Industrial Applications of Hydrogen Manufacture from Fossil Fuels with CO_2 Enhanced Oil Recovery

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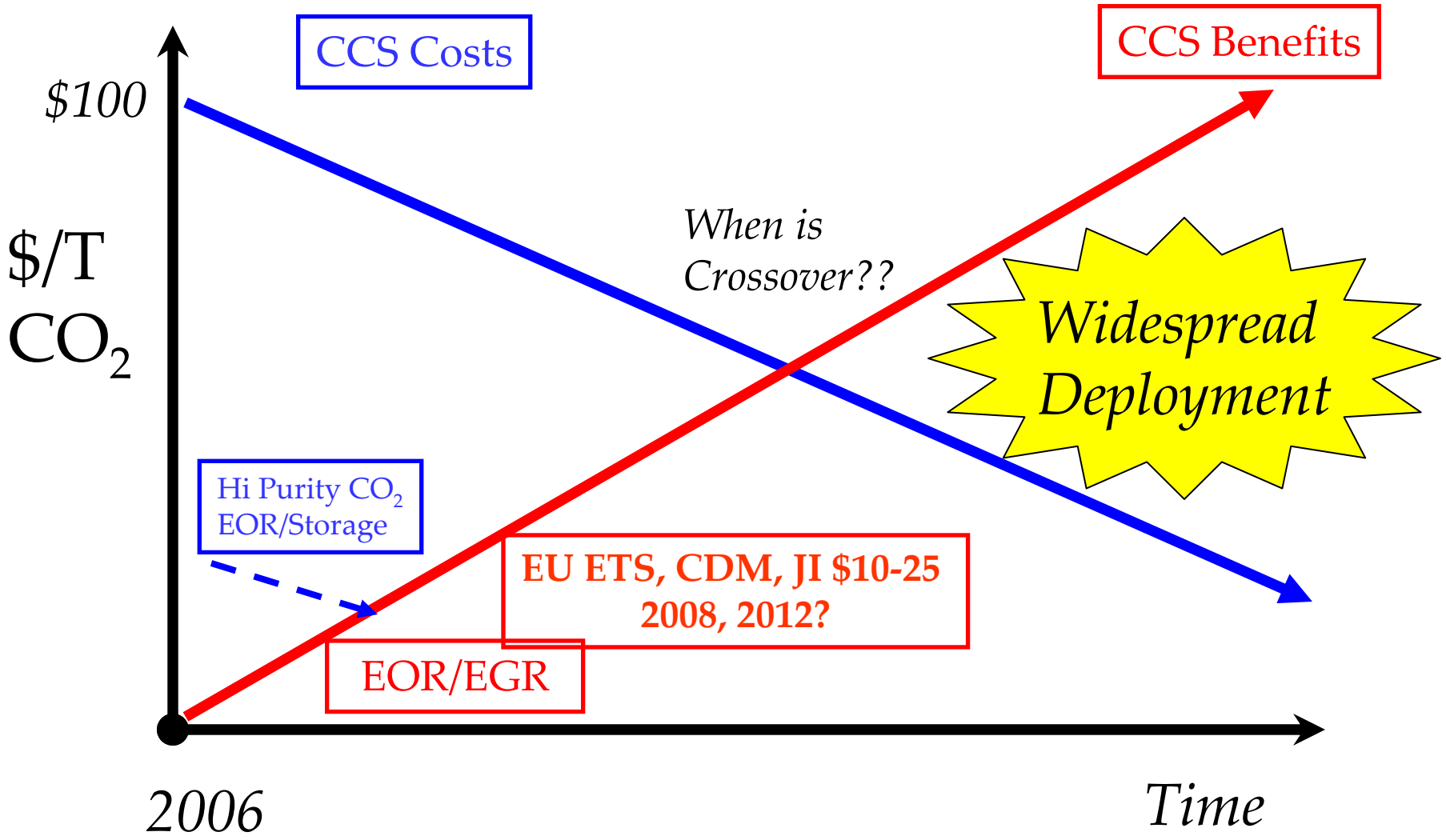
Agenda

- **Commercial Deployment of CCS with EOR**
  - **Lessons Learned**
- **BP-led Demonstration Projects:**
  - **Peterhead, Scotland (2010)**
    - **CO_2 EOR the Miller Depleted Oilfield**
  - **Carson, California (2011)**
- **Summary**

Commercial Deployment of CCS



Hydrogen to Power: A Business Model

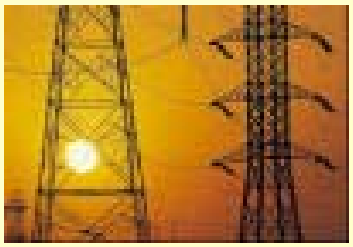
Hydro-Carbon

syngas manufacture

H_2

Combined Cycle Power Generation

e^-



'Carbon Free' Electricity

CO_2

CO_2 EOR

Provides optionality for future to supply H_2 into other sectors

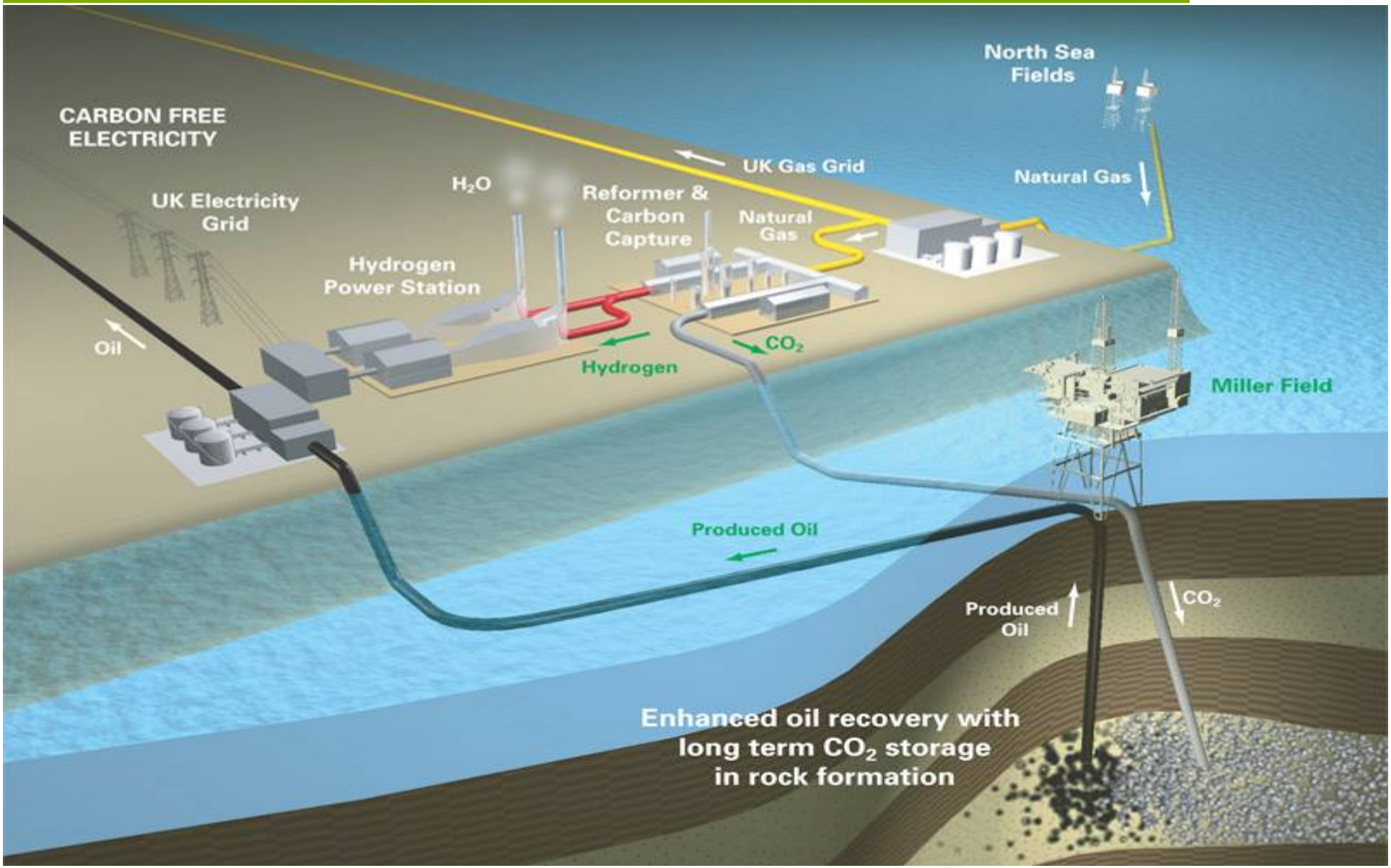
H_2

Transportation

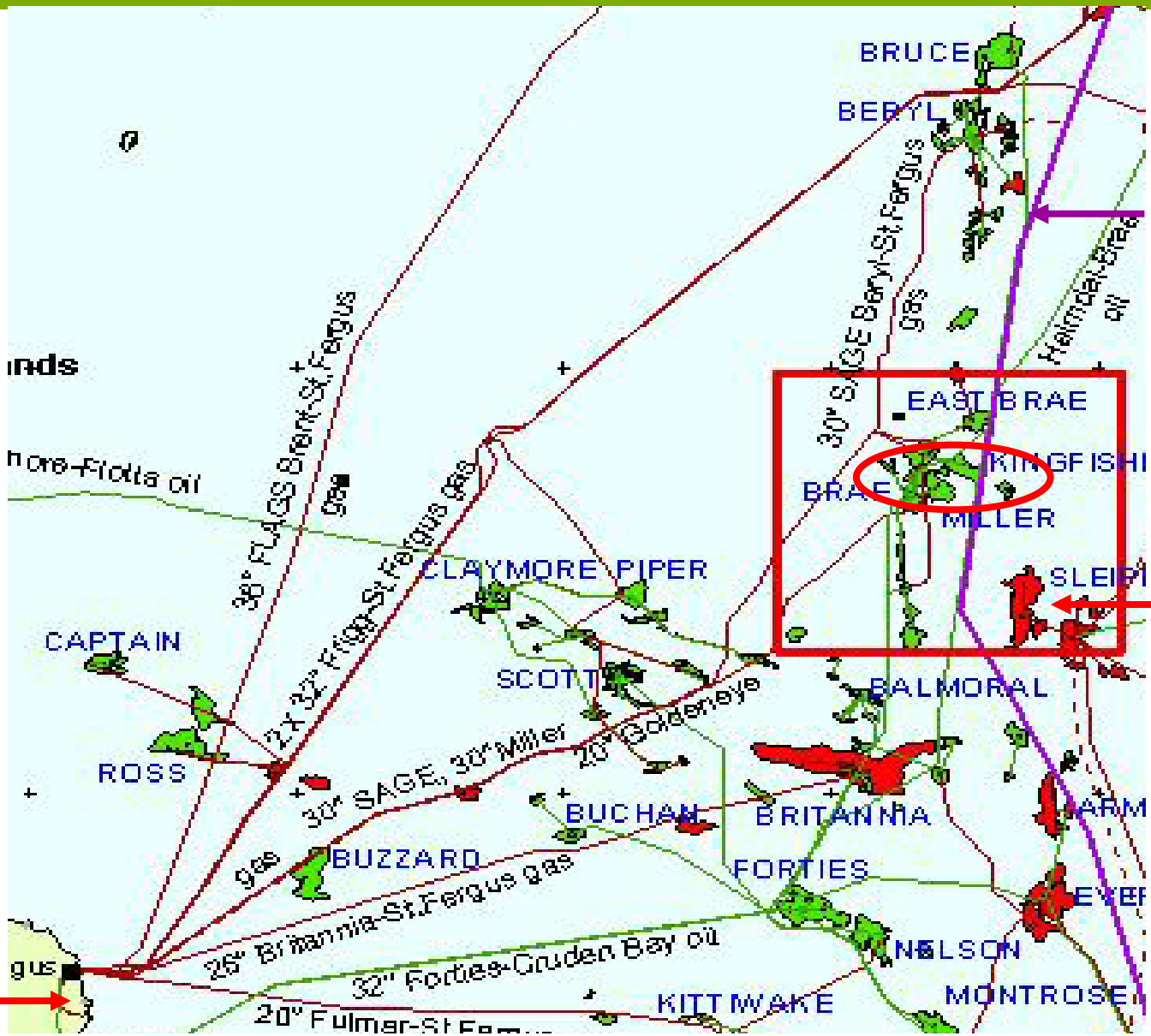
Peterhead Hydrogen Project (Scotland)

- **Industrial-Scale Demonstration of Hydrogen Manufacture from Natural Gas with CO_2 Capture & EOR**
- **Recycles Mature Infrastructure for Power Generation and Incremental Oil Production**
- **475MW Power Generation**
- **1.8mmtpa CO_2 recovers 50+ mmbbls Oil**
- **$600+mm Investment**
- **Planned to start CO_2 injection 2010**
- **Needs a Green Credits to compete with Fossil Fuels**

Peterhead & Miller (Scotland): 2010



Project Location (UK North Sea)



UK-Norway border

Sleipner

Peterhead

Focus on CO_2 Storage at Miller

- **Miller Field**
- **CO_2 injection**
  - **New CO_2 = 100mmscf/d**
  - **Recycling = 200mmscf/d**
- **CO_2 EOR**
  - **Design rate = 150mbd, 15 years**
  - **EOR rate = 10mbd, 30 years**
- **Storage Monitoring Program for Green Credits**

Miller Storage Program Objectives

1. Inject CO_2 into the Miller reservoir

- **6,000 tpd (100 mmscfd at 90%) from 2010 to 2030**
- **Assure CO_2 disposal – well number, injectivity, availability**

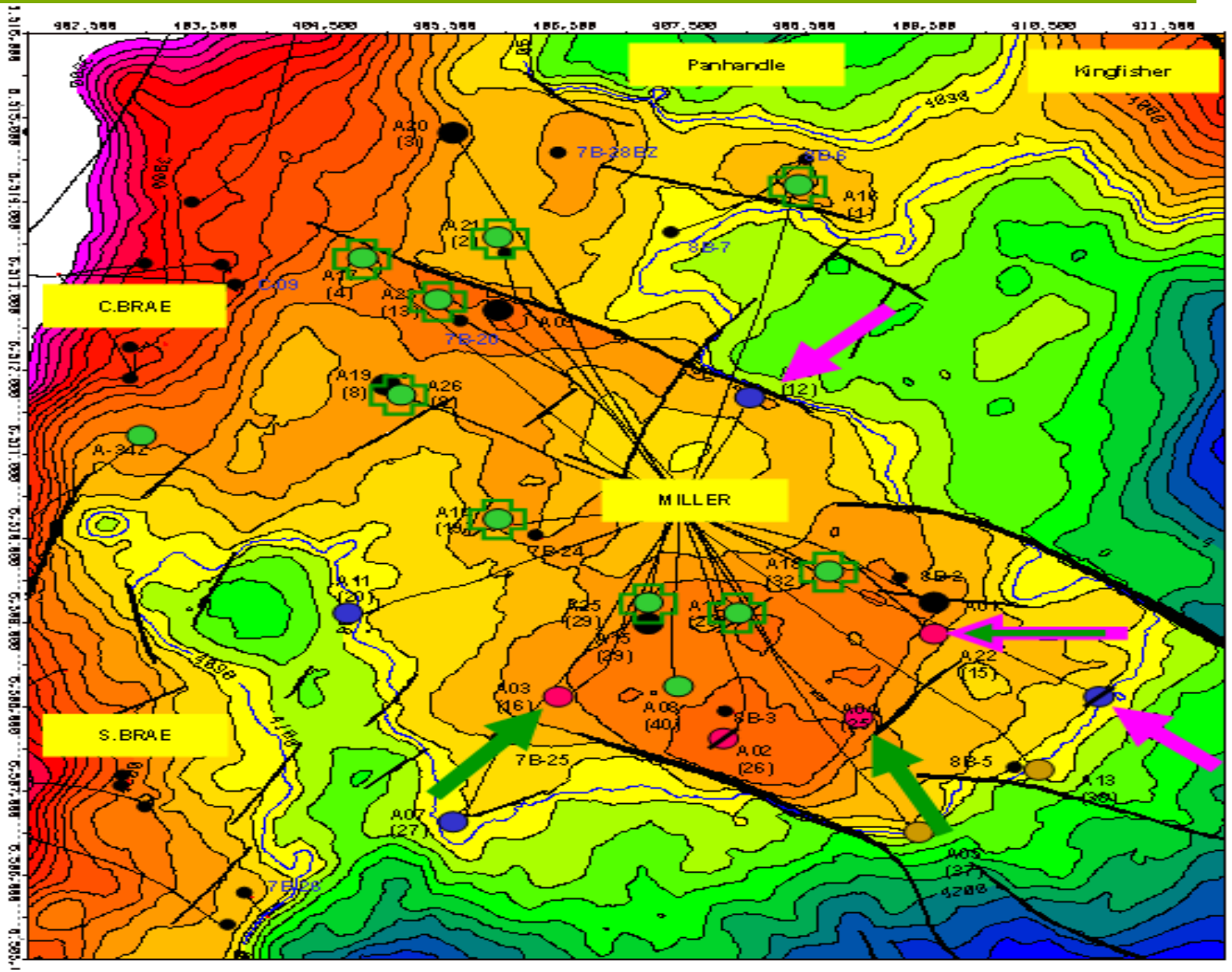
2. Produce incremental oil

- **Re-inject the re-produced CO_2 (100 mmscfd, rising to 200 mmscfd with recycle)**
- **Manage CO_2 flood to maximise oil production and minimise water production**
- **Use existing wells, workover as required**

3. Assure storage of injected CO_2

- **Maintain reservoir pressure below original**
- **Assess CO_2 seal integrity over 1,000 yrs**
- **Assess and mitigate potential CO_2 migration**
- **Monitor for potential leakage during injection**
- **De-commission wells as required to mitigate leakage**

CO_2 in Miller: Development Wells



Storage Monitoring for Green Credits

EOR Reservoir surveillance

- **CO_2 tracer**
- **Reservoir logging in observation wells**
- **CO_2 material balance**

Well surveillance

- **Annular gas pressures and compositions**
- **'Noise logs' for flow behind casing in injectors**

Seabed imaging

- **High-res side-scan sonar + swathe bathymetry**

Gas sampling

- **Sample any seeps (including natural) for tracer**

Water chemistry

- **Monitor pH or CO_2 directly to compute seabed flux**

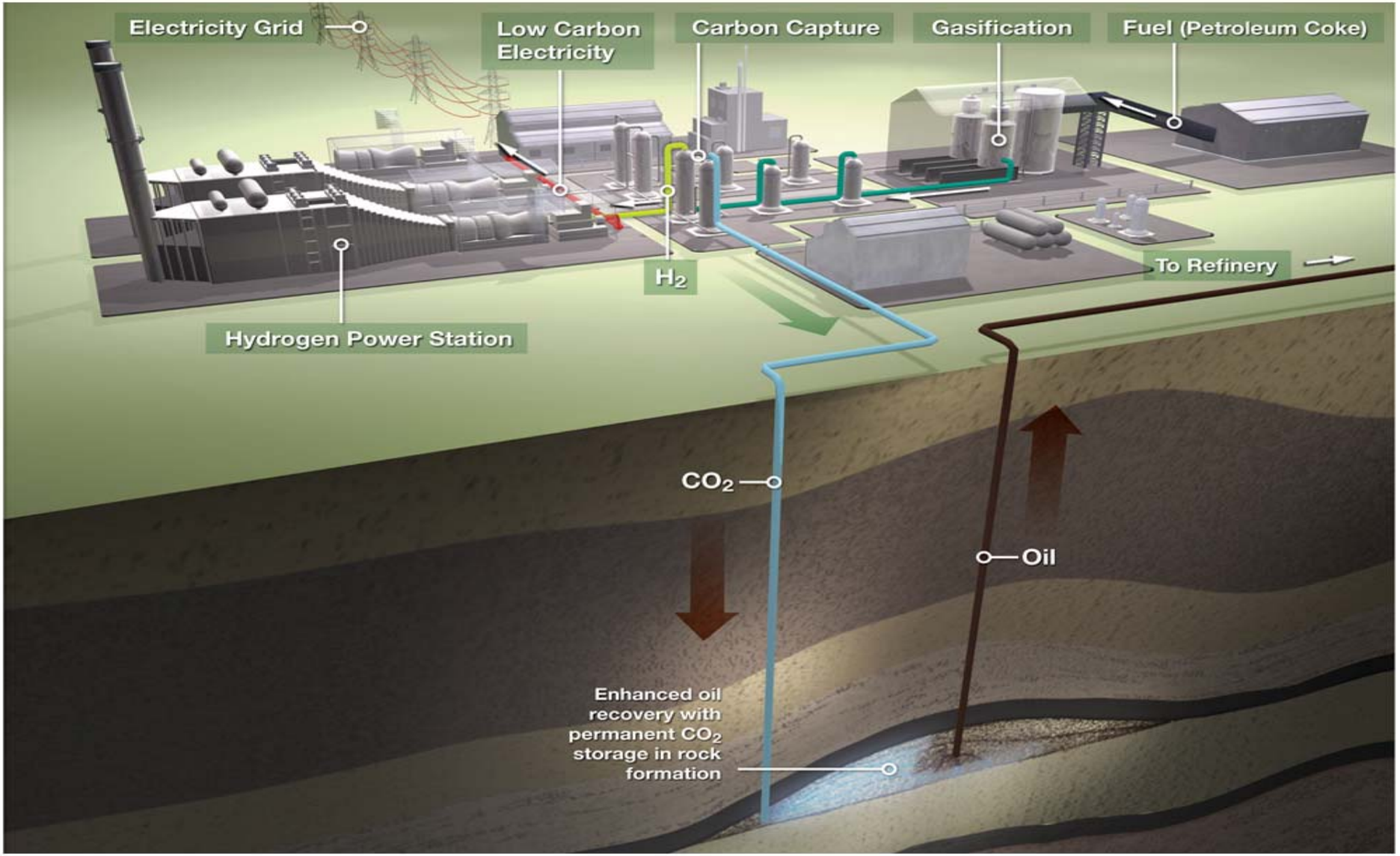
Additional surveys

- **Shallow seismic + high-res 2D for near-surface gas accumulations**
- **Logs during workovers**

Carson Hydrogen Power Project (California)

- **Industrial-Scale Demonstration of Hydrogen Manufacture from Petroleum Coke with CCS**
- **Brownfield site**
- **500MW Power Generation**
- **4mmtpa CO_2 for EOR**
- **$1,000mm Investment**
- **Planned to start in 2011**
- **To be competitive, this project needs access to the new policy frameworks being put in place in California and at Federal level**

Carson Hydrogen Power Project (CA): 2011



Summary

- **CCS and CO_2 EOR can provide Win-Wins**
  - **Green Power and more Oil from existing fields**
  - **Currently no green credit for CO_2 Storage**
- **Peterhead and Carson are providing BP with valuable knowledge on CCS and Hydrogen scale-up and integration**
- **BP is investing CCS / EOR projects in mature oil/gas basins where we believe green credits will appear in the near future**
- **BP is evaluating other opportunities for CCS Projects……**