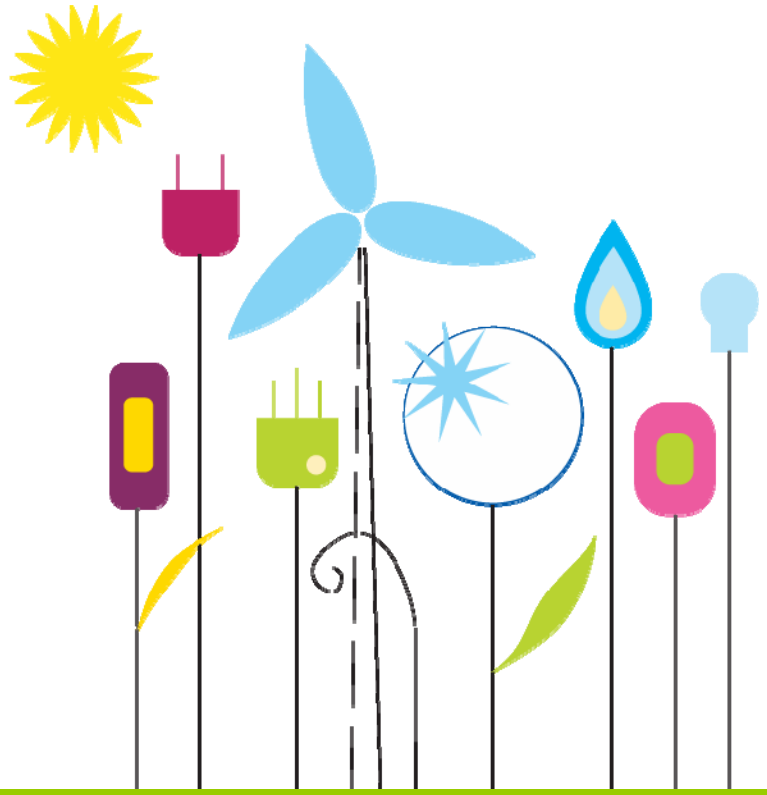
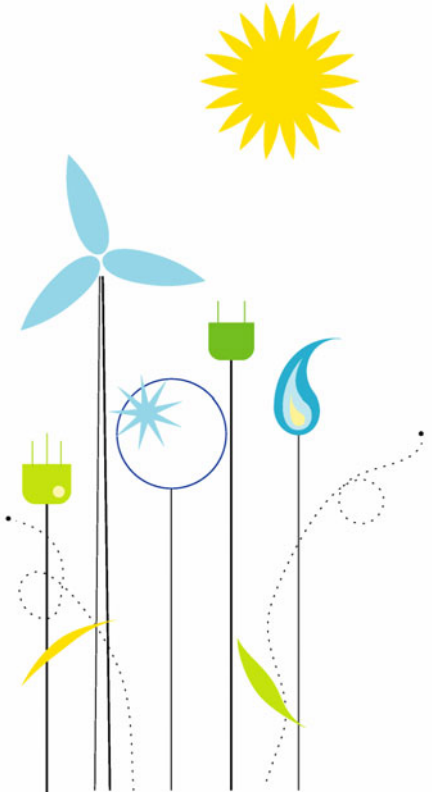


Industrial-Scale CCS Projects: US and International

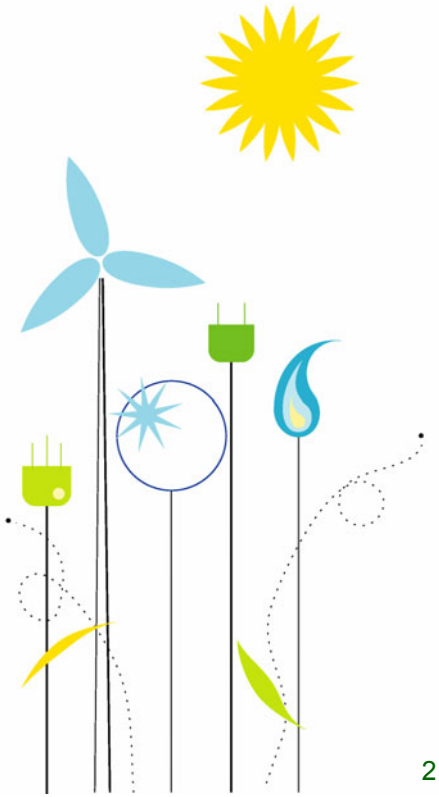
Iain Wright, CO_2 Project Manager, BP

NETL CCS Conference: Pittsburgh May 8th 2007



Agenda

- What does a CCS Project Developer need?
- Progress in:
  - USA
  - Europe
  - Australia
  - China
  - Middle East
- Summary



BP CCS Technology Program

Research

Industry / Academic Initiatives

Technical Demonstrations

Industrial Scale Projects

Carbon Mitigation Initiative — CMI — Princeton University — PEI Princeton Environmental Institute

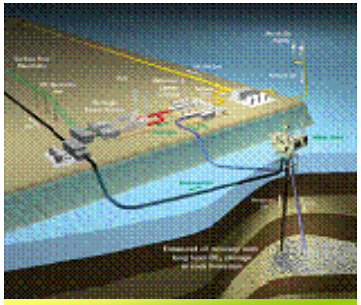
CO_2 Capture Project

Source-sink matching
CO2CRC, EUGeocapacity, Coach, US Regional partnerships

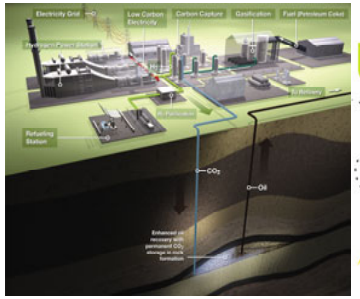
Public policy support
CSLF, ECCP, EU-ZEPP, CDM

Assurance framework
CO2CRC, CSLF, IMCO2, WRI

3rd Party Demonstrations
Sleipner, Weyburn, CO2Remove



DF1

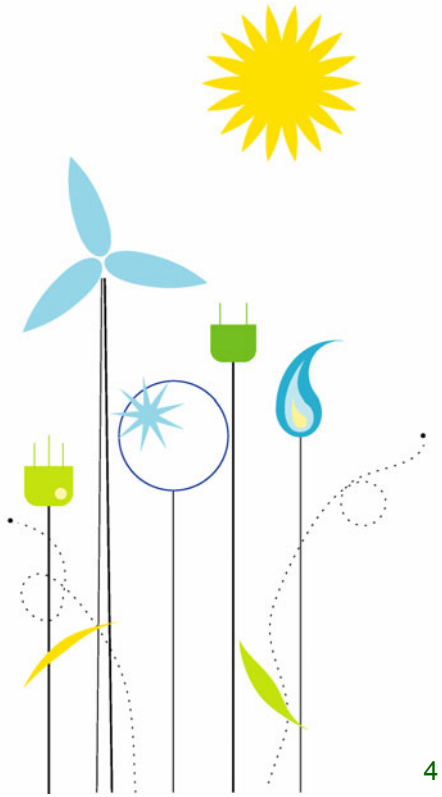


DF2

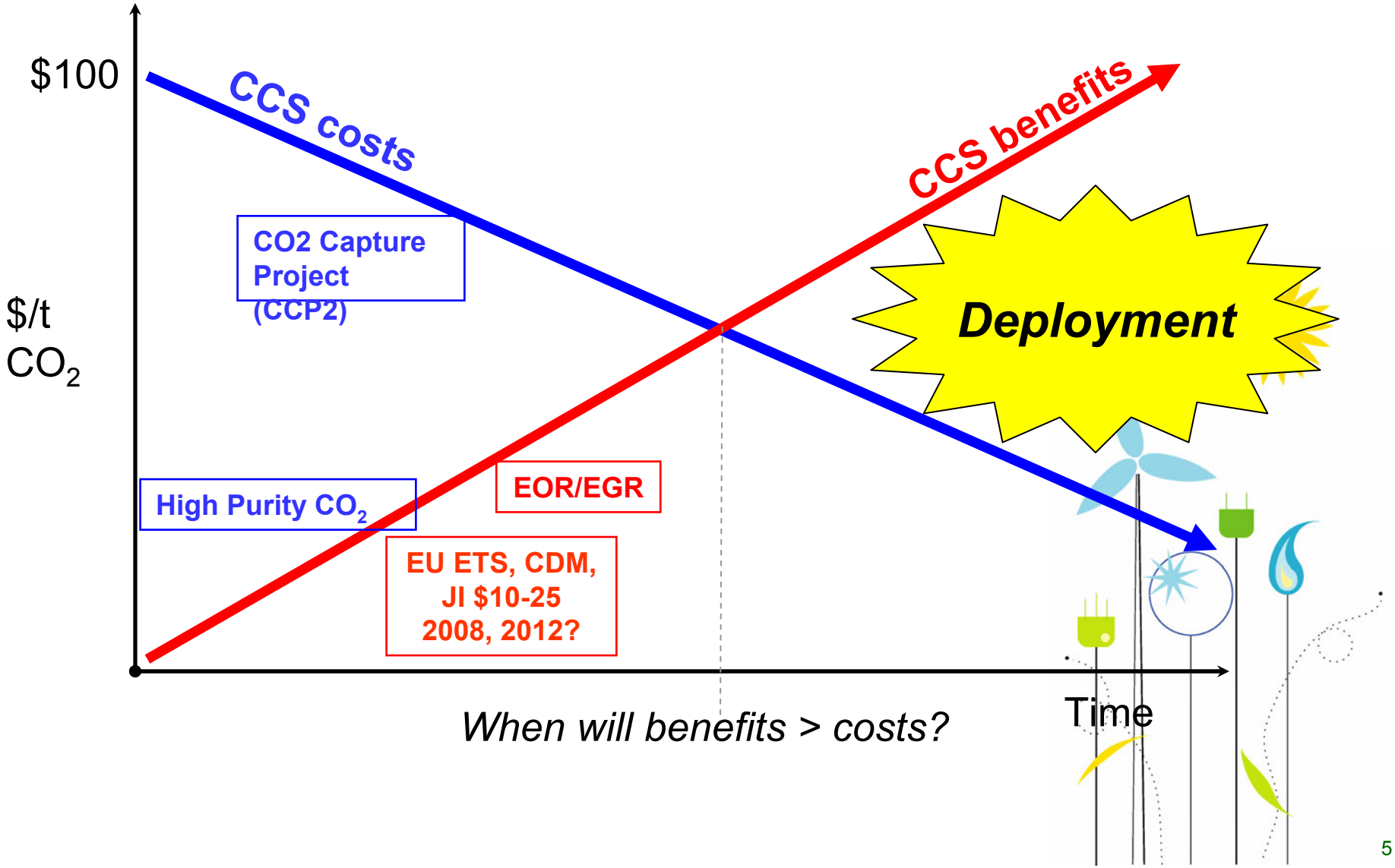
TBA

DF3, 4, 5 . . .

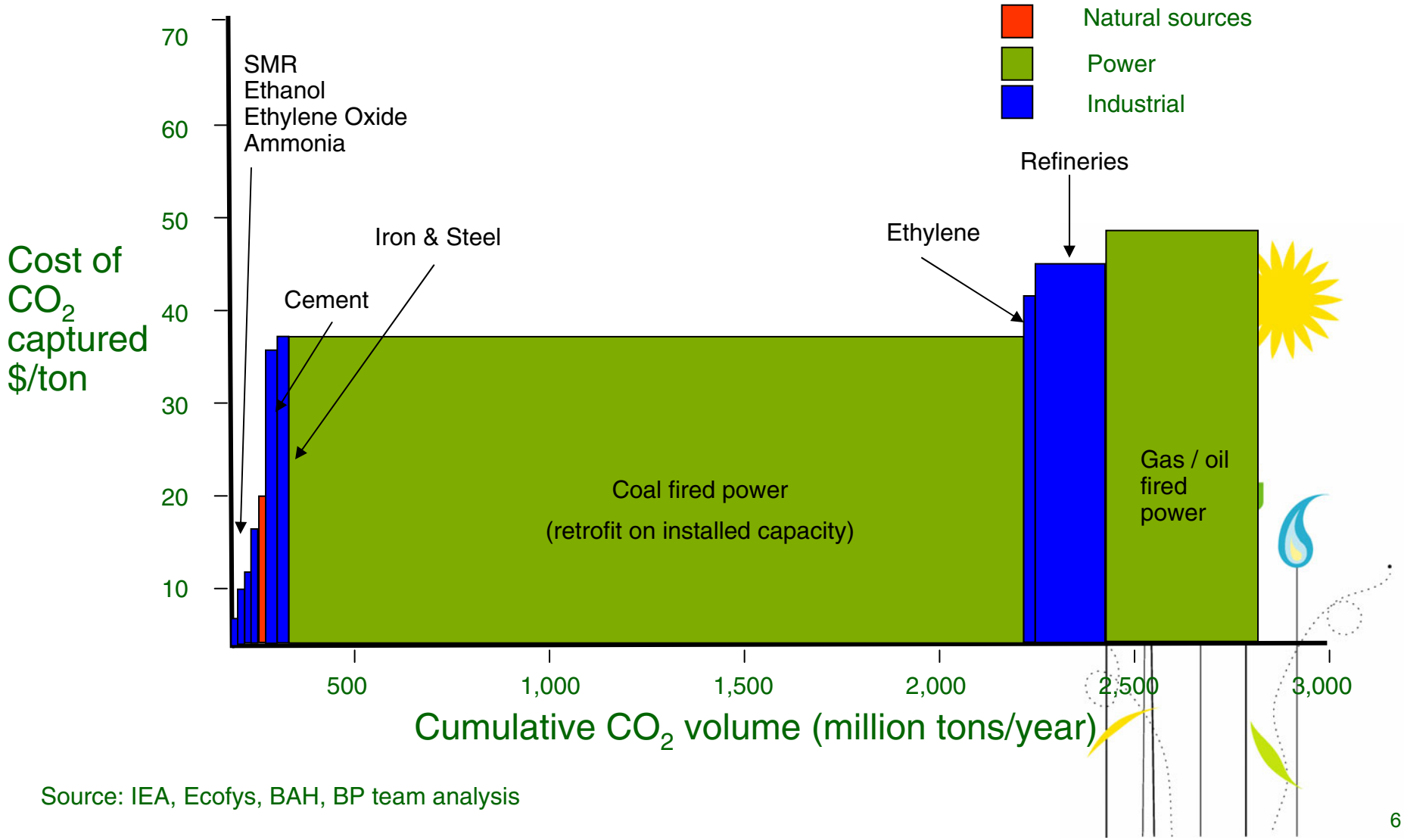
What does a CCS Project Developer need?



When Will CCS be Deployed?



US CCS Opportunities



Source: IEA, Ecofys, BAH, BP team analysis

A Business Model for CCS Deployment

CO_2

CO_2 Storage

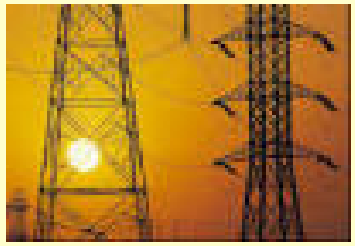
Hydro-Carbon

syngas manufacture

H_2

Combined Cycle Power Generation

e^-



'Carbon Free' Electricity

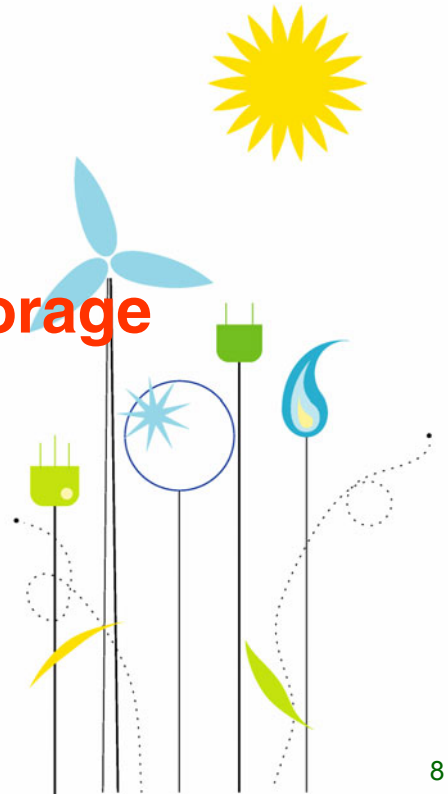
Provides optionality for future to supply H_2 into other sectors

H_2

Transportation

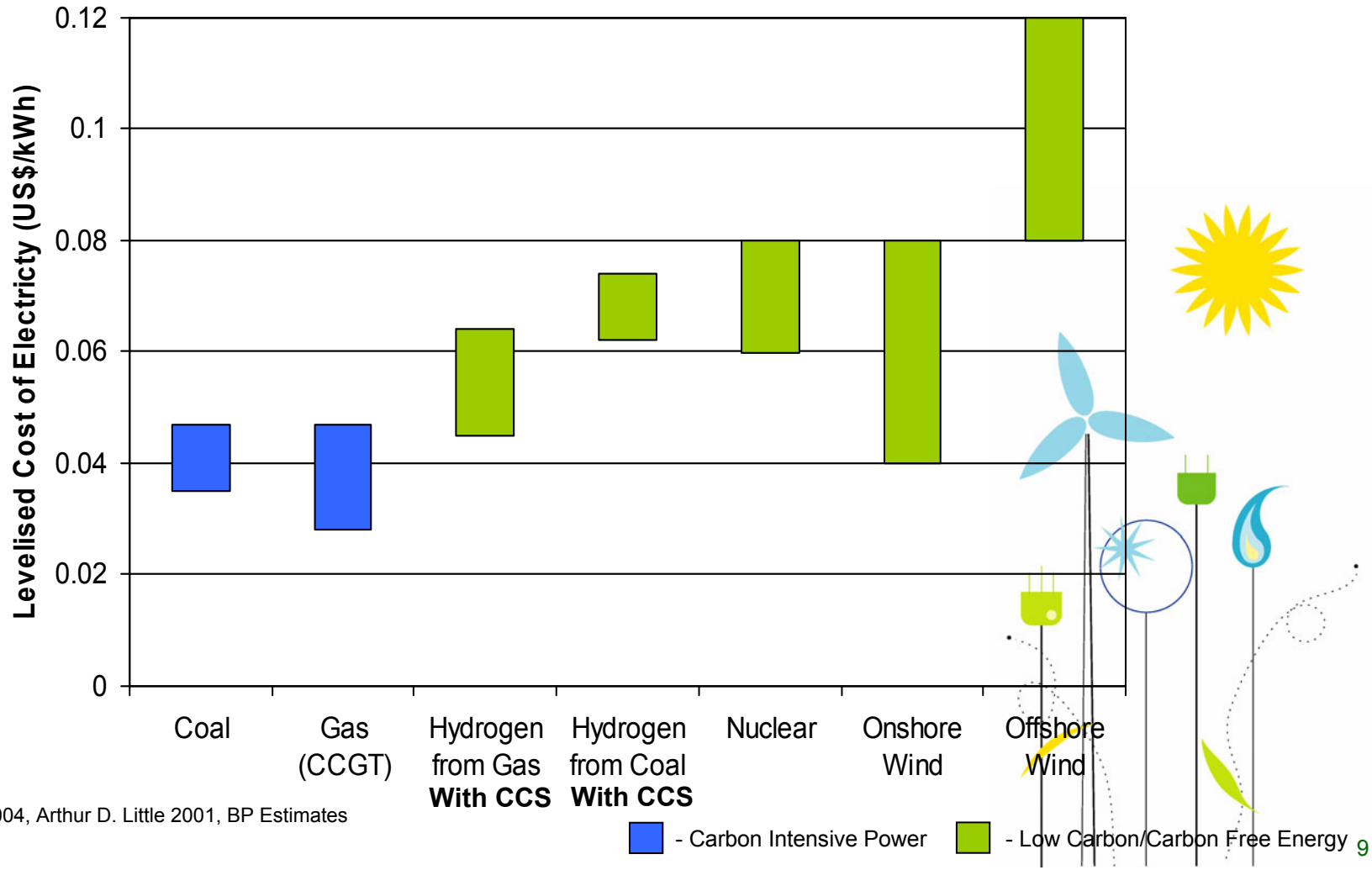
CCS Project Developer Requirements

- Growing Power Market
- Advantaged fuel, infrastructure, geology
- Supporting Government Policy
- Regulatory Framework for Geological Storage



Policy Framework

CCS allows fossil fuels to deliver a similar product to other technologies
Project incentives could be similar



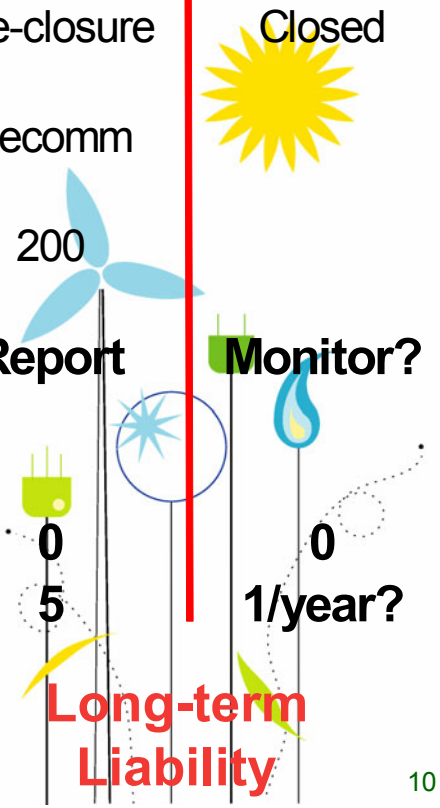
Sources: Navigant 2004, Arthur D. Little 2001, BP Estimates

Regulatory Framework (for CO_2 Storage)

Responsibility		Nation		Commercial Entity	Nation	
			Site Certification		Site Certification	
Timeframe	Years	0-3	4-6	7-40	41	42-1,000
Project Activity		Plan	Build	Operate	Pre-closure	Closed
Value Process		A, S, D	Execute	Operate	Decomm	
Project Cost	$million	100	1000	100/year	200	
Monitoring		Appraise/ Characterize	Baseline	Monitor	Report	Monitor?
Monitoring Cost						
Oil/Gas Field	$million	1	2	1/year	0	0
Saline Formation	$million	100	10	5/year	5	1/year?

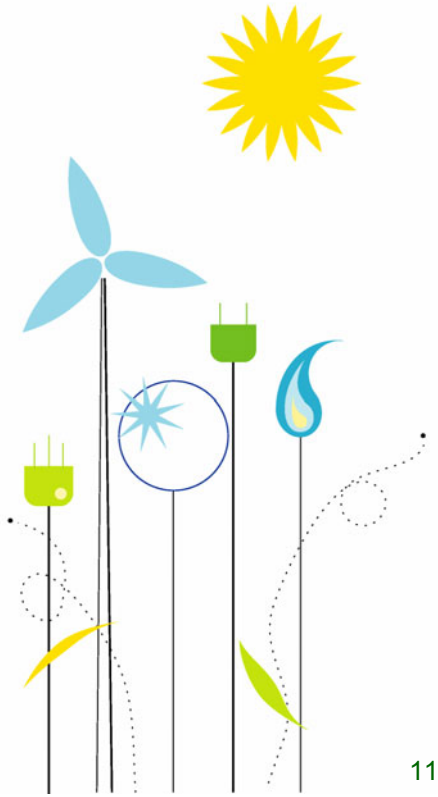
Is it Legal?

Long-term Liability



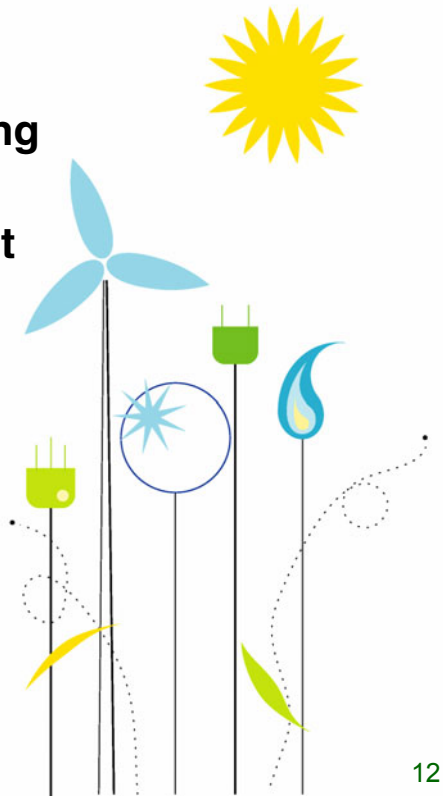
CCS Initiatives: Around the World in 10 Minutes

- **USA**
- **Europe**
- **Australia**
- **China**
- **Middle East**



USA Initiatives: Federal

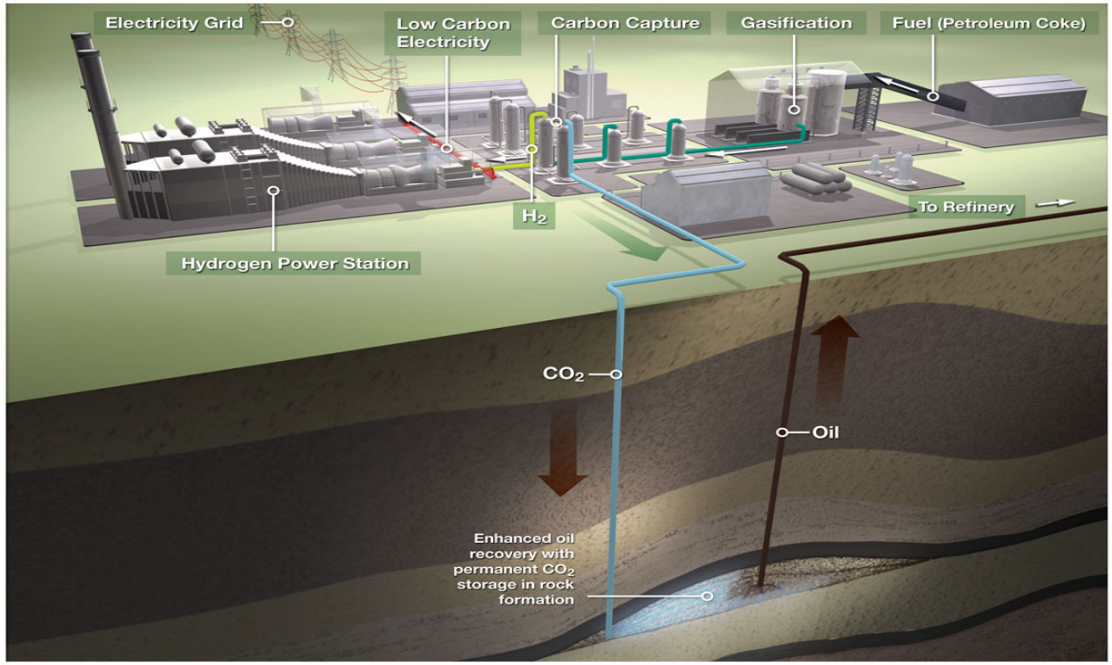
- Ongoing DoE R&D Funding:
  - Regional Partnerships (Phases 1, 2, 3)
- Congress:
  - Numerous Hearings and Bills:
    - Bingaman: Funding for CCS Pilot Projects
    - Salazar: Mapping Storage Locations (not re-inventing the wheel)
- EPA and DoE to jointly evaluate how the storage of CO2 might affect groundwater supplies



USA Initiatives: State

- Texas
  - Early Policy Framework enabled Texas to become the leading provider of wind power
  - 2007 so far: 15 State initiatives to support low-carbon power
  - Huge appetite for CO_2 EOR (Tax Breaks)
  - Pursuit of FutureGen has driven new legislation
- California
  - Leadership in Climate Change Policy via AB32, SB1368, CA PUC GHG Emission Performance Standard, and AB 1925
  - AB1925 (law) Requires CEC to provide policy recommendations to the CA legislature by Nov 2007 "to accelerate the adoption of cost-effective geological sequestration strategies for the long-term management of industrial CO_2"
  - Pending bills:
    - AB705: establish jurisdiction for CCS regulatory framework
    - AB114: incentivize carbon capture technologies

Carson Hydrogen Power Project, California



Project Milestones

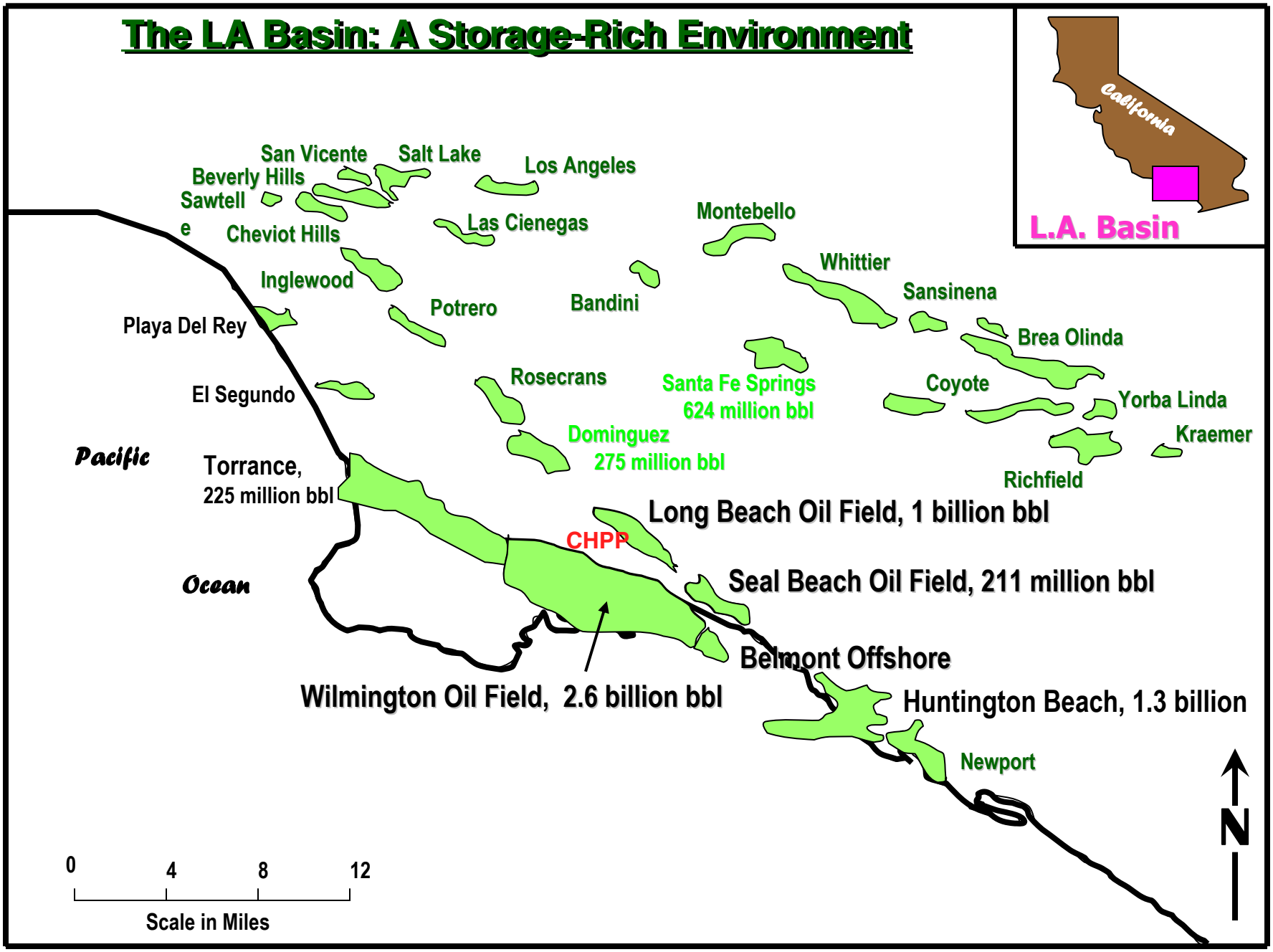
- World's largest hydrogen-fired power generation facility
- Would use gasification technology to gasify petcoke – a solid fuel generated as a byproduct of the refining process

Climate Change Milestones

- 500 MW of clean electricity ~ 325,000 Southern Californian homes
- 4 mmtpa CO_2 avoided
- Pipeline infrastructure to transport the CO_2 for EOR and permanent storage
- Lowest CO_2 emissions in the world for an IGCC plant.

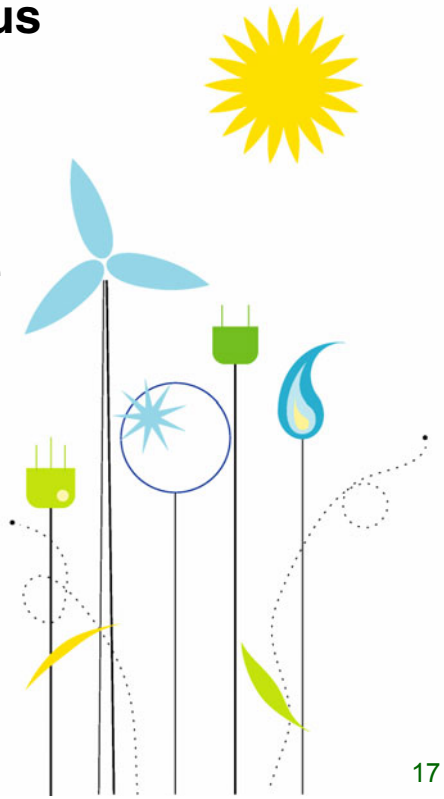
alternativenergy
Powered by BP


CHPP – an advantaged location
• Industrial zoning
• Coke disposition
• Existing H_2 infrastructure
• Local CO_2 sequestration options
• Major (Electrical) Load Center
CoP
Valero
PRAXAIR
Shell
Kinder
CoP Carson
LADWP sub-station
CHPP
Air Prod's
BP Carson Refinery
SCE Sub-station
Rail Corridor
West Basin


The LA Basin: A Storage-Rich Environment
California
L.A. Basin
San Vicente
Salt Lake
Los Angeles
Beverly Hills
Sawtell
e
Cheviot Hills
Las Cienegas
Montebello
Whittier
Inglewood
Potrero
Bandini
Sansinena
Playa Del Rey
Brea Olinda
Rosecrans
Santa Fe Springs
624 million bbl
Coyote
Yorba Linda
El Segundo
Dominguez
275 million bbl
Kraemer
Pacific
Torrance,
225 million bbl
Richfield
Long Beach Oil Field, 1 billion bbl
CHPP
Ocean
Seal Beach Oil Field, 211 million bbl
Belmont Offshore
Wilmington Oil Field, 2.6 billion bbl
Huntington Beach, 1.3 billion
Newport
N
0
4
8
12
Scale in Miles

CHPP: Enabling Policies

- **Permits for Power Plant, Pipeline, Sequestration**
- **Long-Term Low-Carbon Power Procurement Contract**
- **Reasonable Policy Framework for CCS Siting, Monitoring, Measuring & Verification and Long-Term Liability**
- **Emission Reduction Credits from SCAQMD via Rigorous Offset Strategy**
- **E-NGO Support and Engagement at local, state and federal levels**
- **Public Awareness and Understanding of CCS as viable part of a Climate Solution**

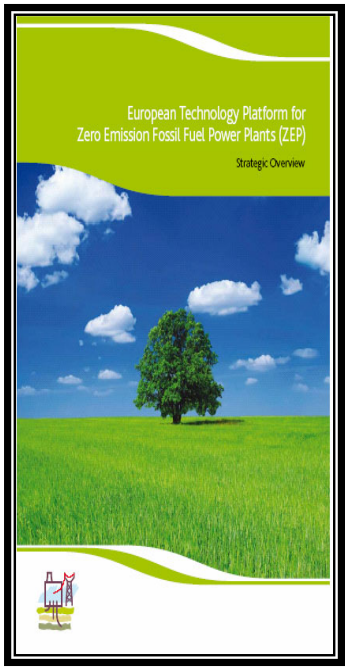


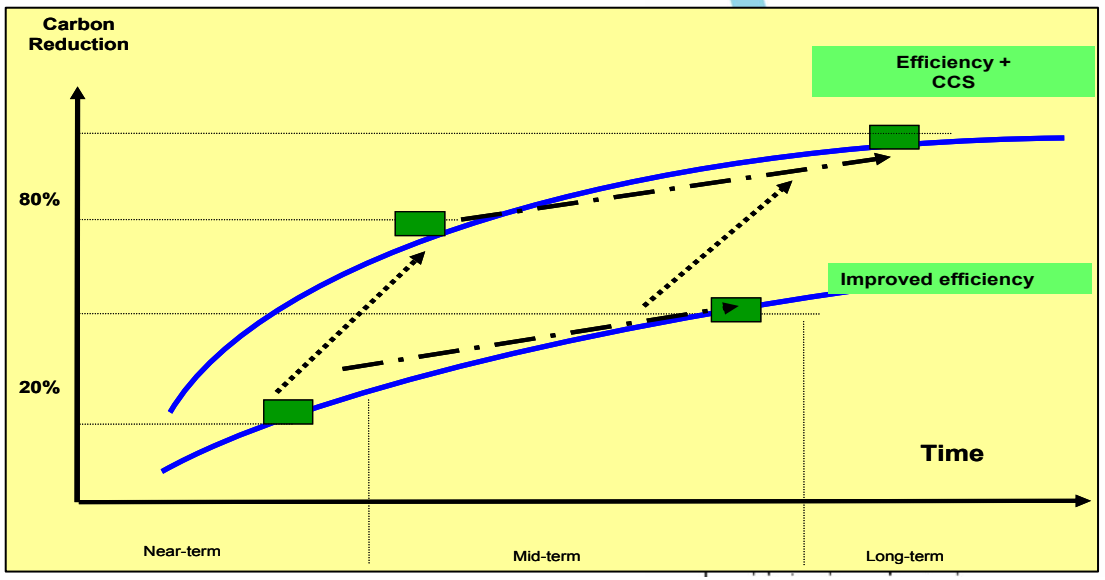
Europe

- EU-Level
  - ZEP (Zero Emissions Fossil Fuel): Flagship Program
    - Website: www.zero-emissionplatform.eu
    - Strategic Agendas for Research and Deployment
  - EC Communications on CCS (TREN,ENV,RES)
  - DG ENV EU ETS initiatives to:
    - Accommodate CCS in Phase II
    - Fully recognise in Phase III

- Member-State Level
  - UK
    - Cross-departmental regulatory task force
    - UK- Norwegian North Sea Task Force
    - DTI led competition to select a CCS project for support
  - Germany

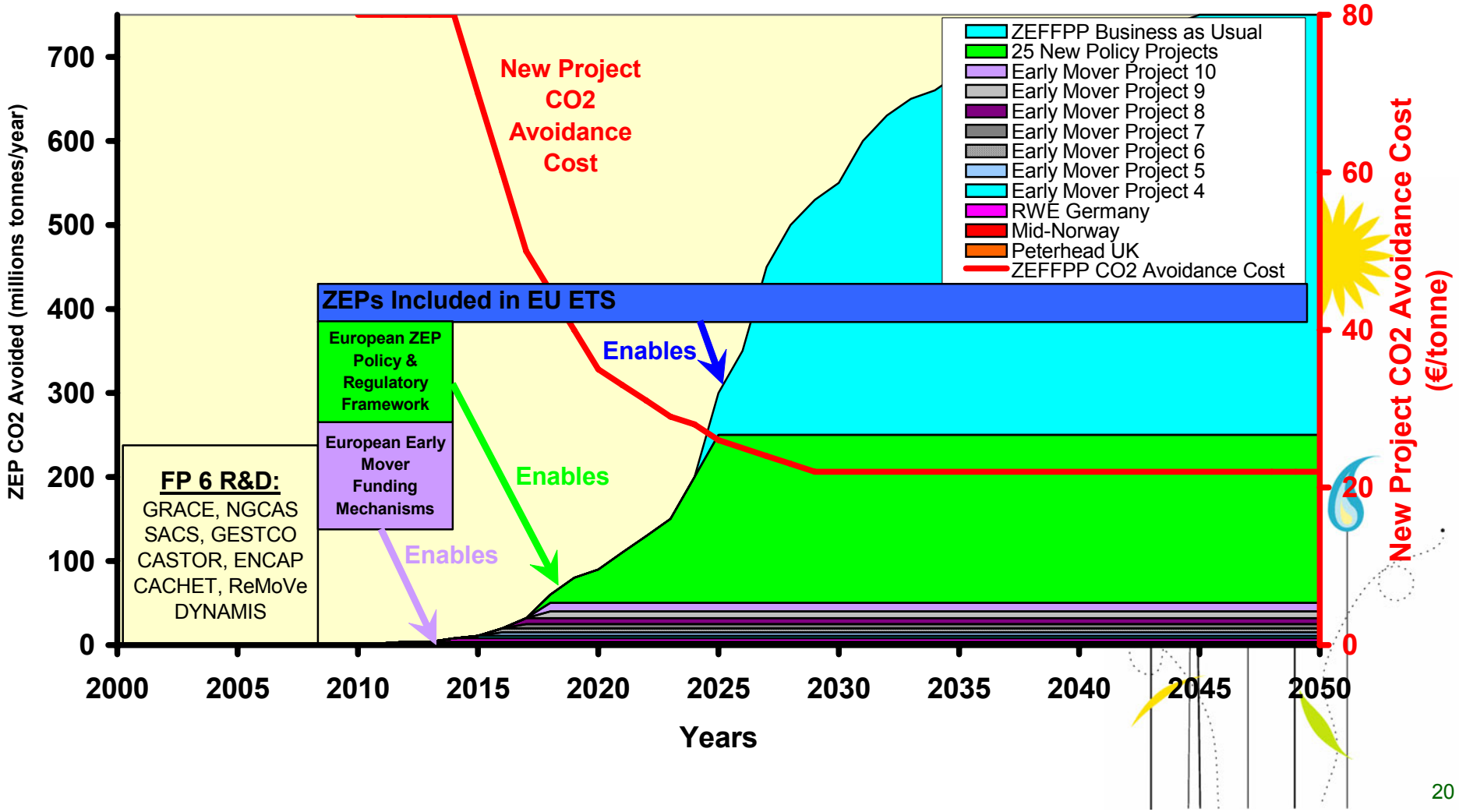
European Technology Platform ZEP





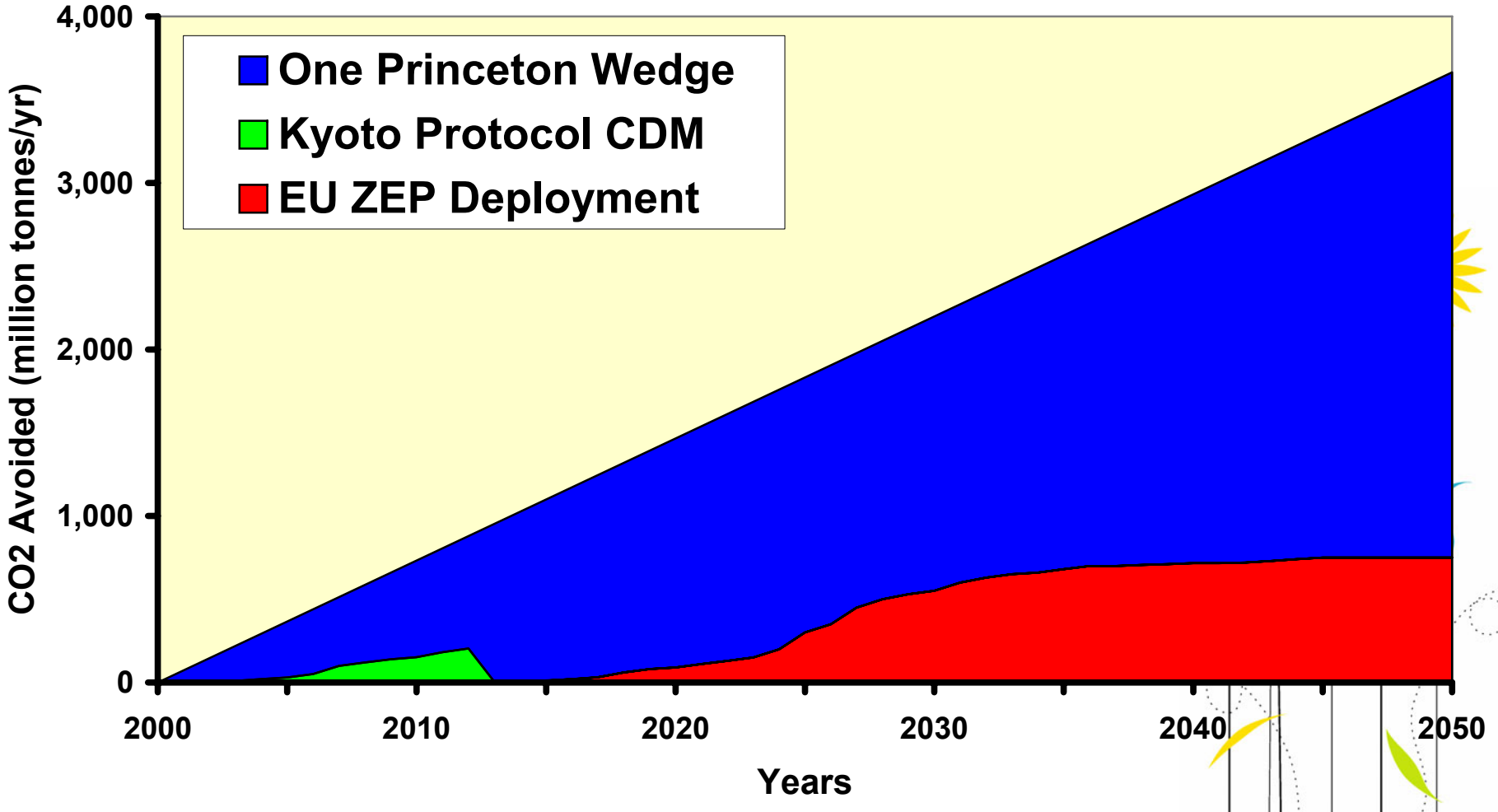
CCS Deployment Roadmap for Europe

EU ZEP Deployment Roadmap

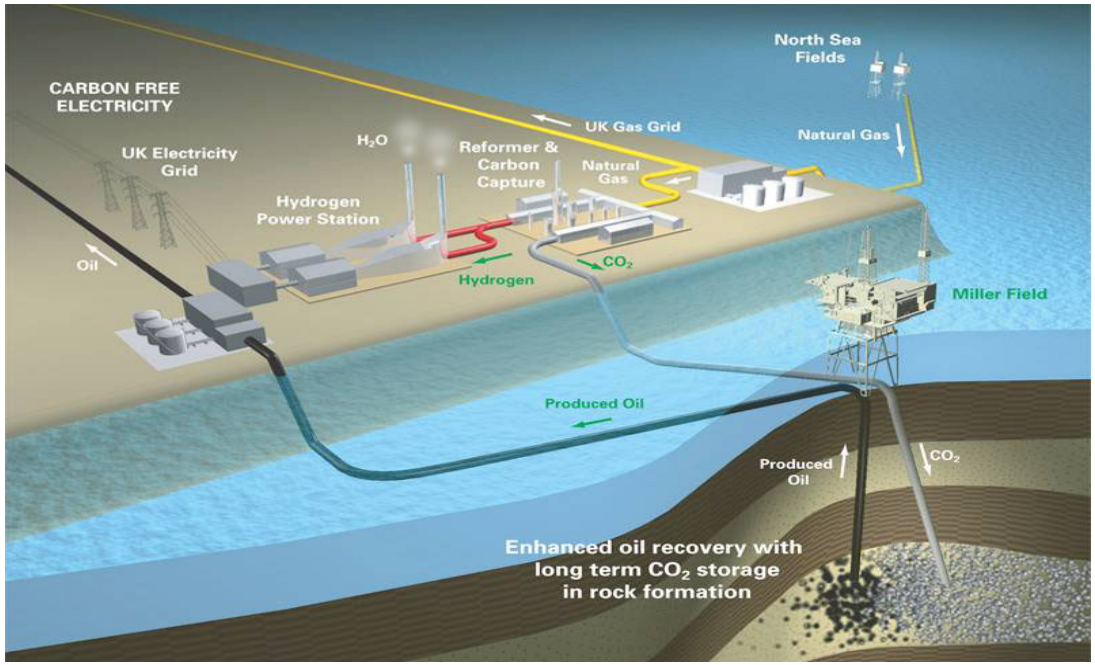


EU CCS Deployment, CDM and One Wedge

CO2 Mitigation vs One Princeton Wedge



Peterhead Hydrogen Power Project, Scotland



Project Milestones

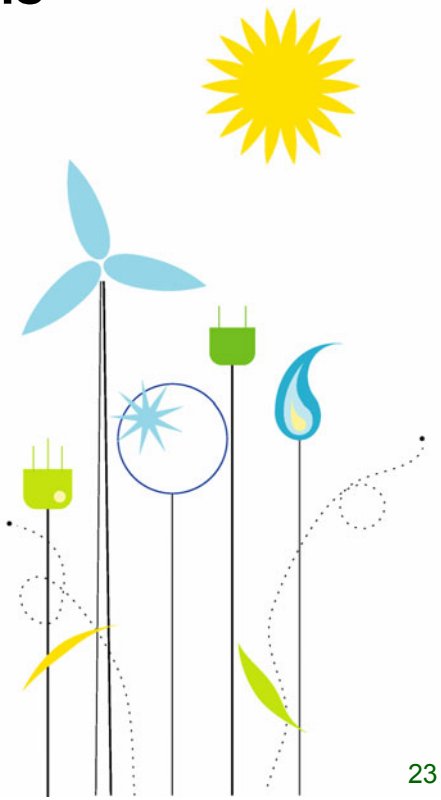
- Europe's largest hydrogen-fired power generation facility
- First CO_2 EOR project in North Sea
- 1st CO_2 storage in an offshore oil field
- Uses Auto Thermal Reforming technology

Project Fun Facts

- 475 MW of clean electricity - enough to power about 300,000 homes
- 1.8 mmtpa CO_2 captured and stored = 500,000 cars off the road
- Almost equivalent to the UK's installed wind farm capacity

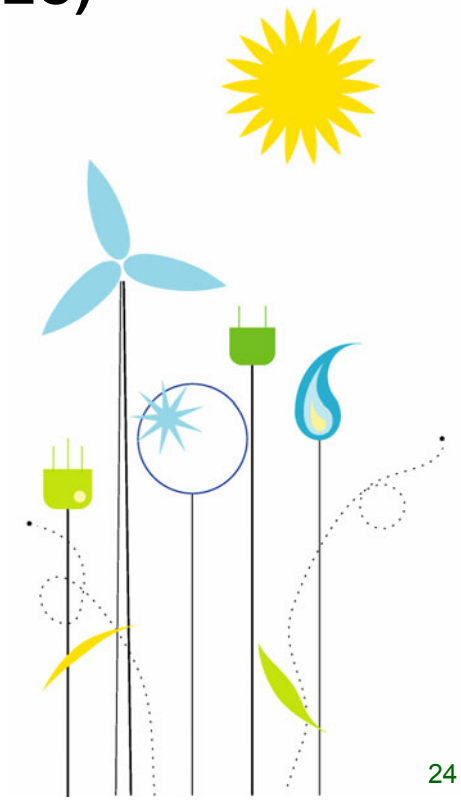
Australia

- Joined-up thinking on both Policy and Regulatory Frameworks
- Major Government-backed Project funding Program
  - Managed by CSIRO
- Draft legislation to enable CCS in saline formations



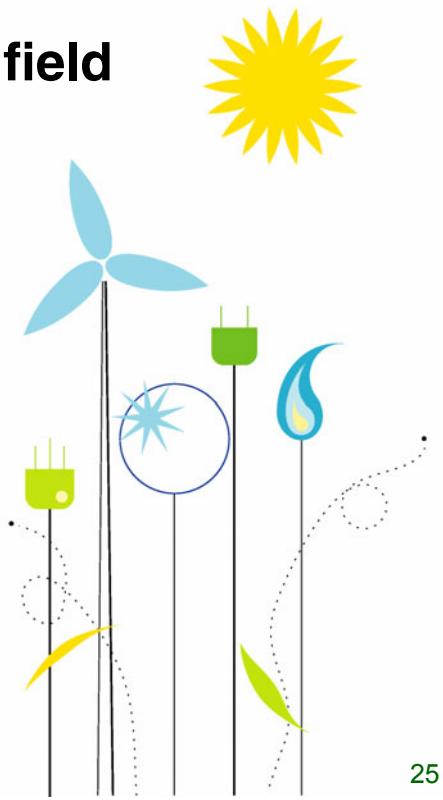
China

- Domestic Programs for IGCC and CTL
- US: Participation in FutureGen
- EU: Cooperating Action on CCS in China (COACH)
- UK: Near-Zero Emissions Coal Co-Operation (NZEC)
- AP6: IGCC / Co-Production Initiative
- Otherwise waiting for Annex 1 countries to lead



Middle East

- Rapid Industrial Development
- Growth in power demand (gas-fired) and desalination
- Desire to diversify oil-dependant economies
- Huge CO_2 EOR opportunity
- Opportunity to use CO_2 to replace methane for oilfield pressure support
- OPEC Promoting CCS in CDM

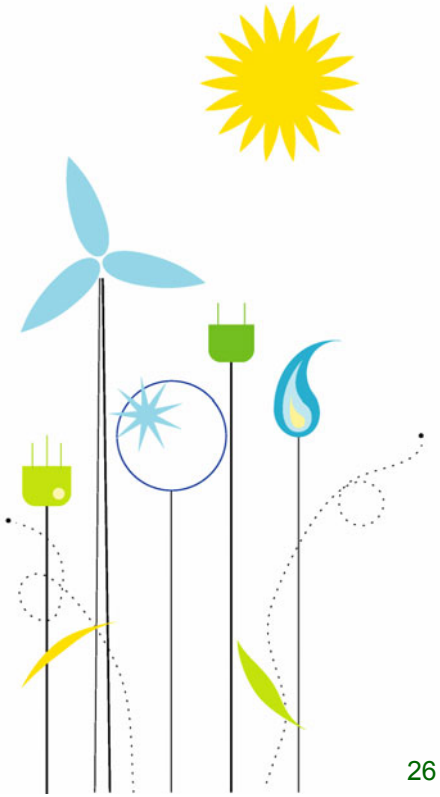


Summary

- **BP is Taking Big Steps Towards CCS Deployment**

- **What's required:**
  1. **Growing Power Market**
  2. **Advantaged fuel, infrastructure, geology**
  3. **Supporting Government Policy**
  4. **Regulatory Framework for CO_2 geological storage**

- **BP is ready to invest in CCS projects where we think the four requirements can be met**



Thank You: Questions?