Energy research Centre of the Netherlands

Policy Studies

The Cost of Pipelining Climate Change Mitigation

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Our fields of interest

Hydrogen…
- **production**
- **distribution**
- **end-use in fuel cells**

Component learning

Progress ratio 80%

costs (c_0)

cumulative capacity
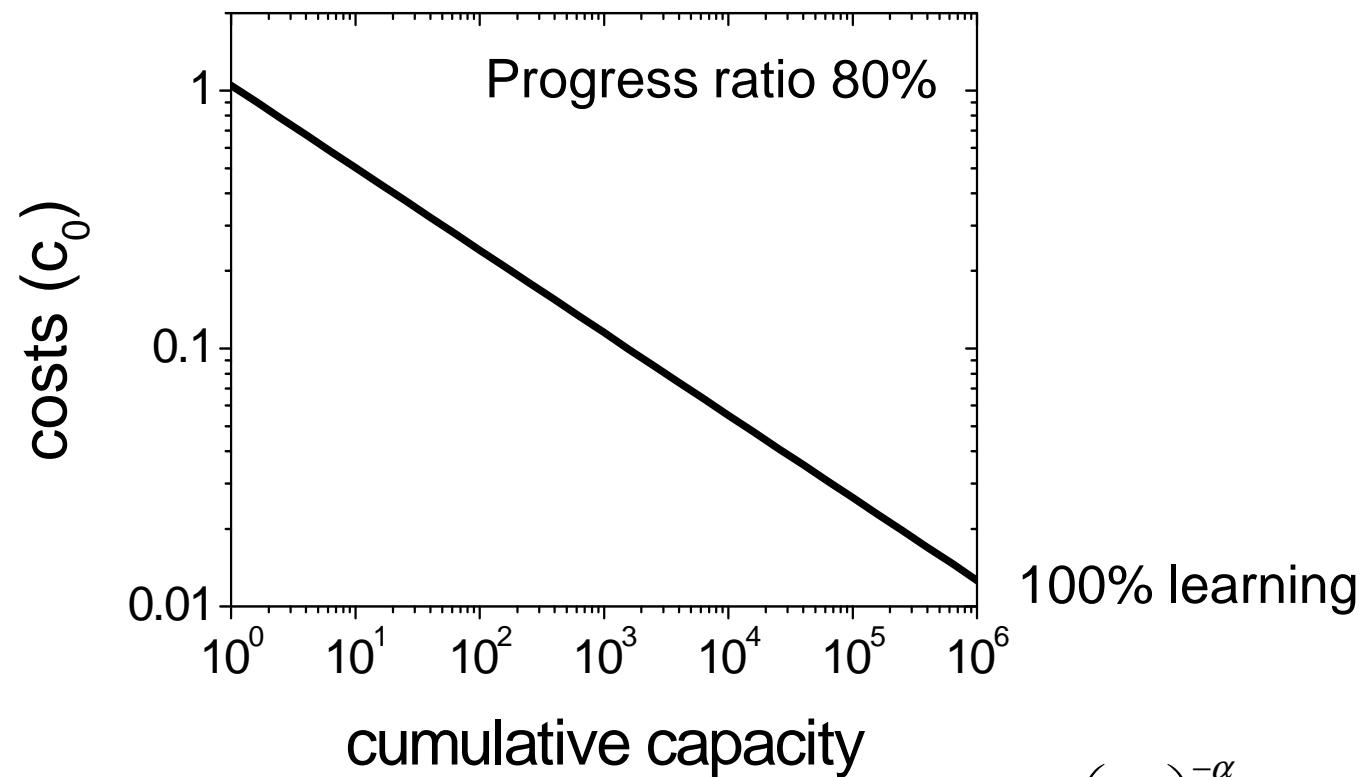
100% learning

$$c(P) = c_0 \left(\frac{P}{P_0} \right)^{-\alpha}$$

F. Ferioli, *et al.*, Energy Policy **37** (2009), 2525-2535.

Component learning

Progress ratio 80%

90% learning

10% raw materials

100% learning

costs (c_0)

cumulative capacity
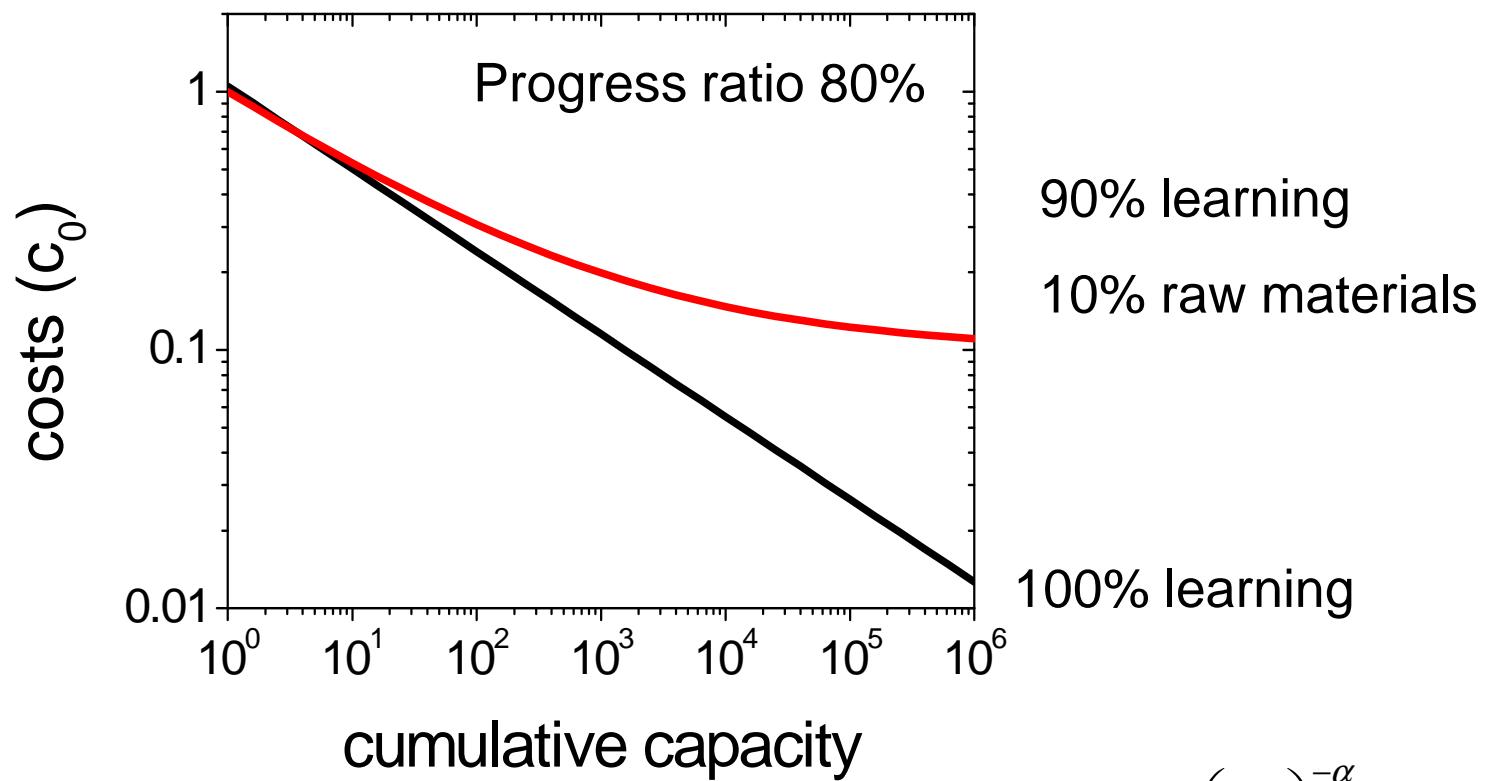
$$c(P) = (1-\varepsilon)c_0\left(\frac{P}{P_0}\right)^{-\alpha} + \varepsilon c_0$$

F. Ferioli, *et al.*, Energy Policy **37** (2009), 2525-2535.

The rock bottom

Progress ratio 80%

90% learning

10% raw materials

costs (c_0)

cumulative capacity
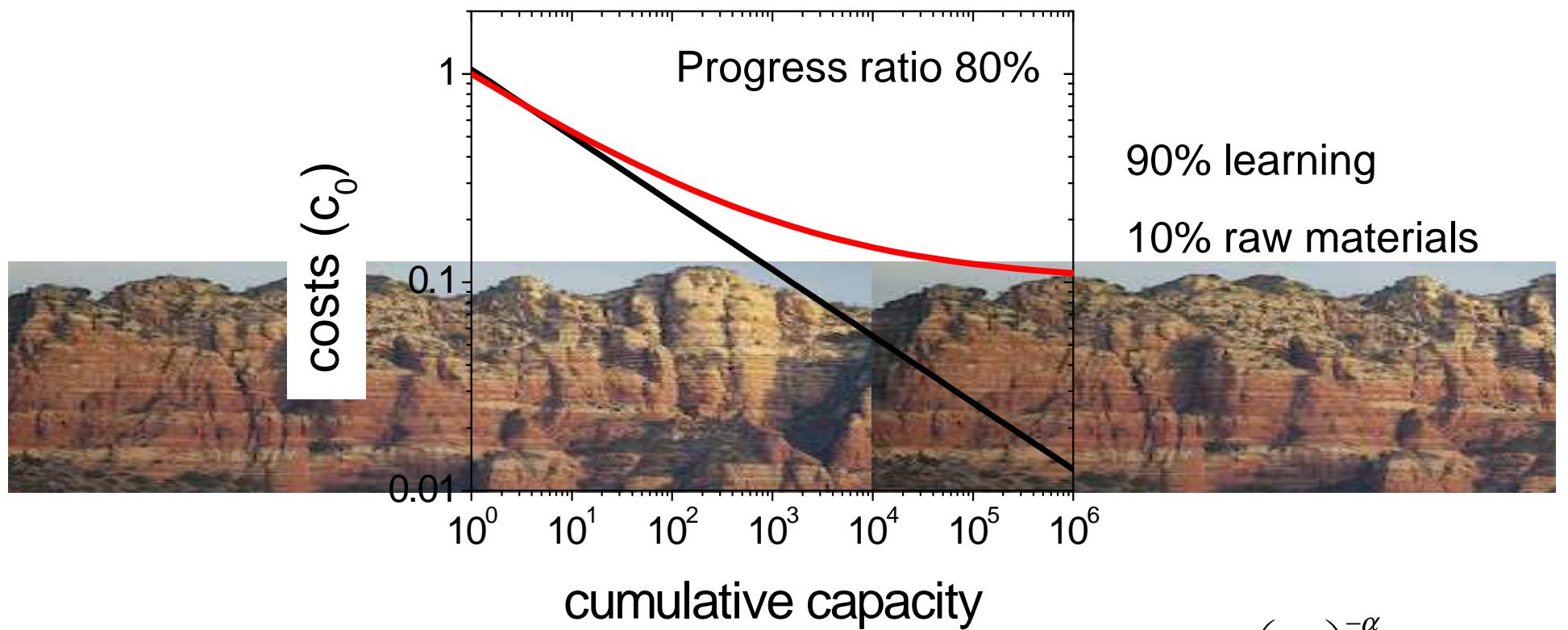
$$c(P) = (1-\varepsilon)c_0\left(\frac{P}{P_0}\right)^{-\alpha} + \varepsilon c_0$$

F. Ferioli, *et al.*, Energy Policy **37** (2009), 2525-2535.

# Pipeline cost components

- Materials

- Labor

- Right-of-way

- Miscellaneous
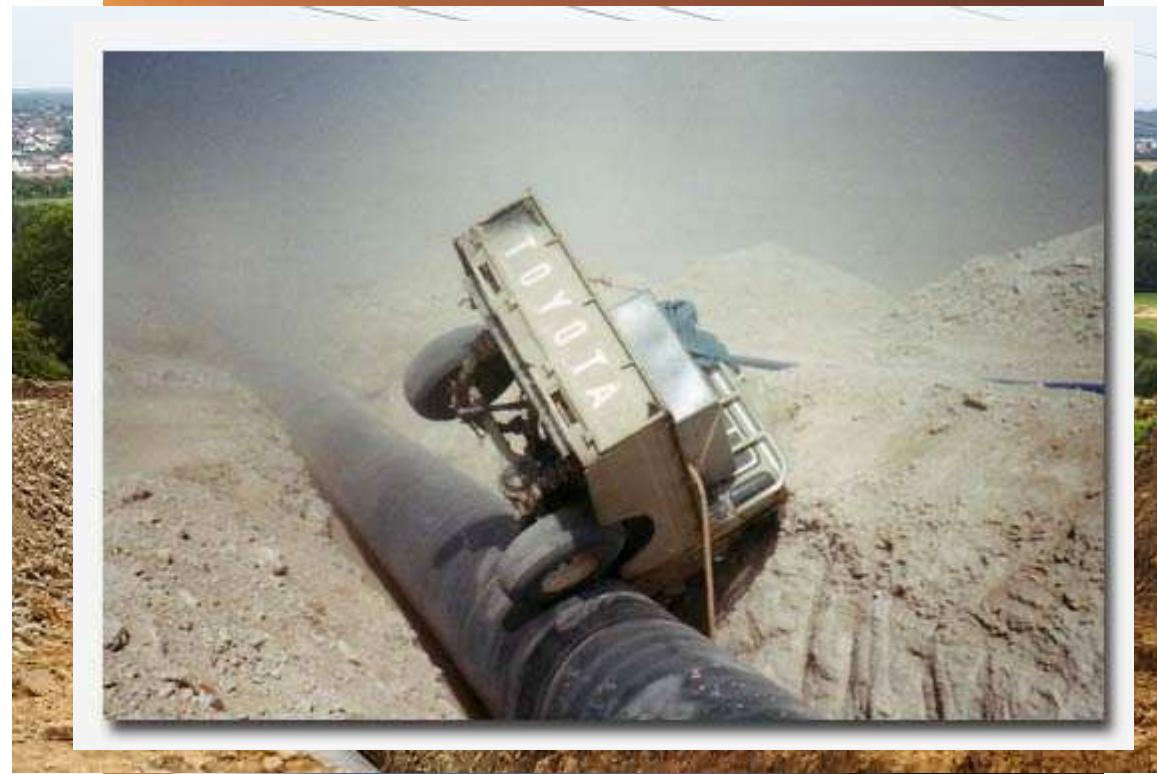
Cost evolution for CH$_4$ pipelines
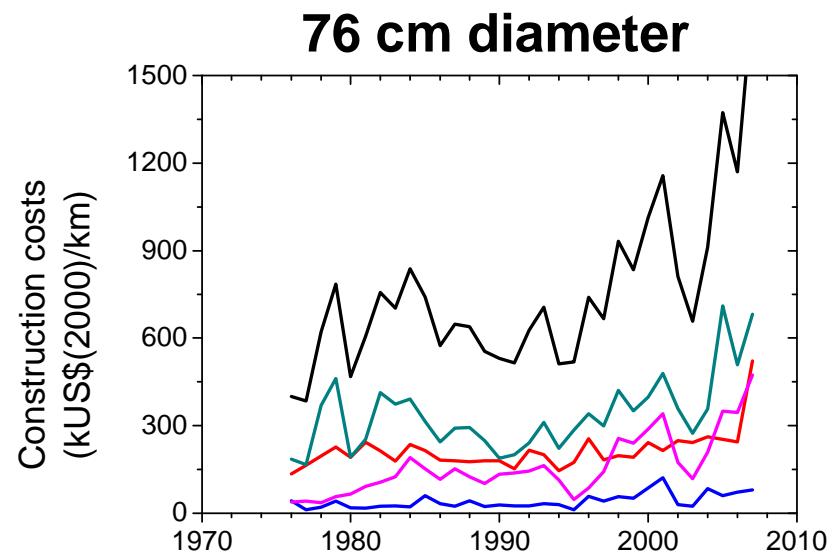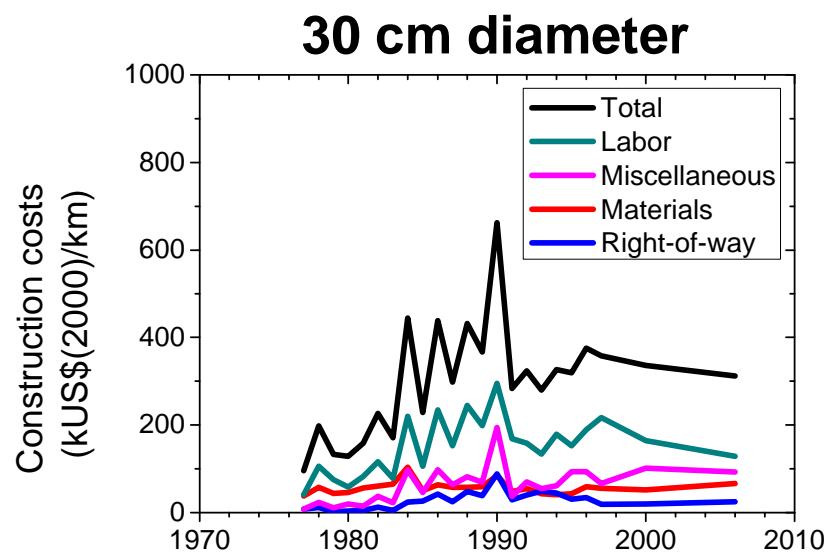
Terrain and regional effects

Terrain	Factor
High urbanization	+700 kUS$
Mountainous	x 1.5-1.3
Wooded/Cultivated land/Desert	x 1.1
Grass land	x 1.0

Country/region	Factor
Europe/UK	x 1.0-1.2
US/Canada	x 1.0
Middle East	x 0.9
Asia	x 0.8-0.7
Africa	x 0.9-0.7

Construction cost breakdown CH$_4$

Ø 91 cm

1193

Ø 51 cm

Ø 20 cm

367

Ø 76 cm

1035

Right-of-way

Labor

774

kUS$/km

Misc.

Ø 30 cm

715

Ø 61 cm

1032

Materials

Ø 40 cm

760
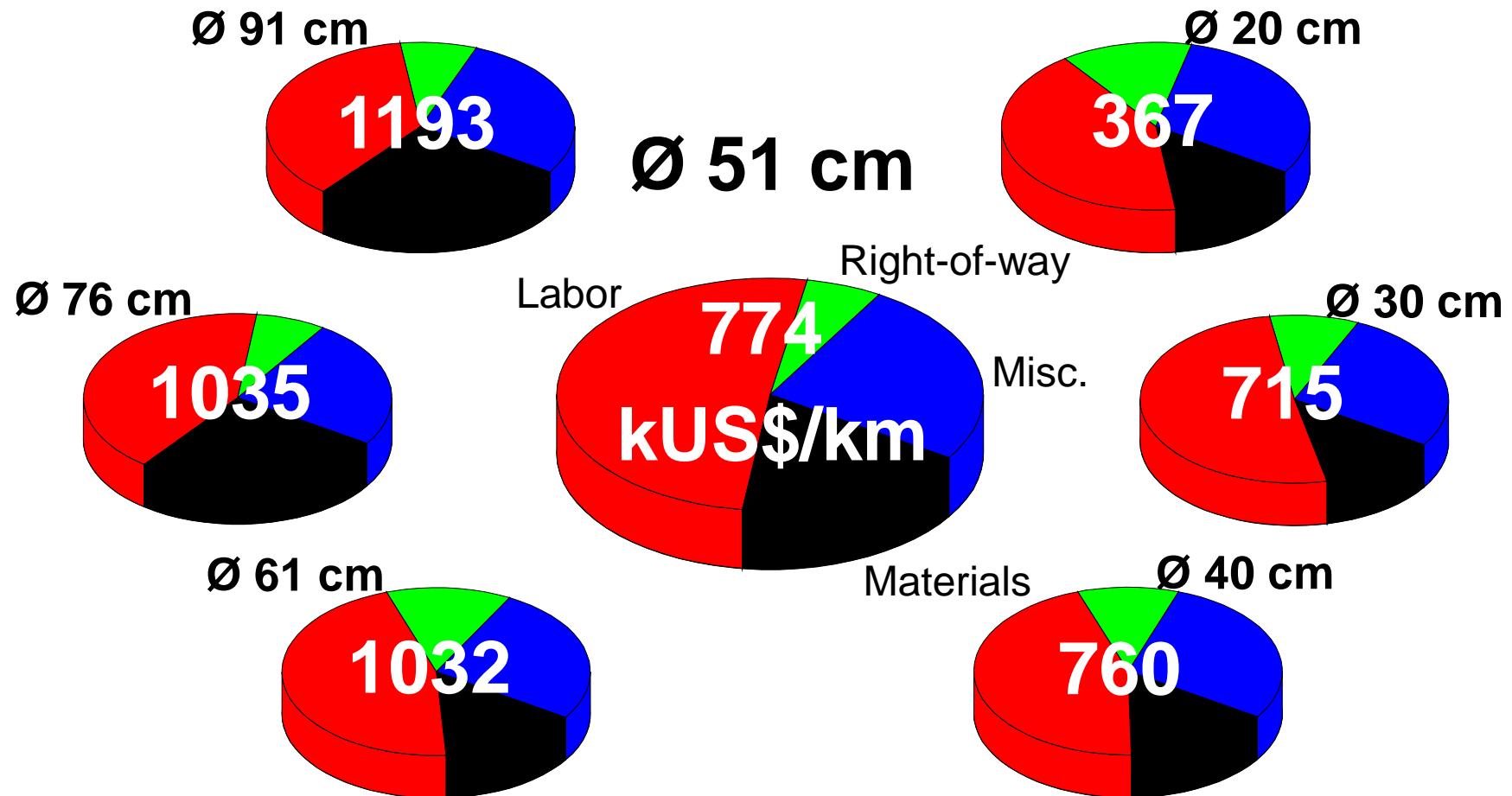
10 year average 1999 – 2009, costs in US$(2000)

Construction cost vs. diameter
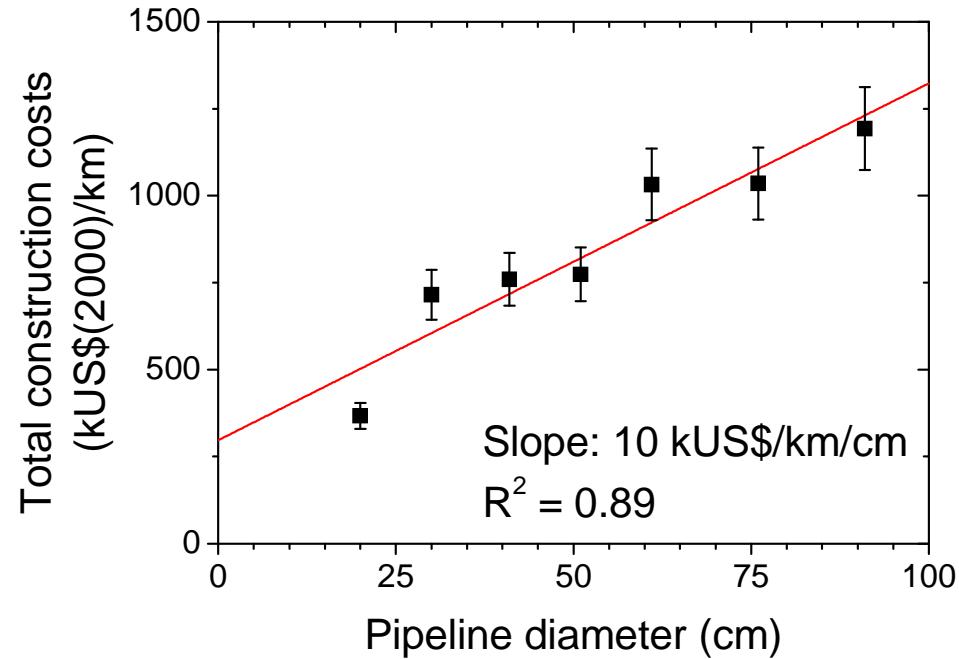
Component cost analysis
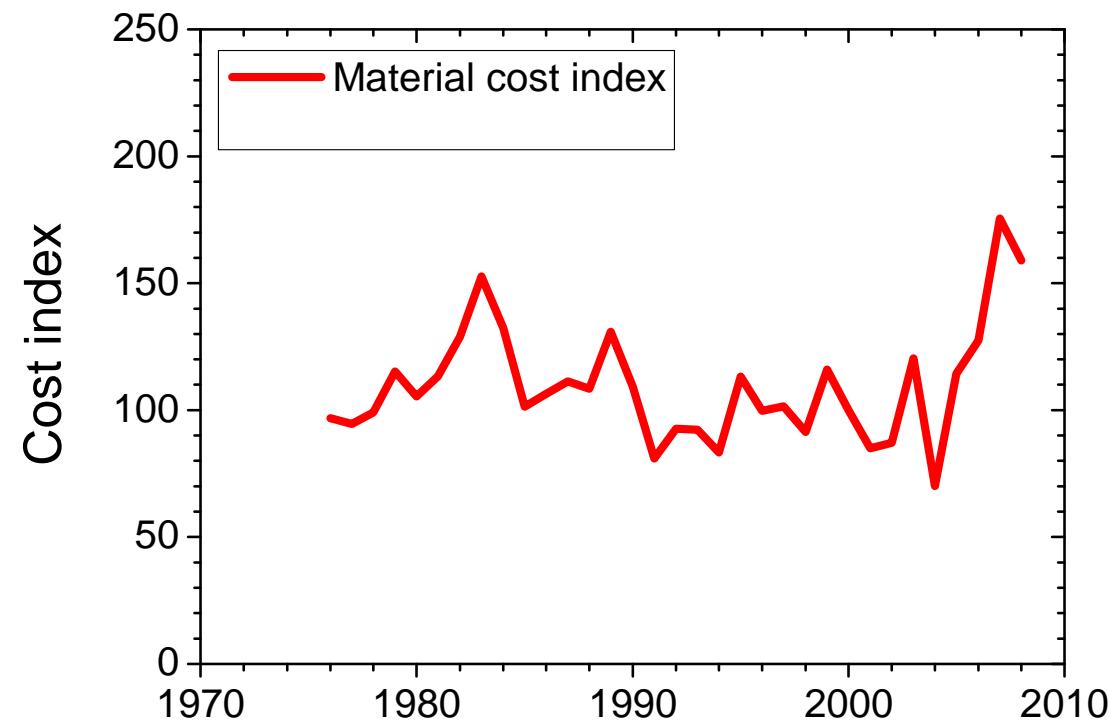
Material costs

Component cost analysis

Material costs
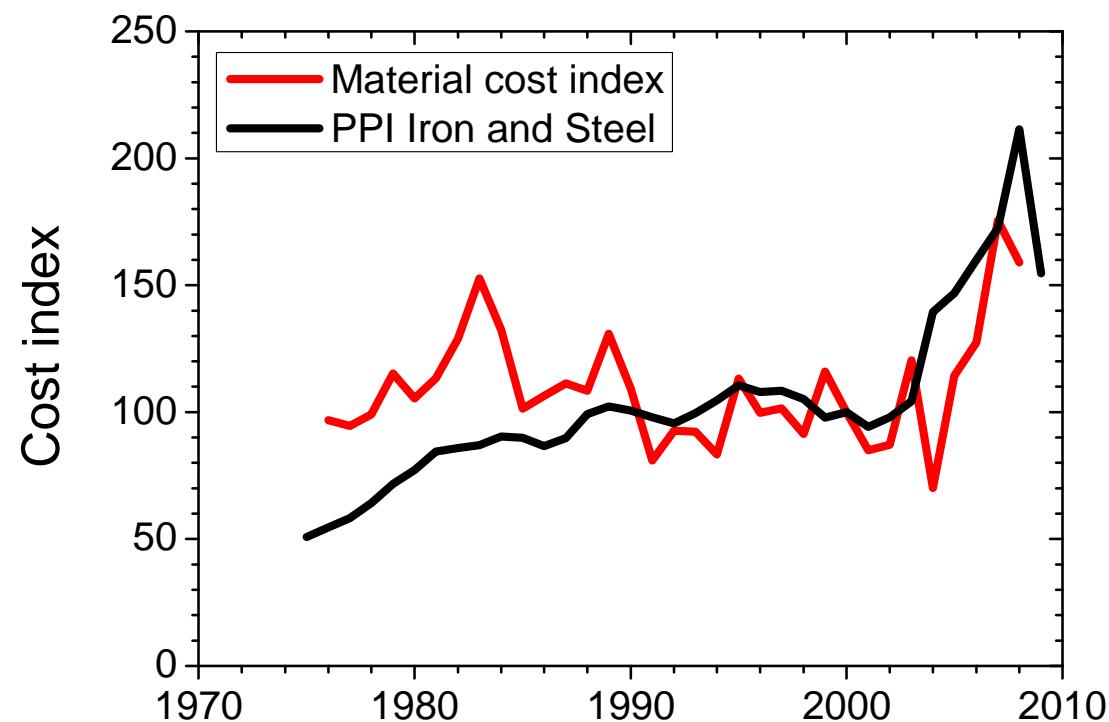
Component cost analysis

Labor costs
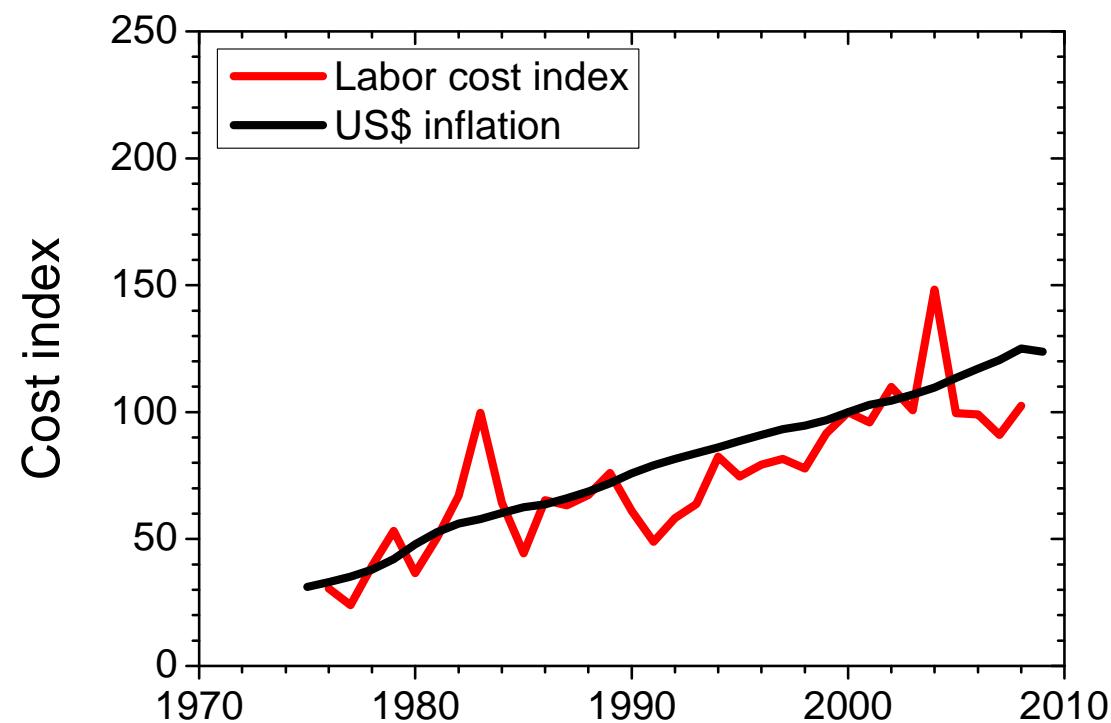
Component cost analysis

Right-of-way costs
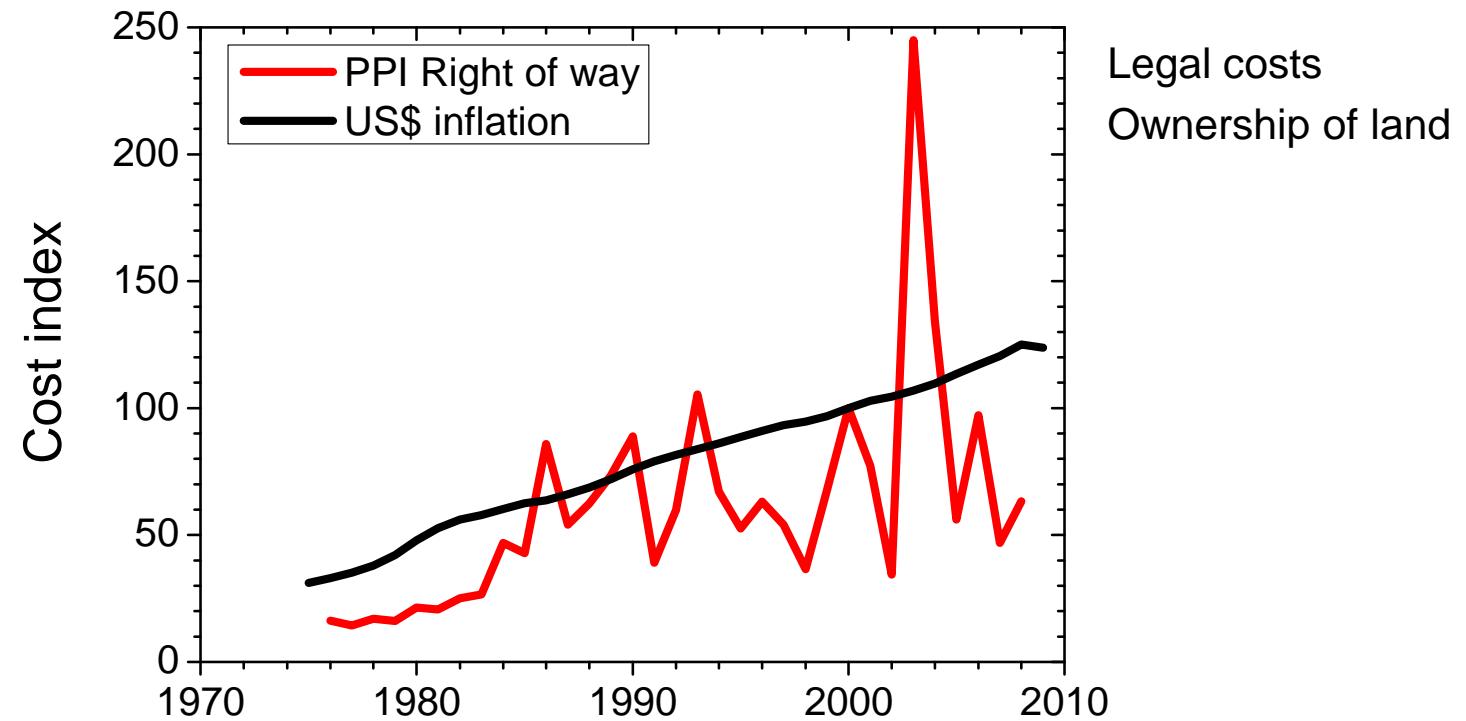
Component cost analysis

Miscellaneous costs

Surveys

Engineering

Supervision

Interest

Administration

Overheads

Contingencies

Allowances for funds
during construction

Regulatory fees
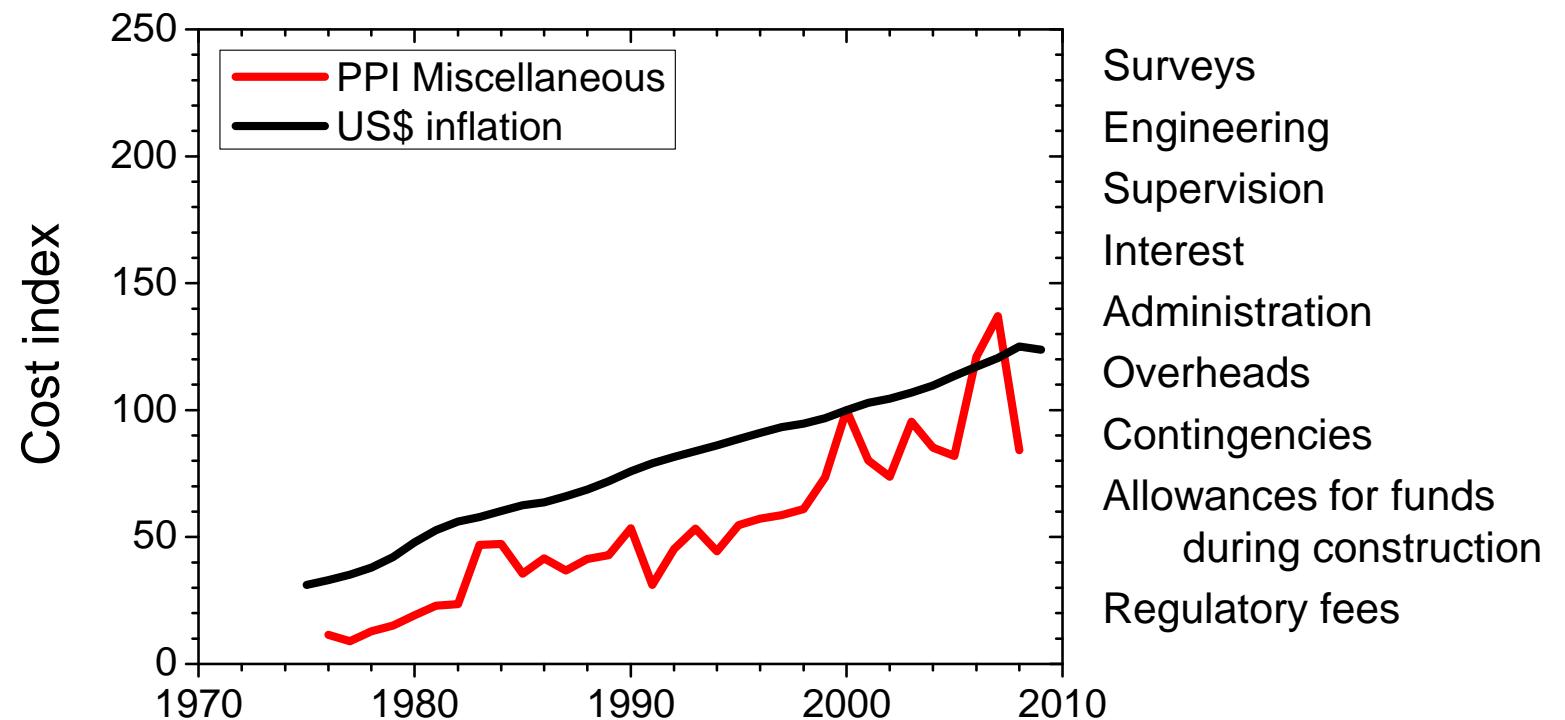
Onshore CH$_4$ pipeline length
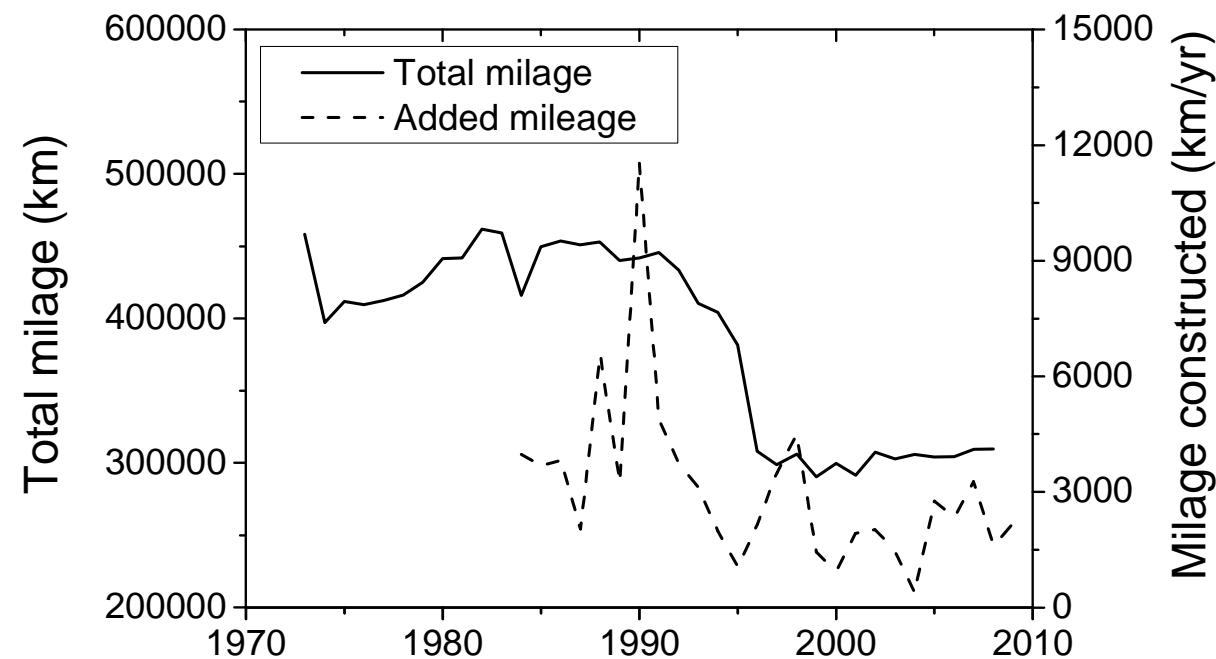
Cost evolution for CO_2 pipelines

30 cm diameter

Construction costs
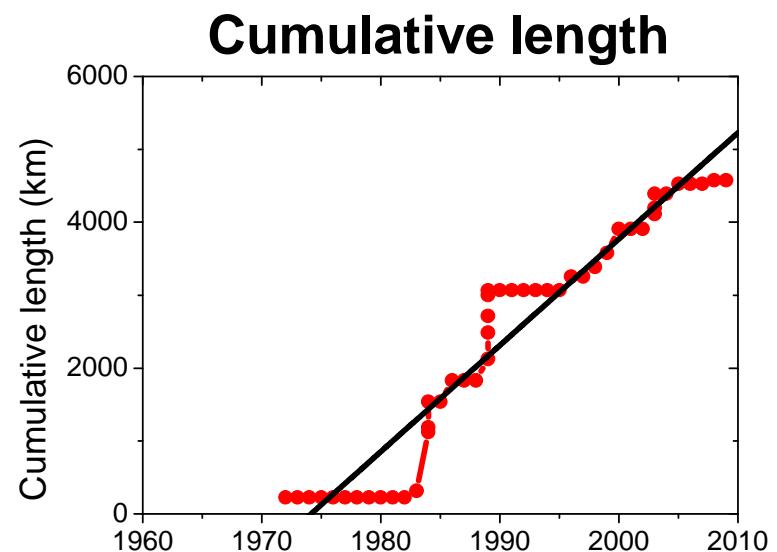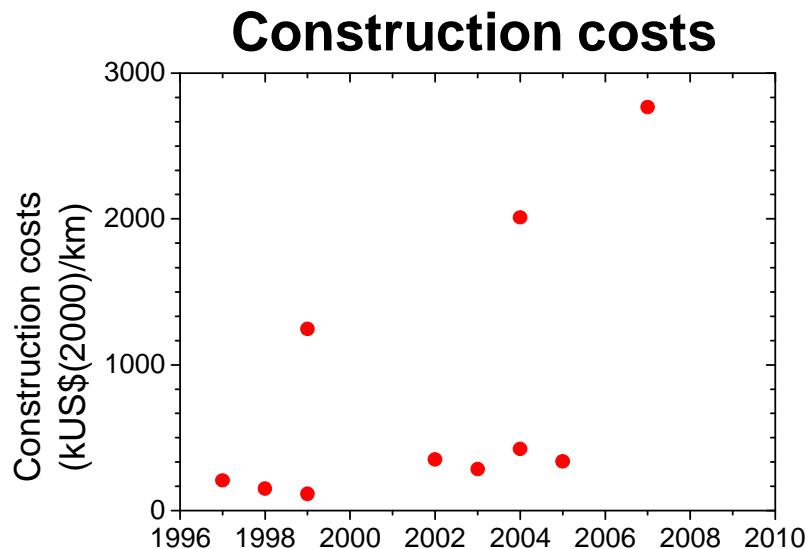
Cumulative length

Cost evolution for H₂ pipelines

30 cm diameter
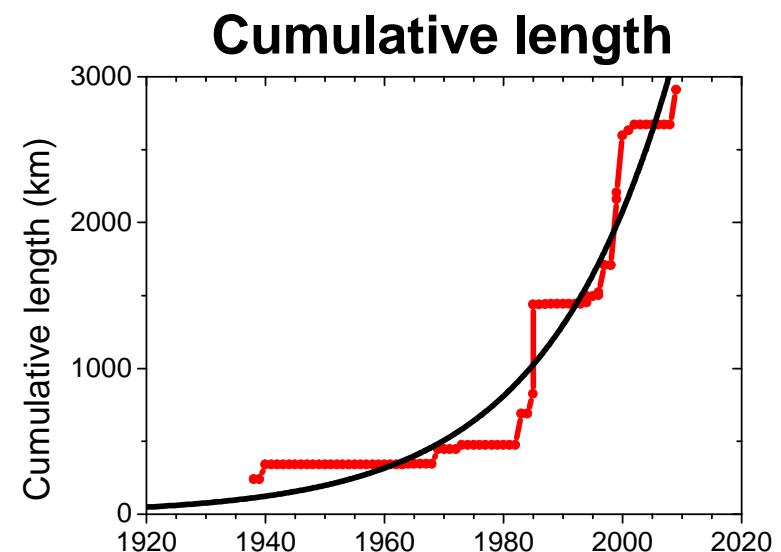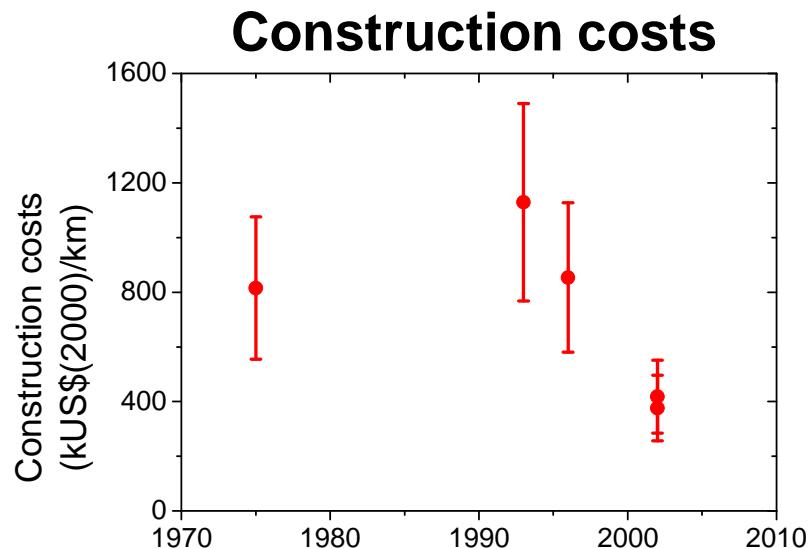
No learning for pipeline construction

CO$_2$

Construction costs (kUS\$(2000)/km) vs. Cumulative CO$_2$ pipeline length (km)

H$_2$

Construction costs (kUS\$(2000)/km) vs. Cumulative H2 pipeline length (km)

Progress ratio: 80 ± 21%
$R^2 = 0.33$
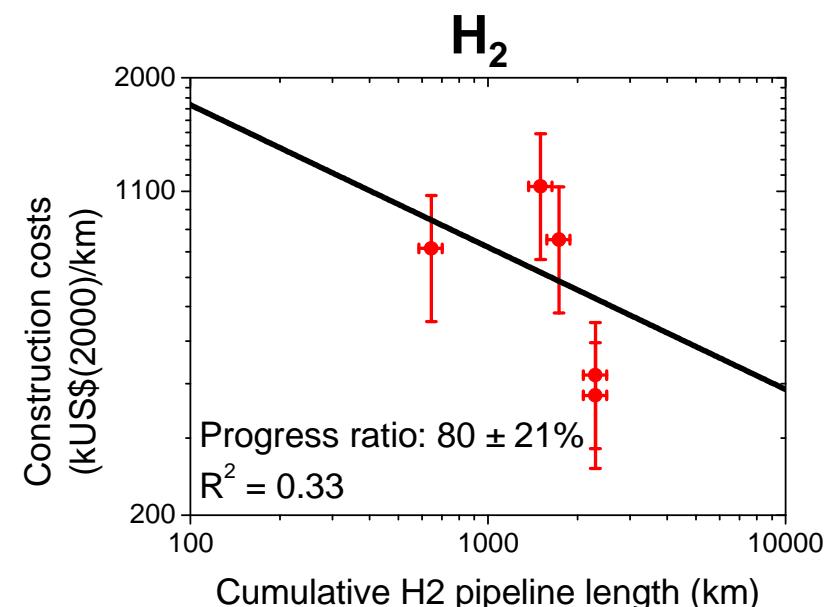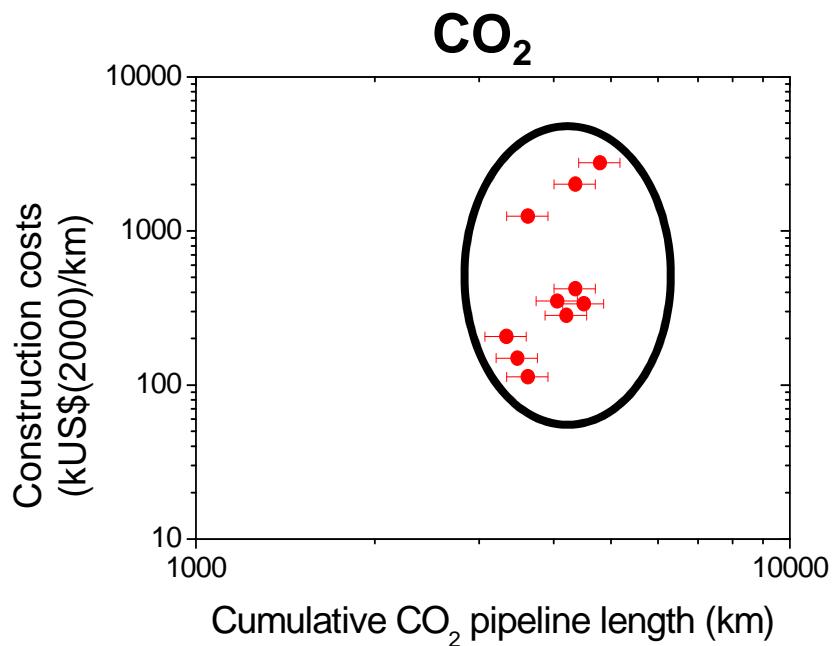
Construction costs and bandwidths

Gas transported	Cumulative length in 2003 (km)	Construction costs (kUS$(2000)/km)	Construction costs bandwidth (kUS$(2000)/km)
CH_4	n.a.	715	228-1807
CO_2	4200	788	113-2767
H_2	2400	854	376-1129

Cost comparison

Cost component	Costs (kUS$(2000)/km)		
	CH4	CO2	H2
Materials	89	187	143
Labor	363	358	463
Right-of-way	67	44	69
Miscellaneous	196	199	179
Total	715	788	854

Conclusion

- Limited learning is observed for pipeline construction
    - Mature technology, limited improvement opportunities
    - Much experience already gained
    - Each pipeline project unique → scattered cost data

- Cost components reflect market price developments

- Costs determined by properties of transported gases