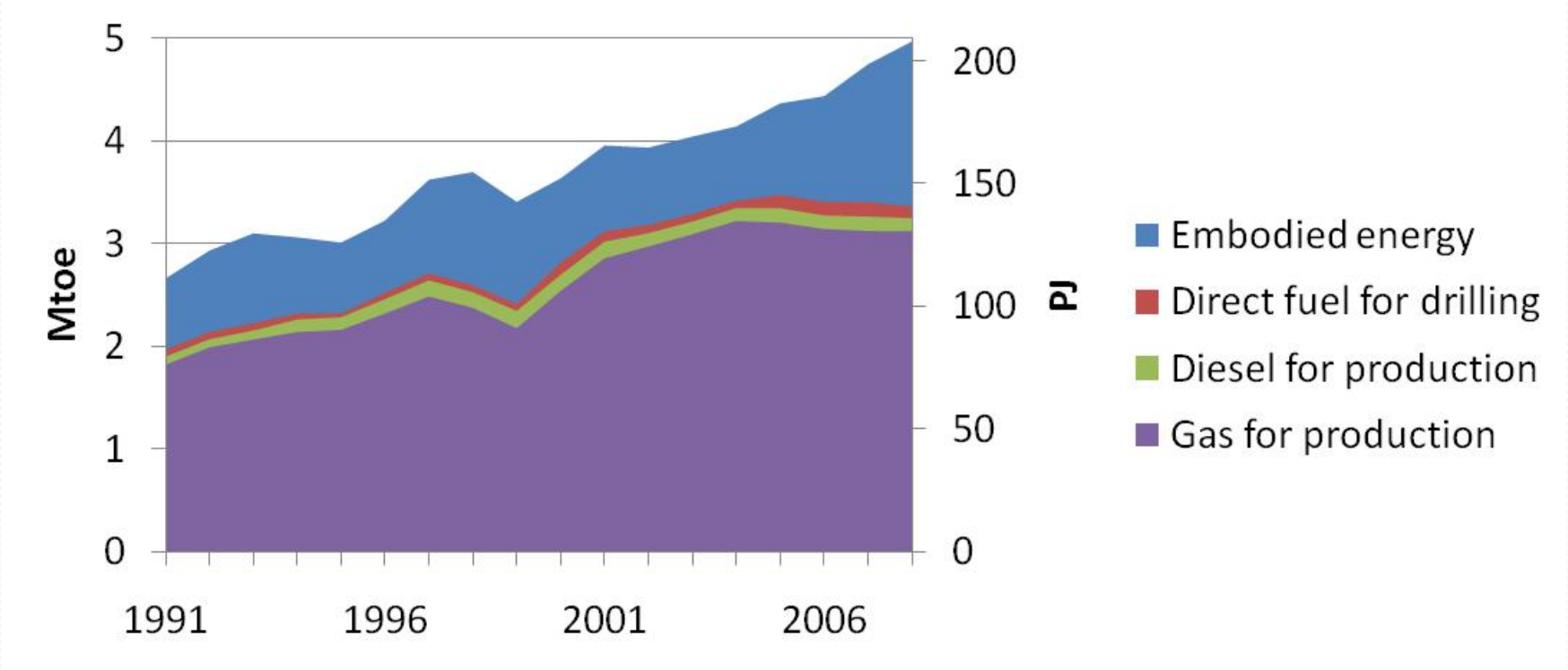
- Fuel (diesel + gas) for petroleum production
  - data provided by NPD
  - data covers only the petroleum production phase
- Fuel used to drill wells
  - exploratory drilling and production drilling
  - Statistics Norway, investment data
  - "*Monetary expenditure for fuel„* / "*average fuel price*"

  → estimate for fuel consumption

Energy Input
Indirect Energy Component

- Energy consumption of materials, services etc. related to petroleum production
- "*Investments in the petroleum sector*" × "*energy intensity*" → indirect energy cost
- Investment data by Statistics Norway
- Energy intensity of the Norwegian economy averages 4.01 MJ/US$

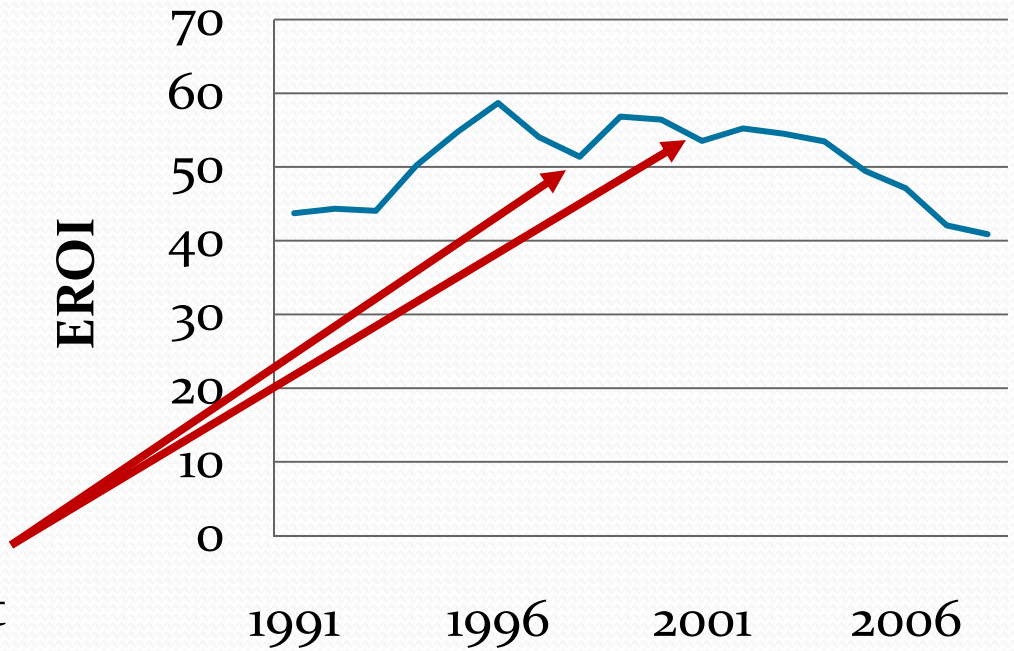
Energetic Cost of Petroleum Industry



- 74% of energy cost diesel & gas for petroleum production
- 2% direct fuels for drilling
- 24% indirect energy

Results and Discussion

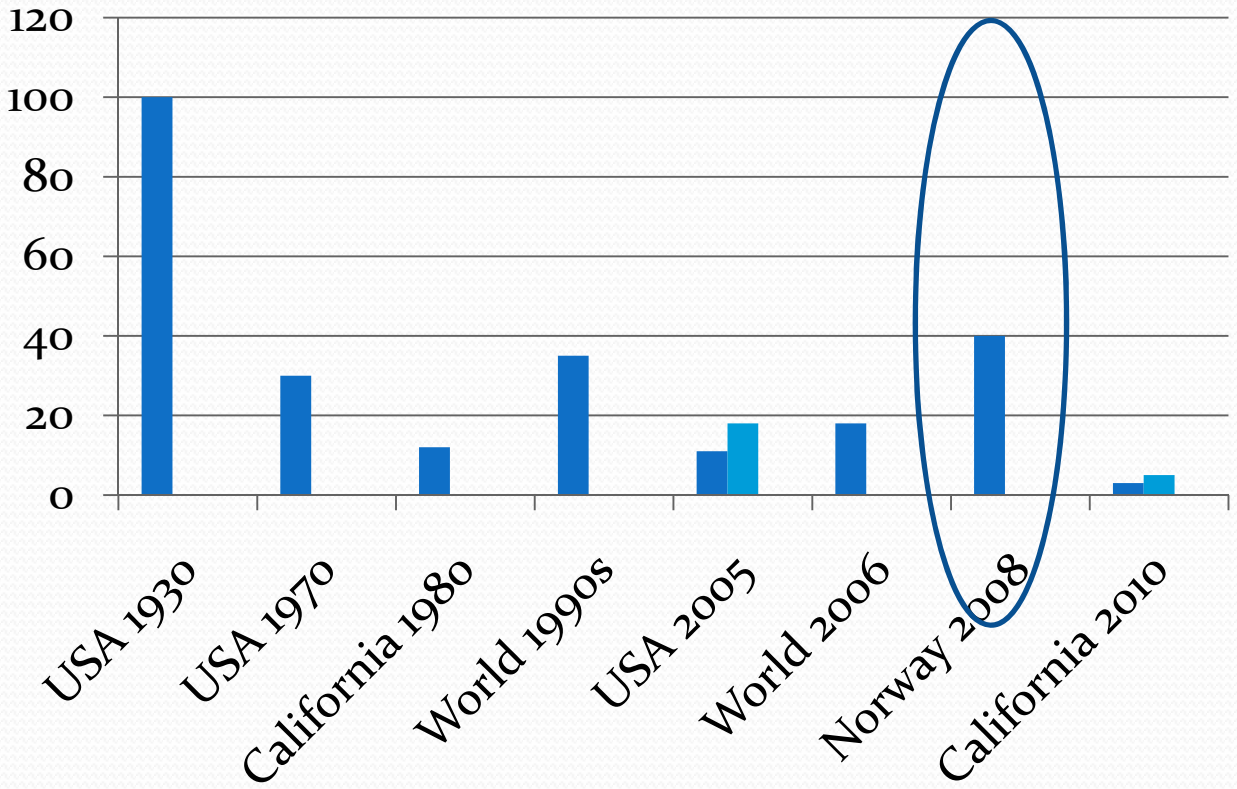
- In 1996 59:1
- In 2008 40:1
- Depletion leads to growing water production and sinking reservoir pressure
- Effect of drilling activity:
- 7-17% of total energy cost caused by drilling



Between 1999 and 2001 there was an almost a 30% increase in drilling activity.

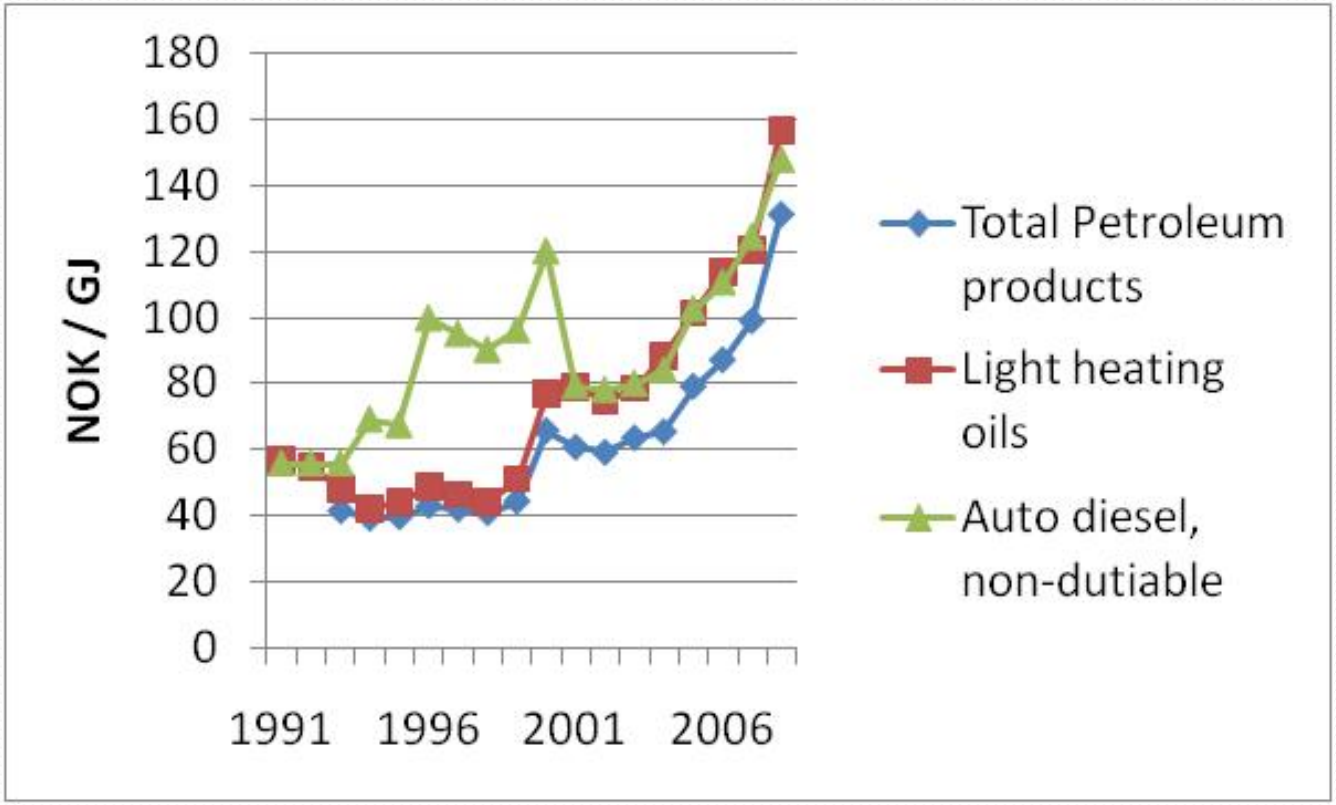
Since 2003 the drilling activity has been oscillating between 700-800 km annually whereas EROI has declined steadily by 25% from 2003 to 2008.

International Comparison



However, still a very favorable EROI in international comparison

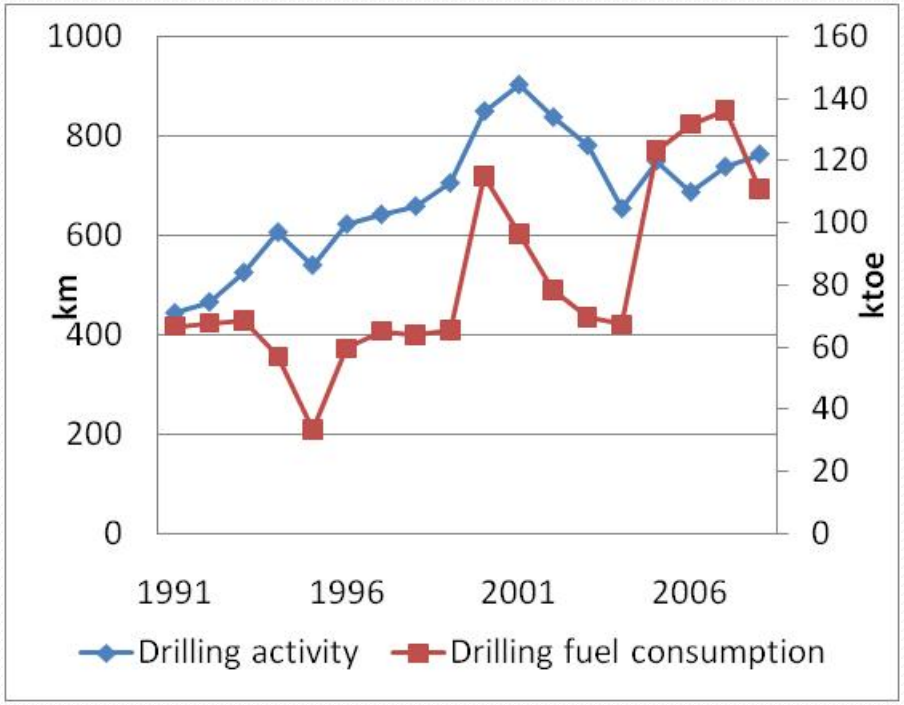
Average fuel prices paid by Norwegian industry



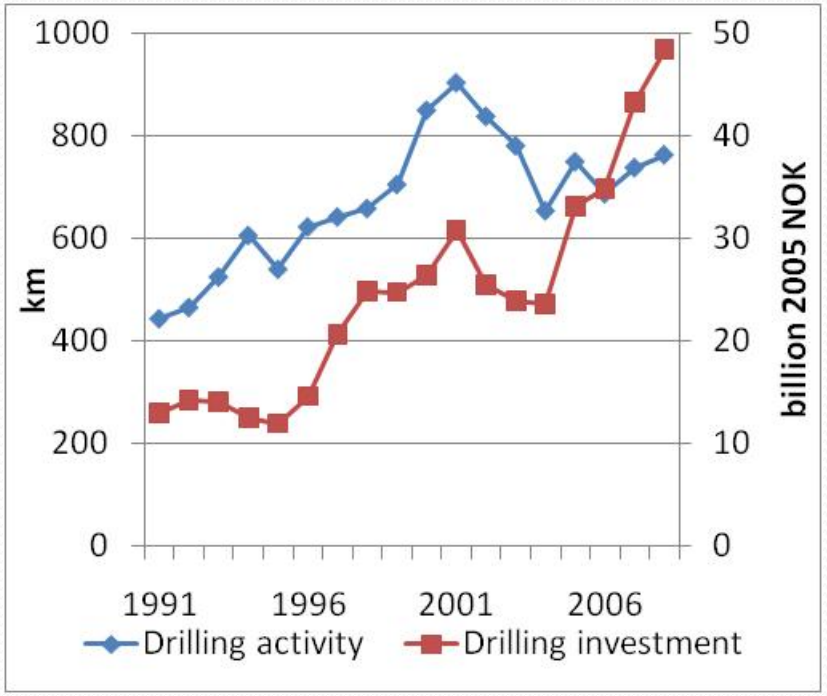
For the purpose of the analysis we chose the price for light heating oils.

Data source: Statistics Norway

Correlations

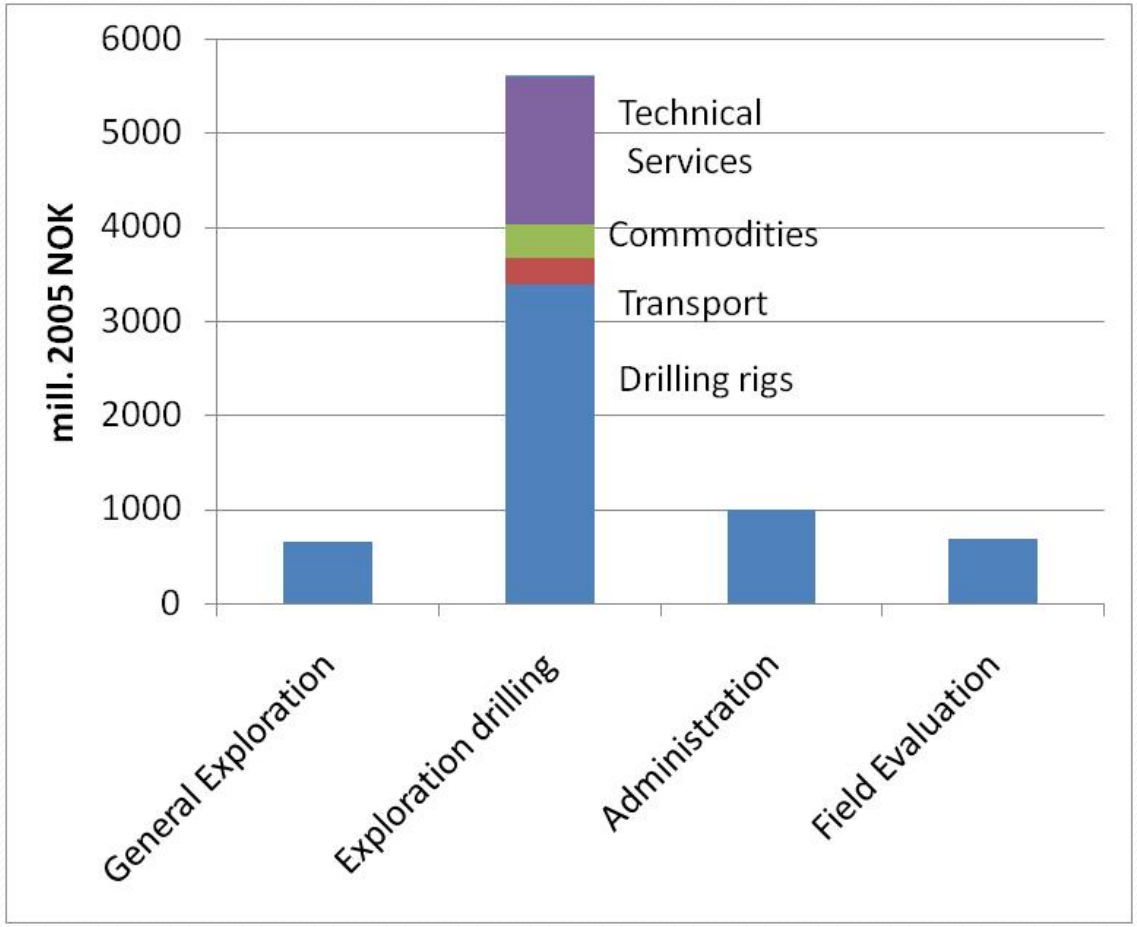


r2 = 0.55



r2 = 0.66

Example of investment data

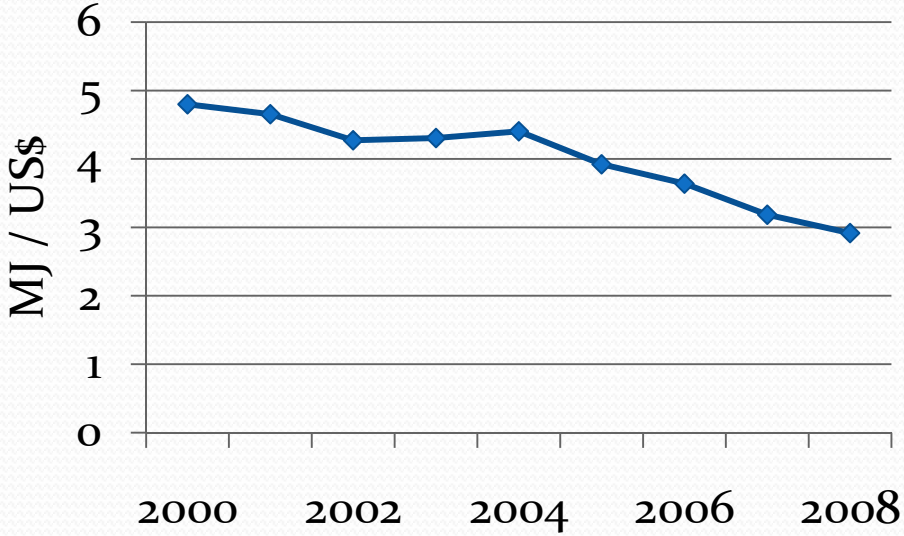


Exploration investments for the year 2000

Investment for fuels is found under subcategory „Commodities“

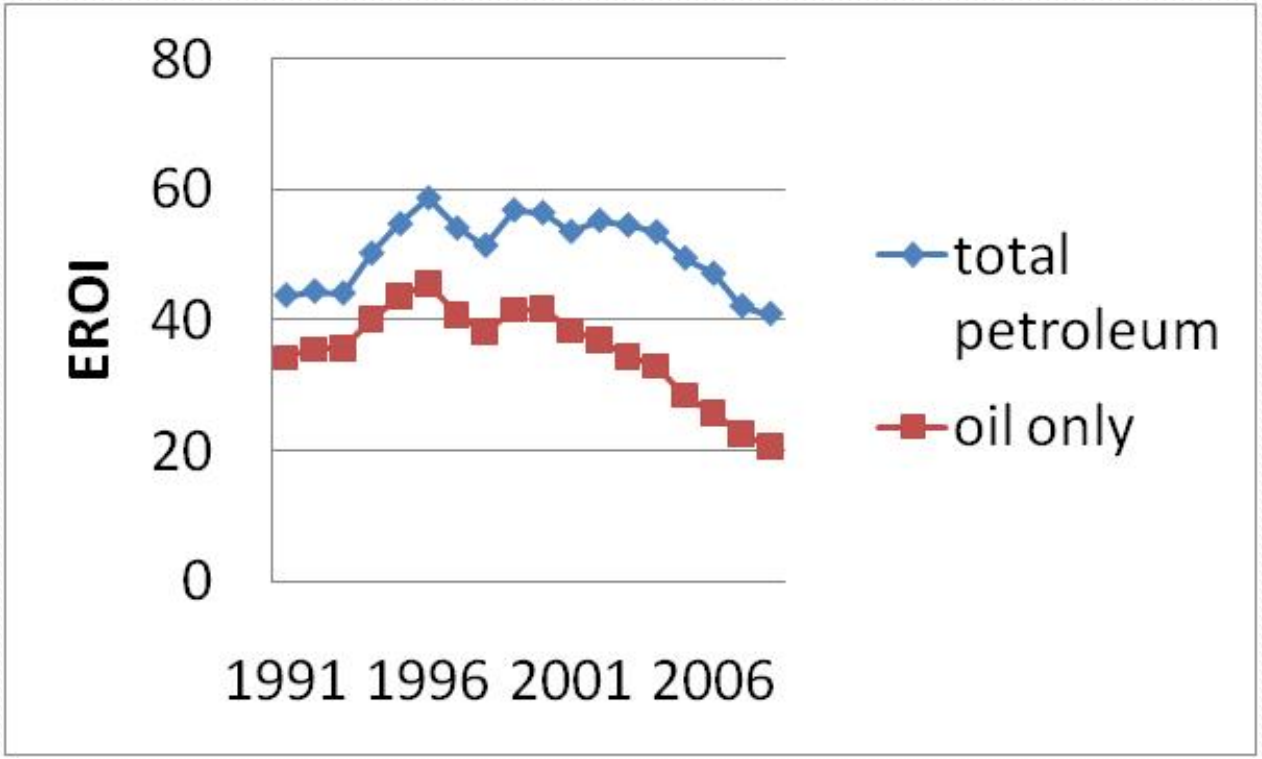
Energy Intensity

- Norwegian GDP
- inflation adjusted to 2005
- compared to the primary energy consumption of the Norwegian economy



Energy intensity of the Norwegian economy averages 4.01 MJ/US$

Results: EROI for Oil Only



EROI values for oil alone varied from 46:1 in 1996 to around 20:1 in recent years.