

## Summary of PTAC Identified R& D Projects and Priorities for the Canadian Upstream Oil & Gas Industry

### A. COURSE (Co-ordination of University Research for Synergy and Effectiveness)

#### A.1 Future Research Priorities

The April 1999 COURSE workshop identified numerous energy research priorities:

<http://www.ptac.org/links/dl/coursenotes.doc>

#### A.2 Projects

<http://www.ptac.org/course1.html>

Brief project descriptions for COURSE may be found on the PTAC web site under the above noted URL in each of the 3 COURSE newsletters.

### B. Conventional Heavy Oil

#### B.1. Future Research Priorities

Workshop notes: <http://www.ptac.org/techchow.html>

##### B.1.1. Beyond Cold Flow Workshop

<http://www.ptac.org/techchow.html>

Saskatchewan and Alberta have enormous conventional heavy oil resources. Over the past decade the commercial production of heavy oil using "cold flow" techniques (co-production of sand and oil commonly considered to be by wormhole/foamy oil flow) has led to the drilling and production of over 5,000 new wells. The production technique has been very successful and many oil reservoirs now use the method. Unfortunately, individual well cold flow production is relatively short lived with a typical recovery of about 5-15% of the oil in place. Predictions of future heavy oil production show a drop in total heavy oil production beginning in about 2005 as production from large numbers of the cold flow wells decline below economic rates. The 2001-04-03 workshop notes document future research priorities.

##### B.1.2. Venting

Methane emissions from upstream oil and gas production and transmission sources comprise approximately 8% of Canada's GHG emissions. As well as being a GHG concern, producers are becoming more aware of the economic potential to utilize vent gas. Conventional heavy oil methane vent emissions represent 79% of the 328 million cubic meters (31 MMSCFPD) of vent gas measured and reported in AEUB's Upstream Petroleum Industry Flaring Report for 1999, which does not include additional volumes vented by operations in Saskatchewan.

In June 2000, New Paradigm Engineering Ltd. launched a project to investigate and define economic options for utilization of methane vented from conventional heavy oil well casings. The main project report has now been completed and issued to participants.

##### B.1.3. Artificial Lift (Rodless Downhole Drives)

<http://www.ptac.org/cho/dl/chow9901n.doc>

#### B.2 Conventional Heavy Oil Projects - \$7.4M

<http://www.ptac.org/techchop.html>

- 1) Development of Full Project Engineering and Economics for the Vapex Process – \$450K(14)<sup>1</sup>
- 2) Assessment of Heavy Oil Fluid Gathering System Alternatives – \$250K (10)<sup>1</sup>
- 3) Cyclic Waterflood Simulation Study – \$18K<sup>2\*</sup>
- 4) Reducing the Cost of Tank Cleaning in Heavy Oil Operations – \$176K (8)<sup>2\*</sup>
- 5) Heavy Oil Upgrading with Water via Super Critical Partial Oxidation – \$325K<sup>2</sup>
- 6) Evaluation of Markets for Produced Sand – \$30K\*<sup>2</sup>
- 7) Pipelineable Bitumen and Heavy Oil Project (NCUT/AST) – \$76K<sup>2</sup>
- 8) Thermal Solvent Process – Field Scale Engineering & Economics – \$600K<sup>3</sup>
- 9) In Situ and Refinery Upgrading of Vapex Heavy Oil Production for Increased Value and Reduced Emissions (Vapex Phase II) - \$500K<sup>3</sup>
- 10) Casing Deformation Study - \$200K<sup>3</sup>
- 11) Vapex Refinery Upgrading Project – \$68K<sup>3</sup>

- 12) Bio-upgrading for Heavy Crude Quality Improvement – \$253K<sup>3\*\*</sup>
- 13) Heavy Oil Vent Gas Utilization - \$70K (1)<sup>3\*</sup>
- 14) Progressive Cavity Pump Run-Life Improvements – \$200K<sup>4</sup>
- 15) Characterization of Conventional Oil and Gas, Heavy Oil and Bitumen Formations using low field NMR Spectroscopy – \$333K<sup>4\*\*</sup>
- 16) Asphaltene Deposition – \$243K<sup>4\*\*</sup>
- 17) Intermetallic-based alloy-coatings on steel structures used in oxidation, sulphidization and carburization environments – \$128K<sup>4\*\*</sup>
- 18) Enhanced oil recovery by urease-catalyzed, microbial calcium carbonate blocking – \$137K<sup>4\*\*</sup>
- 19) In-line multiphase flow meter development – \$115K<sup>4\*\*</sup>
- 20) Performance evaluation of shale for ensuring hydraulic isolation around thermal wellbores – \$380K<sup>4\*\*</sup>
- 21) Vapex Engineering and Economics, Phase 3 - \$300K<sup>4</sup>
- 22) Foamy Oil Behaviour: Beyond the Cold Production Process – \$107K<sup>4</sup>
- 23) Cyclic Solvent-Based Process for Heavy Oil Reservoirs – \$107K<sup>4</sup>
- 24) SAGD Application in Reservoirs with Depleted Gas Caps – \$107K<sup>4</sup>
- 25) Geological Controls on the Isotope Geochemistry of Formation Gases in the Alberta Oilfields - \$275K<sup>5\*\*</sup>
- 26) Data Sufficiency for Petroleum Reservoir Decision Making - \$155K<sup>5\*\*</sup>
- 27) Foamy Oil Flow in Cold Production of Heavy Oil - \$182K<sup>5\*\*</sup>
- 28) Effect of Residual O<sub>2</sub> in CO<sub>2</sub> for a Combined Miscible Flood/CO<sub>2</sub> Sequestration Process - \$959K<sup>5\*\*</sup>
- 29) Seismic Monitoring for Enhanced Heavy Oil Recovery - \$415K<sup>5\*\*</sup>
- 30) Control of Methane Emissions from Heavy Oil Development - \$191K<sup>5\*\*</sup>

## C. Drilling

### C.1. Future Research Priorities

**2000 Workshop Notes:** <http://www.ptac.org/drl/dl/drlw0002n.doc>

**Overall Top Priorities** (1 and 3 are very similar)

- 1) Heavy Oil Drilling
- 2) Cold Region Arctic Drilling
- 3) Wellbore Stability & Casing Integrity at shallow depths in weak (including hot) formations
- 4) Drilling Low Pressure Zones

#### Alternate Drilling Systems

#### Drilling/Rock Interaction

1. Novel drilling for ROP in hard rock
2. Cold region, Arctic drilling
3. Wellbore stability casing integrity shallow, weak (including hot)

#### Surface Equipment

1. Advanced drilling systems (lighter, cheaper, small footprint)
2. Rig automation (pipe handling/reduced labour)
3. Closed Loop
4. Slimhole exploration rigs for deeper wells
5. Rig design improvements (alternates)

#### Drilling Fluid

Drilling Low Pressure Zones

Researching Waste Management

Developing Cementing Expertise in Niche Areas

#### Subsurface Equipment

Heavy Oil Drilling

Underbalanced Drilling and Performance

Sour/Thrust Belt Drilling

Casing While Drilling

Downhole Data Acquisition, Communication & Control

1998 Drilling & Completions Workshop Notes: <http://www.ptac.org/drl/dl/drlw9801n.doc>

(Note: This may be out of date.)

## C.2 Drilling Projects -- \$1.2M:

<http://www.ptac.org/techdrp.html>

- 1) Rotator Project – \$460K<sup>1</sup>
- 2) Research and Software Development Project to Reduce Drilling and Completion Costs Associated with Borehole Instability – \$130K<sup>1</sup>
- 3) Development of Coiled Tubing Drill Strings for Sour Service Underbalanced Drilling – \$100K<sup>2</sup>
- 4) Evaluation of Coiled Tubing Serviceability for Sour Service Applications - \$ 150K<sup>4</sup>
- 5) A New Measurement while drilling surveying technique employing the technology of fiber optic gyroscope in a strap down inertial navigation system – \$113K<sup>4\*\*</sup>
- 6) Borehole Stability and Sand Production Risk Assessment Software - Phase 2 – \$250K<sup>4</sup>

## D. Environment

### D.1 Air

#### D.1.1. Future Research Priorities

##### D.1.1.1. Climate Change

Workshop notes: <http://www.ptac.org/workshops1.html>

- 1) Sour gas for microturbines
- 2) Energy management programs for corporations
- 3) Crankcase vents
  - Assess loss of performance
- 4) Clearstone – see last slide in presentation
  - Waste heat/process modification
- 5) Blair pump demonstrations
  - NPEL demonstrations (see 2<sup>nd</sup> last slide in presentation)

##### D.1.1.2 Flaring

Workshop notes: <http://www.ptac.org/env/dl/envw0001n.doc>

(■ *Actual field work is key*)

- 1) Transform continued/new Combustion Efficiency (CE) research into:
  - Measurement/detection methods
  - Technology to set CE guideline/standards
- 2) Continued/new full-scale technology evaluation – validation
  - Develop test protocol
- 3) Low pressure vent gas management and cost effective technology alternatives
- 4) Well test flaring
- 5) Emissions characterization & sources (e.g. radiant heat loss)
- 6) Sulphur/liquids removal (high hanging fruit)
- 7) What are the specific compounds from flaring and quantities ■
- 8) Gas stream clean-up ■
- 9) Flare efficiency under different conditions ■
- 10) Define and disseminate measure technology requirements ■
- 11) Broaden understanding beyond solution gas flaring
  - Well testing
  - Emergency & maintenance
  - Blowdown/plants/workovers
  - Real world conditions (scenarios)
    - Chlorides
    - Sulphur

- Turbulence
- Emposition – H<sub>2</sub>S

General research (as well as well testing specific)

- Heat loss
- Exit velocity impacts
- Effect of liquid carryover

Impact on combustion efficiencies of real world conditions

12) Improved/increased combustion efficiency

- Incineration
- Cost effective enclosed flare
- Robust flare tips
- Improved flare design
- Effective liquid separation
- Cost effective high temperature materials for incineration
- Destruction/combustion
- Tie to real world conditions
- Time
- Temperature
- Turbulence
- Improved ignition systems
- How to measure efficiency
- NOX

13) Effective energy utilization

- Electrical general
- Heat recovery
- Agriculture uses
- Other uses
- ReInjection of flue gas
- Physical/chemical transformation

14) Fate and transport

- Better dispersion modeling
- Health/environment effects
- Risk assessment
- May be covered by Western Canada Health Study and others

15) Full scale field testing

- Full scale wind tunnel testing
- Field testing (with some control)
- Field testing in field
- Number of sites to be representative
- Equivalent testing methodology
- Consistency with detection equipment
- Testing standards

16) Improved measurement and monitoring

- Innovative technology to measure effluent
- Laser
- Infra red
- Surrogate measurement to validate reasonably i.e.: co/particulate
- Workable/cost effective method acceptable to regulatory needs

17) Improved production techniques to stabilize flow rates.

### **D.1.2 Potential Future Research Based on 2002 CAPP ERAC Applications Air- \$609,800**

- 1) Online odour and fugitive emission monitoring from the petroleum industry using and electronic nose – Richard N. Coleman, Alberta Research Council Inc. Amount requested \$138,000
- 2) Controlled Human Exposure Studies to H<sub>2</sub>S: API Investigation of Neurobehavioural Potential – Geoff Granville, Shell. Amount requested \$200,000
- 3) SRU Incinerator – John A. Sames, Sulphur Experts Inc. Amount requested \$50,000
- 4) Acid Gas BTEX removal for Gas Processing – John A. Sames, Amine Experts Inc. Amount requested \$50,000
- 5) Regional Air Shed Data Analyses and Modeling – Geoff Granville, Shell. Amount requested \$71,800
- 6) Odour Prediction and Measurement – Ahmed Idriss, Alberta Environment. Amount requested \$100,000

### **D.1.3 Projects**

<http://www.ptac.org/projects1.html>

- 1) Onsite Electrical Generation from Flare Gas – \$400K 2
- 2) Flare Speciation – Part I, R&D Provider: University of Alberta– \$266K 2\*
- 3) Flare Speciation – Part II, R&D Provider: Advanced Combustion Technologies – \$270K 2\*
- 4) Flare Performance – Part I, R&D Provider: University of Alberta – \$263K 2\*
- 5) Flare Performance – Part II, R&D Provider: Advanced Combustion Technologies – \$180K 2\*
- 6) Flaring - Improved Liquid Separation, R&D Provider: Synergas Technologies – \$222K 2\*
- 7) Flaring - Alternate Technologies – Part I, R&D Provider: Advanced Combustion Technologies – \$265K 2\*
- 8) Flaring - Alternate Technologies – Part II, R&D Provider: Ontario Hydro Tech/University of Calgary – \$130K 2\*
- 9) Gas Plant Remediation - \$214K3
- 10) Weyburn CO<sub>2</sub> Monitoring Project - \$ 22M4
- 11) Fugitive Emissions – \$162K 3\*
- 12) Emissions from Individual Oil and Gas Reservoirs – \$141K 3\*\*
- 13) Flaring Technology Field Test Facility: Phase 1a - Flaring Mitigation Centre Market Assessment - \$45K 3\*
- 14) Natural Gas Losses – \$55K4 \*
- 15) Improving the performance of high temperature fuel cells – \$184K 4 \*\*
- 16) • Combustion enhancement and emission reduction from flare stacks using passive jet-flow control – \$112K 4
- 17) Options for Conventional Heavy Oil Vent Gas Utilization and Mitigation – \$ 90K 4 \* (6)
- 18) Flare Research Project - \$3.1M 5
- 19) Fatigue Analysis and Damage Mitigating Control of Industrial Co-generation Systems – \$209K 5 \*\*
- 20) A New Technique for Mitigating Electrical Disturbances Caused by Energizing Generator Transformers – \$192K 5
- 21) Fuel Cell for Conversion of Hydrogen Sulfide – \$280K 5 \*\*
- 22) Improving Solid-Oxide Fuel Cell Operation Using Hydrocarbon Fuels – \$1.5M 5 \*\*
- 23) Well Test Flare Plume Monitoring (ARC) – \$26K5 \*
- 24) Well Test Flare Plume Monitoring (SRC) – \$88K5 \*

## **D.2 Soil Remediation, Site Restoration & Groundwater**

### **D.2.1 Future Research Priorities**

Workshop notes: <http://www.ptac.org/workshops1.html>

- 1) Collection of Effective Hydrocarbon Site Remediation Techniques
- 2) Salinity, Salt Impacted Soils and Other Toxicity Sources
- 3) Natural Attenuation, Risk Based Corrective Action, Monitoring Methods for RBCA
- 4) Enhanced Bio-Remediation, Risk-Pathway Analysis Prior to Remediation

### **D.2.2 Potential Future Research Based on 2002 CAPP ERAC Applications Soil - \$982,200**

- 1) Plant Uptake and Degradation of Process Chemicals and Hydrocarbons in Wetlands – Brent Moore, Komex International Ltd. Amount requested \$30,000
- 2) Solar Detoxification of Petroleum Hydrocarbon Contaminated Groundwater – Bill Wong, Science Applications International Corporation Canada. Amount requested \$75,000

- 3) Development of a protocol for site-specific risk assessment and identification of plant species sensitive to flare emissions using physiological and biochemical tests – Jan J. Slaski, Alberta Research Council. Amount requested \$80,000
- 4) Reclamation and management of crested wheatgrass invaded sites in southern Alberta – Dr. M. Anne Naeth, University of Alberta. Amount requested \$67,200
- 5) Book-Installation, Inspection and Maintenance of Fuel Oil Storage Tank – John Butt, Canadian Oil Heat Association. Amount requested \$30,000
- 6) Treatment of PAHs in Soil using a Two-Phase Partitioning Bioreactor – Monique Punt, Science Applications International Corporation Canada. Amount requested \$120,000
- 7) In-Situ Flushing Process for the Treatment of Mixed-Contaminated Soil – Dr. Konstantin Volchek, Science Applications International Corporation. Amount requested \$20,000
- 8) Native Vegetation/Wetland Inventory and GIS Mapping: Parkland Natural Region – Ron Bjorge, Alberta Sustainable Development. Amount requested \$10,000
- 9) LNAPL removal from fractured rock by surfactant flooding – Robert Coupland, Duke Engineering & Services

**Soil & Groundwater – \$407,969**

- 1) Field-Scale Assessments of the Phytoremediation of Weathered Hydrocarbons – Richard E. Farrell, University of Saskatchewan. Amount requested \$70,000
- 2) Framework Foundation and Guidance for Tier 2 Site-specific Development of Soil Contact Cleanup Standards for PHC-contaminated Sites – Gladys L. Stephenson, ESG International Inc. Amount requested \$50,000
- 3) Determination of Environmentally Acceptable Endpoints for Residual Unrefined Petroleum Hydrocarbons in Soil-Phase III – Dr. S. Visser, University of Calgary. Amount requested \$88,000
- 4) The determination of the effect of oil sand mining by-products such as bitumen, naphthenic acids, salts, and alkalinity on the growth and/or survivorship of soil invertebrates and plants, and the implications for site reclamation – Dr. D.G. Dixon, University of Waterloo. Amount requested \$79,969
- 5) Electro-Thermal Remediation of Hydrocarbon Contaminated Soils and Groundwater – Brent Winder, McMillan-McGee Corp. Amount requested \$50,000
- 6) Field- Scale Assessments of the Phytoremediation of Weathered Hydrocarbons in Soil – Richard E. Farrell, University of Saskatchewan. Amount requested \$70,000

**D.2.3 Projects**

<http://www.ptac.org/techenvp.html>

- 1) Determination of Environmentally Acceptable Endpoints for Residual Unrefined Petroleum Hydrocarbons in Soil– \$695K 2\*
- 2) Assessment of Phytoremediation as an In-Situ technique for Cleaning Oil Contaminated Sites Phases 1&2 – \$47K 3\*
- 3) Hydrophobic Soils – \$200K 3\*
- 4) Evaluation of Past Revegetation Mitigation Efforts – \$91K 3\*
- 5) Assessment of Phytoremediation as an In-Situ technique for Cleaning Oil Contaminated Sites Phase 3 – \$422K 4 \*
- 6) Development of Soil and Water Quality Guidelines for Sulfolane and DIPA: Environmental and Human Health – \$100K4
- 7) Monitored Natural Attenuation – \$1.0M 4 \*
- 8) Evaluation of Hydrocarbon Degradation & Uptake by Plants – \$200K 4 \*
- 9) Degradation of Petroleum hydrocarbons at the soil/root interface in contaminated soils – \$102K 4 \*\*
- 10) Natural attenuation of petroleum hydrocarbons at upstream oil and gas facilities – \$883K 4 \*\*
- 11) Real-Time Internet Based Surveillance of Oil/Gas Pipelines – \$342K 5 \*\*
- 12) Geomechanical –Reservoir Processes of Waste Injection (Disposal) into Unconsolidated Formations – \$363K 5 \*\*

**D.3 Wildlife/Ecology**

**D.3.1 Potential Future Research Based on 2002 CAPP ERAC Applications**

*Wildlife/Ecology* - \$ 335,000

- 1) Prediction of groundwater upwelling areas for identifying critical bull trout spawning habitat – Darren Fantin, Burlington Resources Canada Energy Ltd. Amount requested \$40,000

- 2) Monitored Natural Attenuation for Upstream Oil and Gas Industry – James Armstrong, Komex International Ltd. Amount requested \$100,000
- 3) Oldman River Basin Harlequin Duck Nesting Survey – Dale Paton, Anatum Ecological Consulting. Amount requested \$15,000
- 4) Recovery of caribou ranges in Alberta – Bob Wynes, Boreal Caribou Research Program. Amount requested \$180,000

### D.3.2 Projects

- 1) Eastern Slopes Grizzly Bear Project (ESGBP)
- 2) Foothills Model Forest Grizzly Bear Study

## E. Health and Safety

### E.1 Future Research Priorities

2001 Driving Safety Workshop & Forum: <http://www.ptac.org/workshops1.html> and <http://www.ptac.org/forums1.html>

A few specific oil & gas research priorities were identified (fatigue, driver attitude & infrastructure design), but generally driving safety is a high priority area. For more specific research needs, contact Bob Cunningham, PSC or Don Szarko, AMA.

## F. Inactive Well Management and Well Abandonment

### F.1 Future Research Priorities

Workshop Notes <http://www.ptac.org/workshops1.html>

- Carbon Isotope Research (U of A)
- Logging for SCVF source detection and cementing (or alternative) for repair

## G. Natural Gas, Production, Processing & Transportation

### G.1 Future Research Priorities

1997 workshop (may be out of date) <http://www.ptac.org/workshops1.html>

### G.2 Projects – \$1.2M

<http://www.ptac.org/techgasp.html>

- 1) Water Content and Physical Properties of Acid Gases – \$300K <sup>1</sup>
- 2) Mitigation of Harmonic Distortions in Oilfield Electrical Distribution Systems – 212K <sup>3\*\*</sup>
- 3) Optimization of Steam Generator Performance – \$298K <sup>4\*\*</sup>
- 4) Experimental and Modelling Study of the Kinetics and Thermodynamics of Hydrate Decomposition – \$400K <sup>5\*\*</sup>

## H. Oil Production and Transportation

### H.1 Future Research Priorities

1997 Workshop Notes (may be out of date) <http://www.ptac.org/workshops1.html>

### H.2 Projects – \$352K

<http://www.ptac.org/techoilp.html>

- 1) Predicting Internal Pitting Corrosion of Multiphase Pipelines – \$352K <sup>1</sup>

## I. Oilsands

### I.1 Projects - \$4.6 M

<http://www.ptac.org/techosdp.html>

- 1) Development of a Novel Hardfacing Material System for the Oil Sands Industry: Pseudoelastic Composites with Nanostructured Reinforcing Particles – \$330K <sup>3\*\*</sup>
- 2) Investigation of Interfacial Mass-Transfer Mech. in the VAPEX Process for Heavy Oil Recovery – \$96K <sup>3\*\*</sup>
- 3) Online Slurry Air-content Determination and Analysis (OSADA) Technology for Oil sands Development – \$104K <sup>3\*\*</sup>
- 4) Solids Distribution in Hydrotransport Process – \$107K <sup>3\*\*</sup>
- 5) Destabilization of Emulsified Water and Fine Solids Through Asphaltene Precipitation – \$210K <sup>3\*\*</sup>
- 6) Oil Sand Lump Size Estimation (LSE) by 3-D Sensing – \$220K <sup>3\*\*</sup>
- 7) Particle Flow Modelling of Oil Sands Excavation – \$174K <sup>3\*\*</sup>
- 8) Metallurgical Studies for the Production of Rutile Concentrate from Oil Sands Tailings – \$101K <sup>3\*\*</sup>

- 9) Role of Microbial Process on Sulfate-Enriched Tailings Deposits – \$123K<sup>3\*\*</sup>
- 10) Geotechnical Behaviour of Oil Sands Paste Tailings / Geotechnical Physics of Producing Thickened Tailings (Paste) – \$354K<sup>4\*\*</sup>
- 11) Fundamental Study of Bitumen Digestion Process – \$278K<sup>4\*\*</sup>
- 12) Development of a new technology to improve the equipment utilization rate in mining operations – \$149K<sup>4\*\*</sup>
- 13) Research into cold (25C) conditioning of oil sands with regard to solids reduction in froth through solvent/demulsifier nascent froth and naptha/paraffinic diluent post-production froth treatment schemes – \$163K<sup>4\*\*</sup>
- 14) At Face Slurrying: Advancing innovative technology for oil sands production – \$522K<sup>4\*\*</sup>
- 15) Impact of residual bitumen removal methods on the separation of heavy minerals in the oil sands tailings – \$261K<sup>4\*\*</sup>
- 16) Investigation of the Erosion-Corrosion Mechanisms in Slurry Flow - \$290K<sup>5\*\*</sup>
- 17) Intelligent Shovel Excavation in Varying Oil Sands Formation and Bitumen Content - \$505K<sup>5\*\*</sup>
- 18) Impact of Asphaltene-Solvent Interaction on Vapex Process - \$151K<sup>5\*\*</sup>
- 19) Scale-up of Dispersion Coefficients in Vapex Process - \$327K<sup>5\*\*</sup>
- 20) A Microstructural Approach to Modelling Sand Production - \$182K<sup>5\*\*</sup>

## J. Reservoir Recovery/Geoscience

### J.1 Future Research Priorities

Enhanced Petroleum Recovery (EPR) Workshop: <http://www.ptac.org/workshops1.html>

This was an excellent workshop (2000-09-26) with a number of priorities identified. Please refer to notes.

### J.2 Projects – \$1.8M

<http://www.ptac.org/techresp.html>

- 1) Field Pilot for Water Abatement in Gas Reservoirs – \$302K<sup>2</sup>
- 2) Economically Beneficial Waste Gas Injection for Medium/Heavy Oil Depletion – \$100K<sup>2</sup>
- 3) Seismic Velocity Imaging of the Steen River Crater: Technique Development for Exploring Crater Reservoirs – \$95K<sup>3\*\*</sup>
- 4) Increasing Gas/Oil Recovery from Naturally Fractured Reservoirs with Water Coning Problems: Process Understanding and Field Applications – \$211K<sup>3\*\*</sup>
- 5) Evaluation of miscible and sub miscible flue gas injection for improved recovery of light oils and sequestering of green house gases – \$73K<sup>4\*\*</sup>
- 6) Seismic velocity anisotropy and depth imaging – \$430K<sup>4\*\*</sup>
- 7) Enhanced Waterflooding Using Toe-to-Heel Displacement – \$107K<sup>4</sup>
- 8) Water Abatement in Gas Reservoirs – \$107K<sup>4</sup>
- 9) Wireless Digital Sensors and Analysis Systems for Monitoring Petroleum Reservoirs - \$405K<sup>5\*\*</sup>

## K. Well Completion, Stimulation and Workover

### K.1 Future Research Priorities

1997 workshop (may be out of date) <http://www.ptac.org/workshops1.html>

### K.2 Projects – \$1M

<http://www.ptac.org/techcomp.html>

- 1) Field Pilot for Near Well Treatment to Reduce Gas Coning/ Channelling – \$200K<sup>2</sup>
- 2) Low Cost, High Performance Diverting and Blocking – \$190K<sup>2</sup>
- 3) Field Pilot to Remove Pyrobitumen Blockage from Oil and Gas Reservoirs with the PRlStine™ Process – \$400K<sup>3</sup>
- 4) Gel-Foam Applications – \$107K<sup>4</sup>
- 5) Improved Water Production Prediction in Carbonates – \$107K<sup>4</sup>

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111 projects facilitated in total by PTAC, valued at \$ 52.3 Million (M)

<sup>1</sup> 1997 (6)    <sup>2</sup> 1998 (19)    <sup>3</sup> 1999 (26)    <sup>4</sup> 2000 (38)    <sup>5</sup> 2001 (22)

K (000)

( ) Number of project participants

\* This project arose from a PTAC Request for Proposal (RFP)

\*\* This project originated from COURSE (Coordination of University Research for Synergy and Effectiveness)