The Bapco Challenge

Action Learning Program 2008

Presentation Outline

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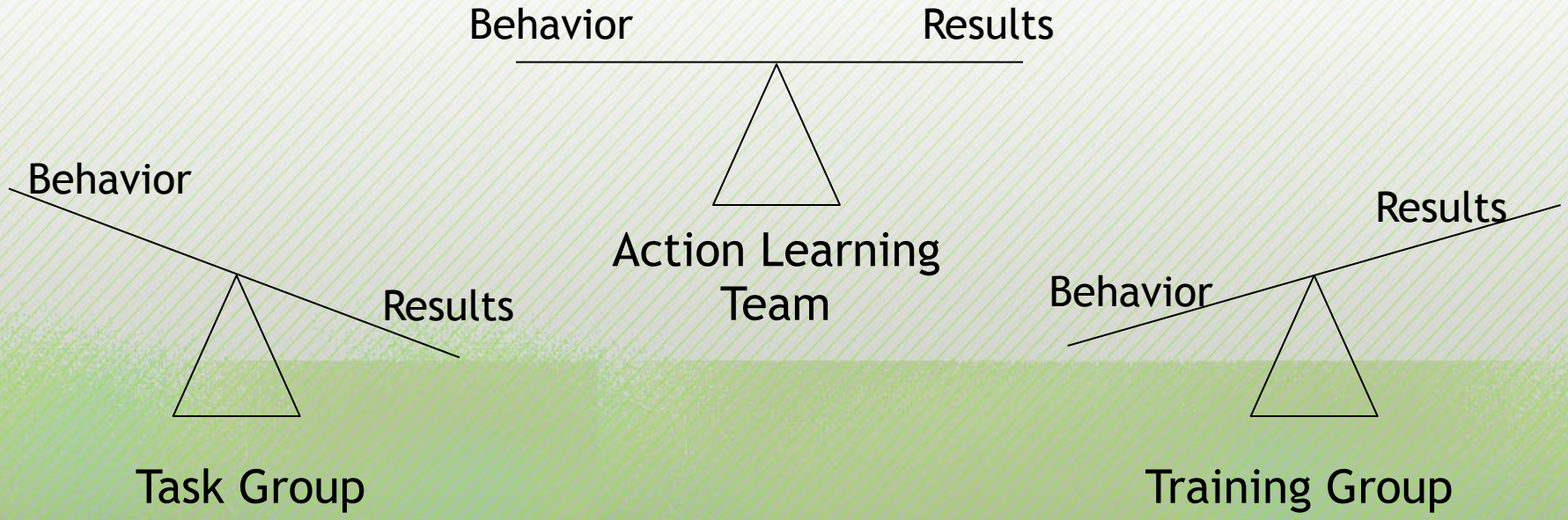
12. Summary

ALP

- Action Learning Program
- Based on action learning, whereby we study our own actions and experience to improve performance
- Balancing behavior and results



Bapco Challenge

"Identify and Evaluate Carbon Credit Opportunities to Improve the Environmental Impact of the Bahrain Petroleum Company"

The Team:

- Ebrahim Al-Qassab (Oundle School, U.K.)
- Hassan Al-Halwachi (Sherborne School, U.K.)
- Mishal Awadah (University of Pennsylvania, U.S.)
- Zainab Abbas (Sedbergh School, U.K.)
- Abdulla Al-Ansari (Bapco, Environmental Engineer, Engineering Division)
- Faisal Ahmed (Bapco, Special Projects Manager, Refining Division)

Project Objectives & Scope

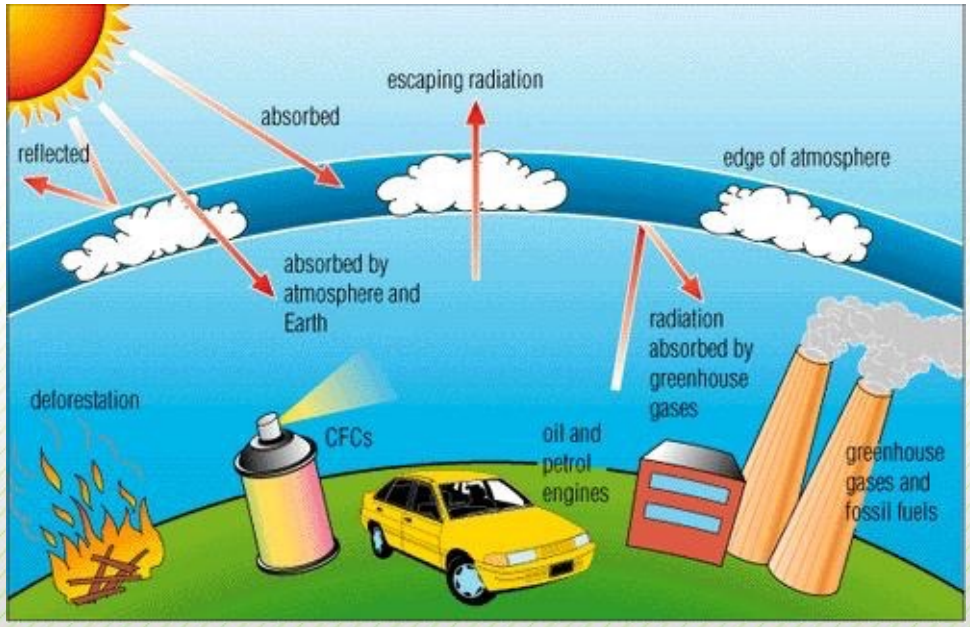
- Define the relevance of **Carbon Credit Trading** to Bapco & Bahrain.
- **Calculate** carbon emissions in Bapco.
- Identify **feasible** Carbon Credit opportunities in Bapco.
- Calculate the **carbon credit benefit** by implementing projects.
- Identify methods to **communicate** the benefits and rationale of CDMs within Bapco & Bahrain.
- Prepare a **business case** for implementing the identified carbon credit opportunities.

About Bapco

- Bapco is owned by the Government of Bahrain, and is an integrated oil and gas company:
  - Bapco was formed in 1929
  - Oil was first discovered in Bahrain in 1932
  - Crude oil and natural gas production
  - Refining crude to produce petroleum products
  - Storage and export of the refined products

Carbon Dioxide … How is it affecting us ?

- Fossil fuels contain carbon
- Burning them generates CO_2
- CO_2 is a greenhouse gas
- It lets heat in, but not out
- The more we emit, the less heat escapes
- Result: temperature rises



It's not just CO_2

Greenhouse gas	Global Warming Potential
Carbon dioxide	1
Methane	21
Nitrous oxide	310
CFCs	125 - 152
HFCs	125
Perfluorocarbon	6500
Sulfur hexafluoride	23900

It's not just CO_2

Greenhouse gases	Chemical formula	Pre-industrial concentration	Concentration in 1994	Atmospheric lifetime (years)***	Anthropogenic sources	Global warming potential (GWP) *
Carbon-dioxide	CO_2	280 ppmv	358 ppmv	50-200	Fossil fuel combustion Land use conversion Cement production	1
Methane	CH_4	700 ppbv	1720 ppmv	12-17	Fossil fuels Rice paddies Waste dumps Livestock	21 **
Nitrous oxide	N_2O	275 ppbv	312 ppmv	120-150	Fertilizer industrial processes combustion	310
CFCs	CFC12	0	503 pptv	102	Liquid coolants. Foams	125-152
HCFCs	HCFC-22	0	105 pptv	13	Liquid coolants	125
Perfluorocarbon	CF_4	0	110 pptv	50 000	Production of aluminium	6 500
Sulphur hexa-fluoride	SF_6	0	72 pptv	1 000	Production of magnesium	23 900

Note : **pptv**= 1 part per trillion by volume; **ppbv**= 1 part per billion by volume, **ppmv**= 1 part per million by volume

* GWP for 100 year time horizon. ** Includes indirect effects of tropospheric ozone production and stratospheric water vapour production. *** On page 15 of the IPCC SAR. No single lifetime for CO_2 can be defined because of the different rates of uptake by different sink processes.

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What can be done?

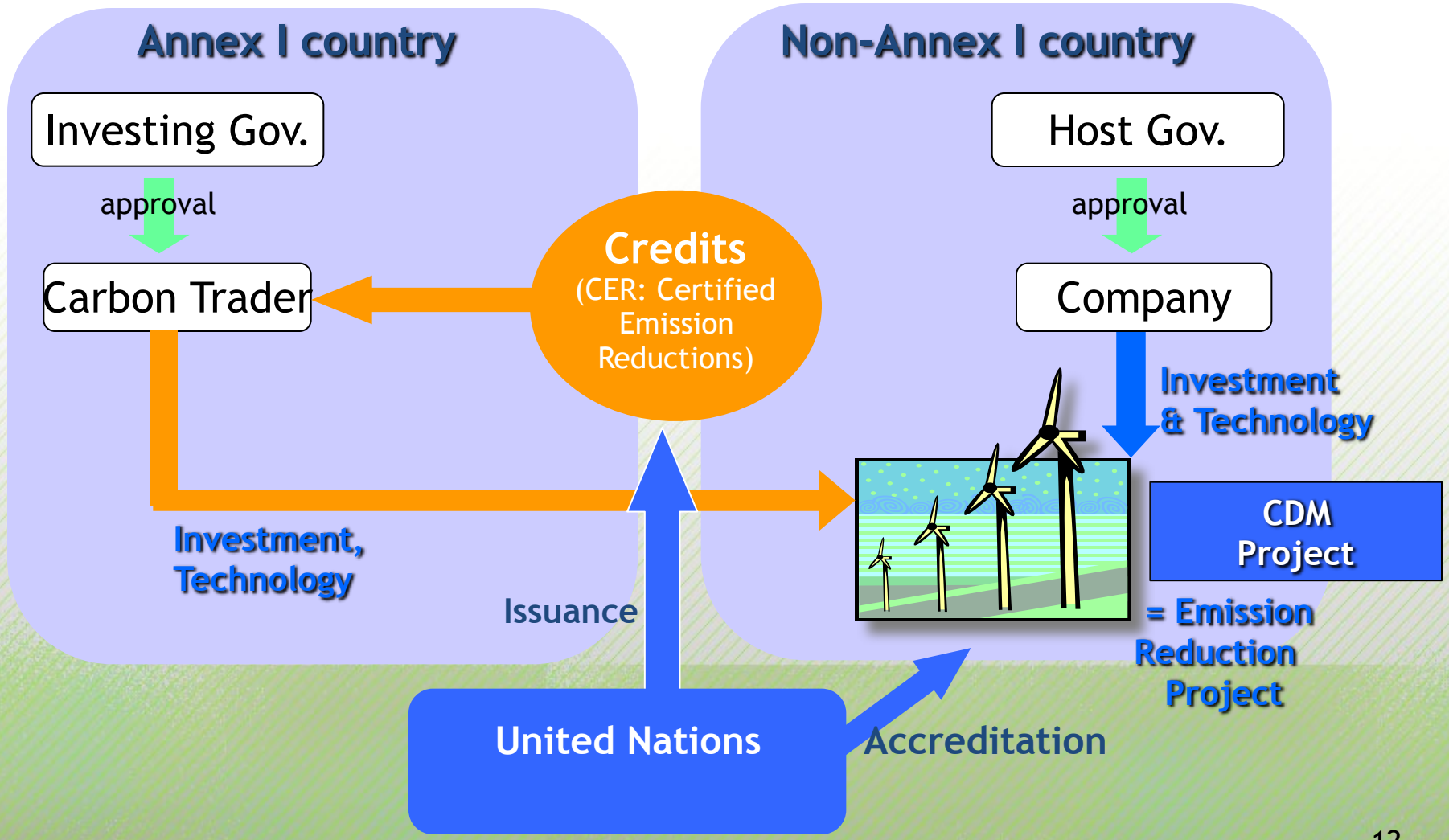
Kyoto Protocol: Reduce emissions of greenhouse gases or engage in emissions trading

- Covers 181 countries (including Bahrain)
- Annex I and Non-Annex I countries
- Carbon Credits and Trading

Clean Development Mechanism

- It is more expensive for developed countries to reduce emissions through project investment
- Developing countries do not possess the same technological standards
- Allows industrialized countries with a reduction commitment (Annex 1) to invest in projects that reduce emissions in developing countries (Non-Annex 1)
- Global cost of reducing net global emissions is lower

Clean Development Mechanism Diagram



Accepted CDM Sectors

- End-use energy efficiency improvement
- Supply-side energy efficiency improvement
- Fuel switching
- Industrial Processes
- Waste management
- Sinks (afforestation and reforestation)

Important CDM Regulations

- "**Additionality**":
  - Project should not be **"Business as Usual (BAU)"**
  - There must be some "barrier" that the project could NOT overcome on a BAU basis.
  - The applied project is commercially / technically not viable without CER revenue
- **Baseline & Monitoring methodology***:
  - Approved by CDM Executive Board (*Method to calculate the CER amount.)
  - Joint project between Annex-I country(ies) and non-Annex-I country.

Our Vision

> To Surpass Global CO_2 Reduction Targets <

- G8 emission reduction target is ≈ 50% by 2050
- Bahrain has no obligation to reduce emissions

CDM Project Plan

Step 1-A: Identify the Problem

- Researched registered CDM projects
- Meetings with carbon credit specialists
- Site visits to different Bapco sectors, specifically within the refinery
- Discussions with respective specialists, engineers, and superintendents
- Spoke to more than 50 Bapco employees

Step 1-B: What Emits CO_2 in Bapco?

- Heaters: Combustion of natural gas to generate heat for specific operations

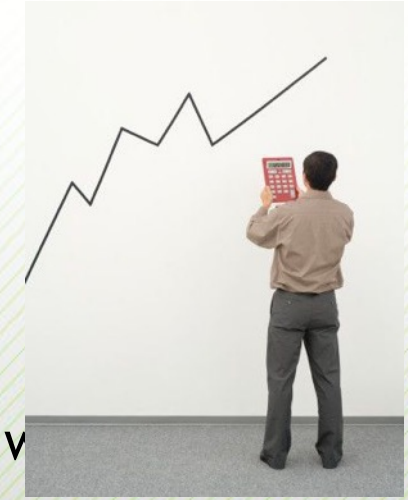
  $CH_4 + O_2 \rightarrow CO_2 + H_2O + Heat$

- Gas Turbines: Natural Gas is burned to drive a turbine which generates electricity

- Process Units: Units whereby a specific process produces CO_2 as a byproduct
- Flaring: Excess gas is flared into atmosphere producing CO_2
- Transportation: CO_2 released from vehicles

Step 1-C: Calculating the Baseline

1. Duty per Stack (heaters and turbines)
   - Calculating amount of energy released by burning fuel
2. FCCU Regenerator
   - Analyzing air flow in and out of regenerator
3. Hydrogen Reformer
   - Combustion of khuff gas + purge gas

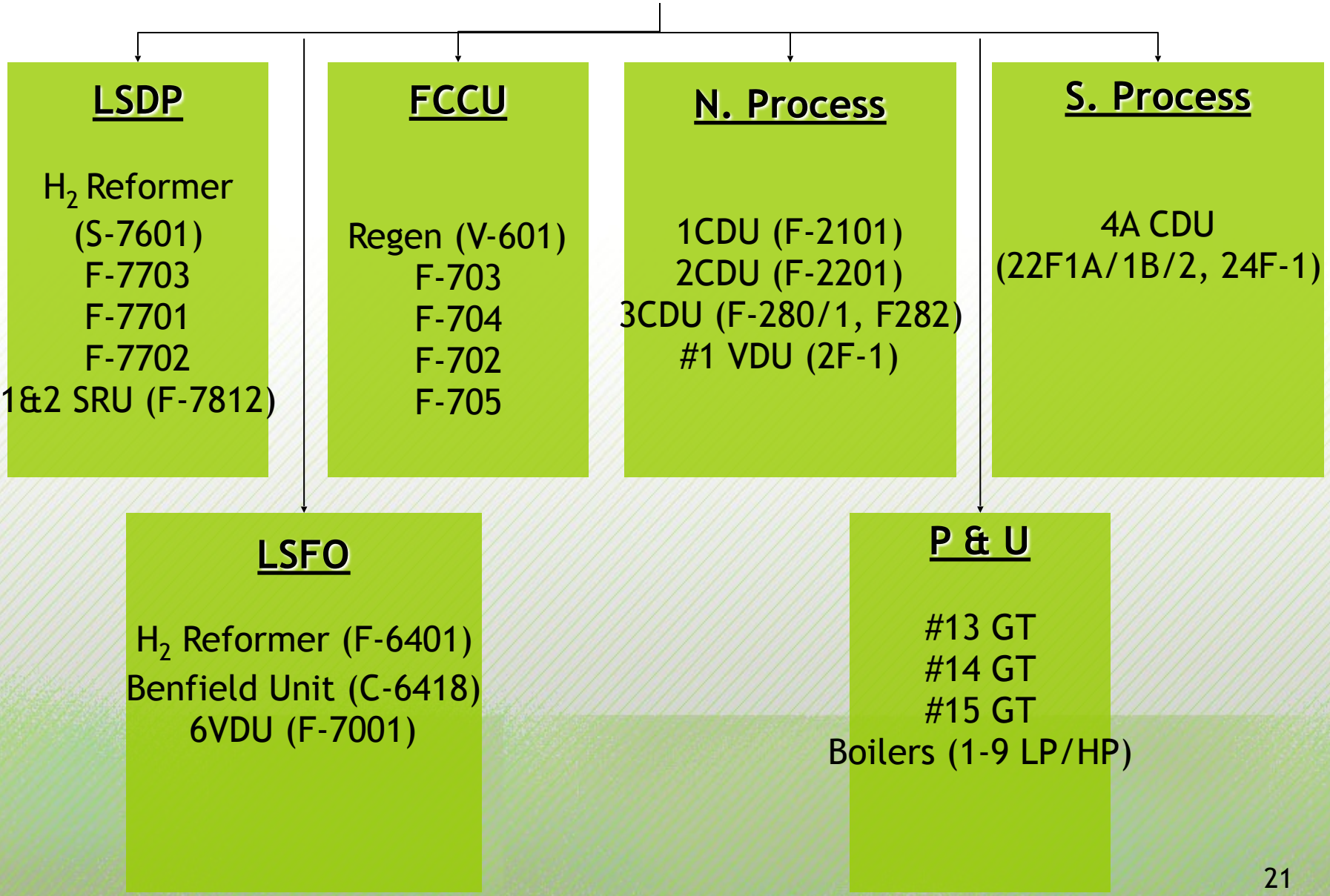


- Calculated Baseline is 3,749,165 Tonnes/Yr
- Error in Bapco's figure: 19% less than the figure v
- Leading cause of error was the lack of inclusion of purge gas in the calculations done for No. 2 H_2 Reformer

Bapco


Refinery
Total CO_2 Emission: **3,749,165** Tons/Yr
Wharf
No significant CO_2 emission
Sitra Tanks
No significant CO_2 emission
Bahrain Field
- No CDMs Applicable
- CO_2 emitted only during flaring

“Bad Actors” of the Refinery



Step 2: CDMs Applicable to Bapco

1. Supply-Side Energy Efficiency Improvement
   - Utilizing as much heat as possible from combustion of gas
   - Reduces required amount of gas to produce the same amount of energy
   - Overall emissions decrease as a result of combusting less gas

2. Carbon Capture (Concern: Not yet accepted as CDM)
   - Capture waste gas from stacks
   - Filter to separate CO_2
   - Liquify CO_2 for storage and export to CO_2 market as product

Step 3: Our CDM Approach

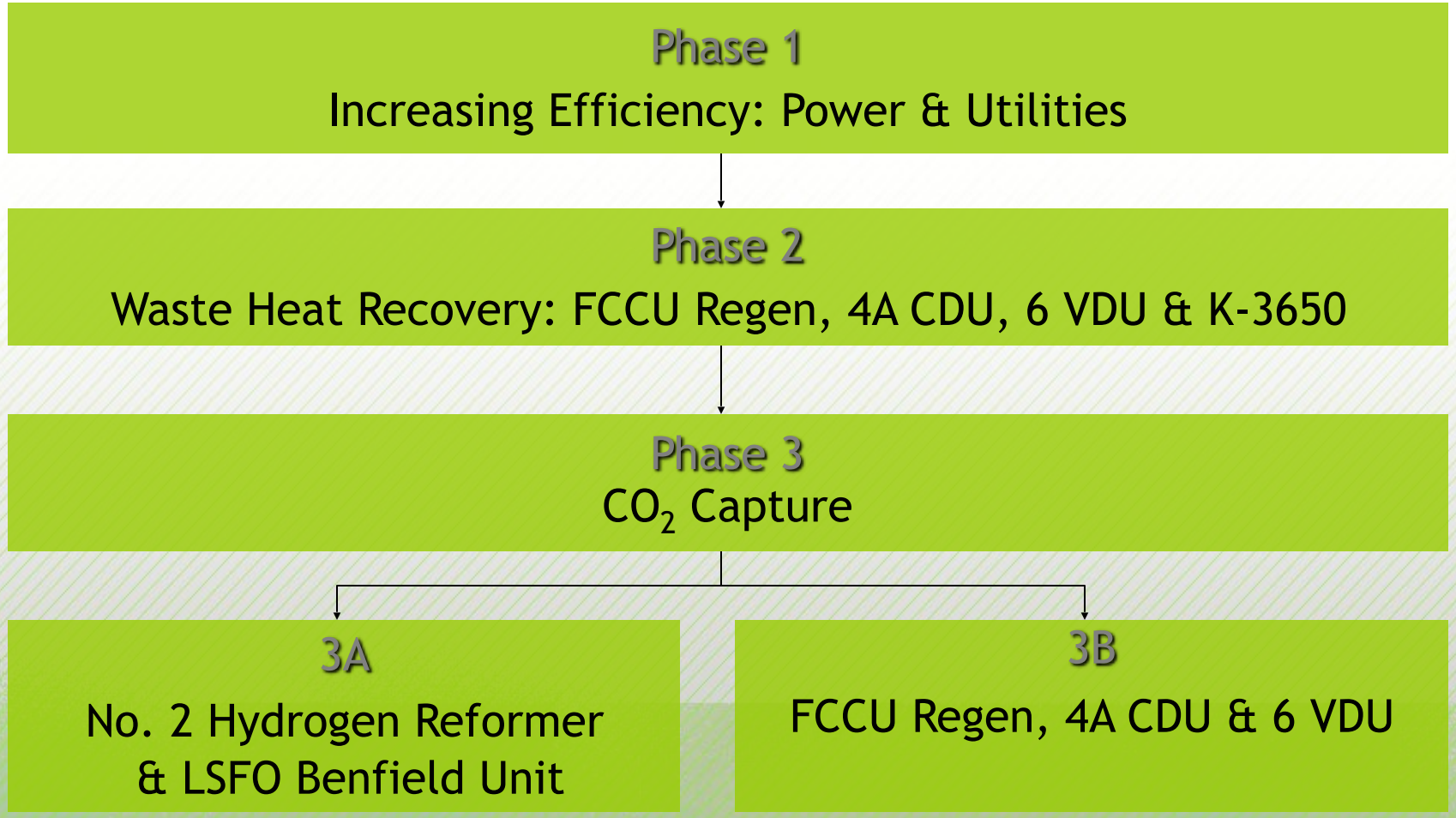
- Identifying potential CDMs
- Ranking CDM
  - CO_2 Reduction (20%)
  - Cost-Benefit Analysis (20%)
  - Feasibility (20%)
  - Reliability & Additionality (40%)
- Estimating *Capital Cost*
- Determining *Return on Investment*
- Calculating *Certified Emission Reductions* **(CERs)**
- Calculating *Simple Payback*

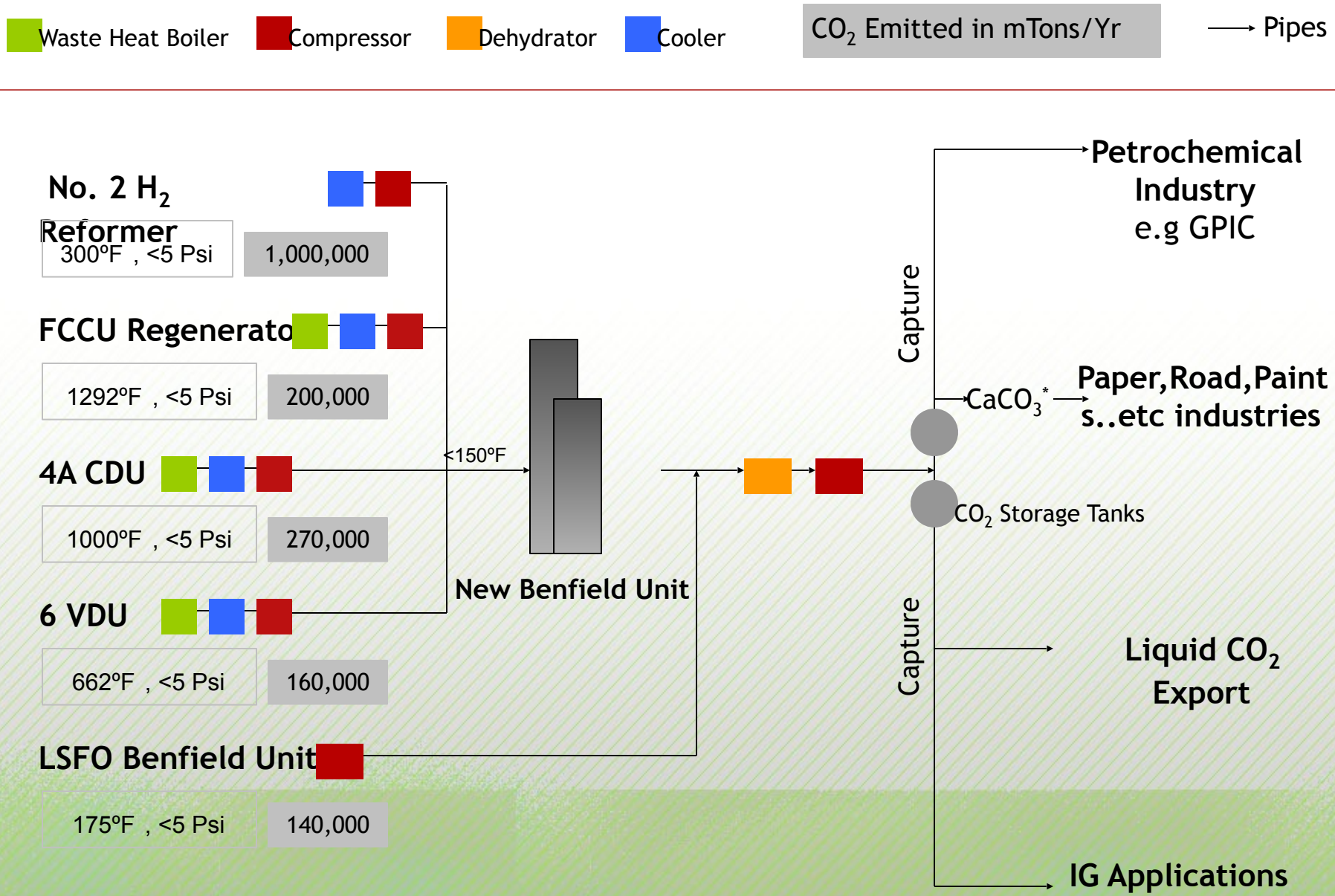
Top CO_2 Emitters in Bapco

	Unit	Quantity Tons/Yr	Contribution to total CO_2 emission/%
1	No. 2 Hydrogen Reformer	1,006,313	27
2	Power & Utilities	526, 040	14
3	4A Crude Distillation Unit	266,159	7
4	FCCU Regenerator	208, 319	6
5	6 Vacuum Distillation Unit	161,998	4
6	Benfield Unit (LSFO)	141,380	3

These six units emit 61% of total CO_2 emissions in the Refinery

Step 4: Recommendation

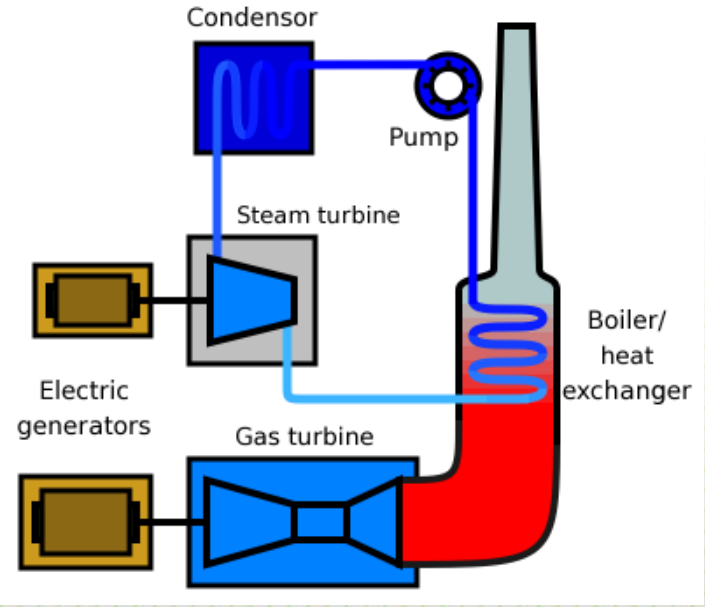




* $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

Phase 1: Increasing Efficiency

- Considered Units:
  - Gas Turbines 13, 14, & 15
- The Problem:
  - The efficiency of gas turbines is low (18%)
  - Turbines run on open cycle configuration
- Solution:
  - Installation of new gas turbines
    - Increased efficiency (18% → 40%)
  - Install combined cycle
    - Utilization of waste heat to generate steam
    - Further increases efficiency (40% → 50%)



Phase 1: Increasing Efficiency

CDM Project Rank:

Project	CO_2 Reduction (20%)	Cost-Return Benefit (20%)	Feasibility (20%)	Reliability & Additionality (40%)	**Weighted Mean**
Phase 1	2.5	4.0	9.5	9.0	**6.8**

Capital cost	$ 60 million
Fuel Savings	$ 3.7 million/Yr
CER Benefit	$ 5.6 million/Yr
Total Return	$ 9.3 million/Yr
Simple Payback	6 years

Phase 2: Waste Heat Recovery

- Units Considered:
  - 4A Crude Distillation Unit (CDU)
  - Fluid Catalytic Cracking Unit (FCCU) Regenerator
  - 6 Vacuum Distillation Unit (VDU)
  - K-3650 Platformer Gas Turbine
- The Problem:
  - Inefficiency → Flue gases are very hot
  - Waste heat is not utilized
- Solution:
  - Install waste heat boilers on stacks
  - Utilizes the heat to produce steam
  - This enables the shutdown of 2 boilers

Phase 2: Waste Heat Recovery

CDM Project Rank:

Project	CO_2 Reduction (20%)	Cost-Return Benefit (20%)	Feasibility (20%)	Reliability & Additionality (40%)	**Weighted Mean**
Phase 2	2.0	3.0	8.5	9.0	**6.3**

Capital cost	$ 40 million
Fuel Savings	$ 2.6 million/Yr
CER Benefit	$ 3.9 million/Yr
Total Return	$ 6.5 million /Yr
Simple Payback	7 years

Phase 3-A: Installing Carbon Capture Complex

- Units Considered:
  - No. 2 Hydrogen Reformer
    Hydrocarbons react with steam to produce H_2 and CO_2
  - Benfield Unit at LSFO
    Filters CO_2 and steam from the other gases emitted
- The Problem:
  - Hydrogen Reformer produces the largest amount of CO_2
  - LSFO Benfield unit is releasing pure CO_2 stream to atmosphere
- Solution:
  - H_2 Reformer waste gases to New Benfield Unit for CO_2 capture
  - Benfield unit pure CO_2 stream to Carbon Complex for capture
  - Price of CO_2 per ton varies between $160 in MENA to $507 in N.A.

Phase 3-A: New Equipment Needed

- Benfield Unit
- 1 Sea water cooling unit
- 4 Compressors
- Dehydrator
- CO_2 storage tanks

Phase 3-A: Installing Carbon Capture Complex

CDM Project Rank:

Project	CO_2 Reduction (20%)	Cost-Return Benefit (20%)	Feasibility (20%)	Reliability & Additionality (40%)	**Weighted Mean**
Phase 3A	10	9.0	6.0	3.5	**6.4**

Capital cost	$ 250 million
CO_2 Sales	$ 184 million/Yr*
CER Benefit	$ 27 million/Yr
Total Return	$ 211 million /Yr
Simple Payback	2 years

* Based on lowest CO_2 price, $160/ton or around 60fils/kg.

Phase 3B: Expanding the Carbon Capture Complex

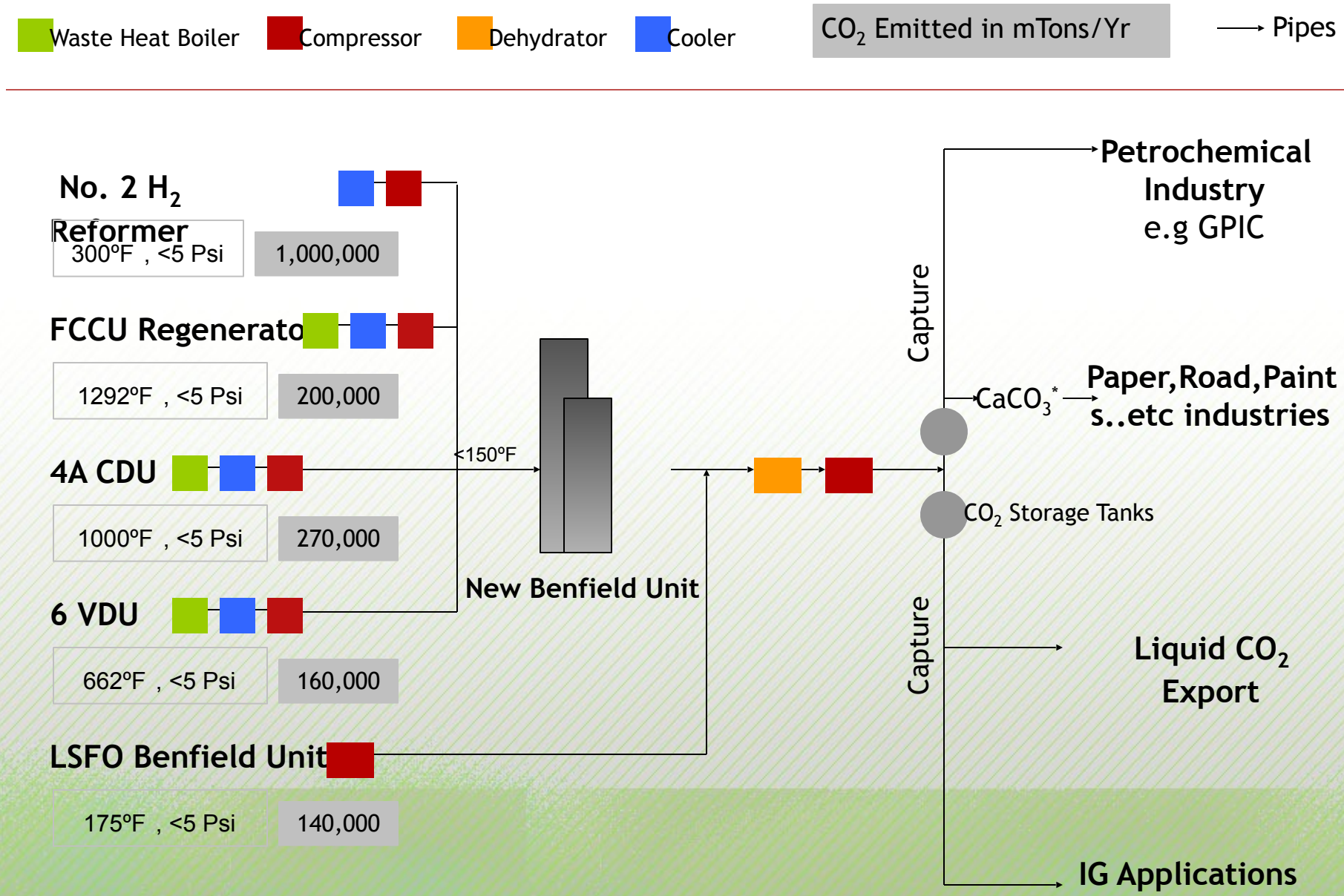
- Units Considered:
  - 4A Crude Distillation Unit (CDU)
  - 6 Vacuum Distillation Unit (VDU)
  - FCCU Regenerator
- The Problem:
  - A large amount of CO_2 is released
  - Heaters at 4A CDU and 6 VDU are already efficient (70-80%)
  - FCCU Regen is a Process Unit (CO_2 must be produced)
- Solution
  - Gases transferred to New Benfield Unit for CO_2 capture.

Phase 3B: Expanding the Carbon Capture Comple

CDM Project Rank:

Project	CO_2 Reduction (20%)	Cost-Return Benefit (20%)	Feasibility (20%)	Reliability & Additionality (40%)	**Weighted Mean**
Phase 3B	6.5	8.0	4.5	4.5	**5.6**

Capital cost	$ 160 million
CO_2 Sales	$ 95 million/Yr
CER Benefit	$ 15 million/Yr
Total Return	$ 110 million /Yr
Simple Payback	2 years



* $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

Ranking Summary

Project	CO_2 Reduction (20%)	Cost-Return Benefit (20%)	Feasibility (20%)	Reliability & Additionality (40%)	**Weighted Mean**
Phase 1	2.5	4.0	9.5	9.0	**6.8**
Phase 2	2.0	3.0	8.5	9.0	**6.3**
Phase 3A	10	9.0	6.0	3.5	**6.4**
Phase 3B	6.5	8.0	4.5	4.5	**5.6**

Total CO_2 Reduction

Phase	Expected Reduction (Tons/Yr)	% Reduction of Total Emissions
1 (P&U)	192,643	5.1
2 (WHR)	134,474	3.6
3A (No. 1&2 H_2 Reformer)	918,199	24.5
3B (FCCU Regen + 4A CDU + 6 VDU)	509,183	13.6
Total	**1,754,499**	**46.8**

Ambitious Ideas

- Use hybrid cars for transportation in Bapco (less pollution and conveys a good image)
- Power street lights using solar panels (savings on electricity)
- Provide district cooling for the whole of Bahrain (big savings on energy and electricity because of high efficiency)

Ambitious Ideas (cont'd)

- Industrial firms utilizing heat to produce steam to drive turbines and supply excess electricity to the national grid (savings on electricity and natural gas consumption)
- Install vapor recovery systems in petrol stations
- Massively improve the public transport system of Bahrain to reduce traffic, congestion and emissions
- Encourage the use of heat insulation in households to cut down on electricity consumption

Aim of the Campaign

The aim of the campaign is to raise awareness about the Clean Development Mechanism (CDM) and the importance of CO_2 reduction, which Bapco is on the path of implementing.

Challenges Faced

- The concept of CDM is difficult to get across considering the complexity of its details.
- Different languages spoken, age groups and working hours.
- Not all employees have the same knowledge and are able to grasp new ideas.
- A campaign has to be delivered in different methods which might increase the costs.
- A considerable percentage of the employees do not have access to Bapco's internet portal.

CDM Campaign In & Out of Bapco

Step 1

Identify the specific message the Campaign is aiming to deliver in and out of Bapco_

↓

Step 2

Meeting with Public Relations Department

↓

Step 3

Draw potential Campaign Plan

↓

Step 4

Assess Feasibility in Bapco

Phases of the Campaign

Phase 1

- Contact department managers
- Initiate a page on Bapco's Intranet portal

Phase 2

- Sending letters to employees and distribute brochures, posters & mugs
- Plant in helmet for each employee
- Paint vehicles with logo & slogan

Phase 3

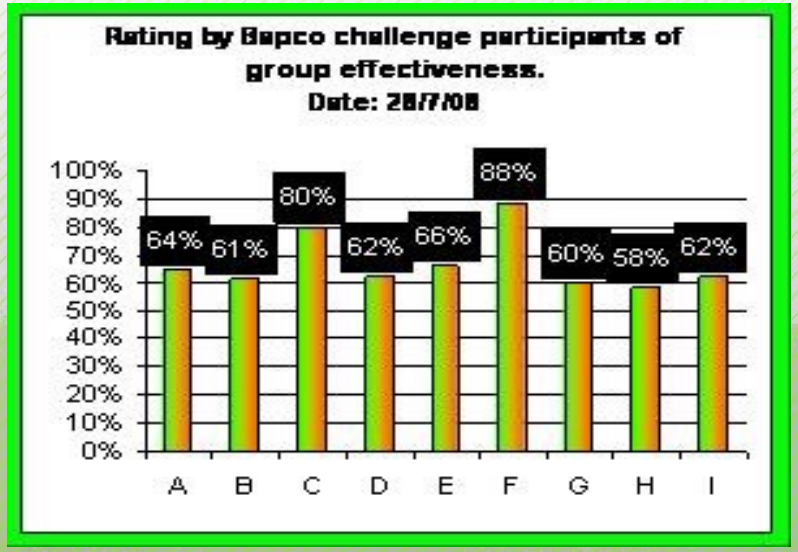
- Community garden
- Bicycle marathon
- Initiate CDM Week

Phase 4

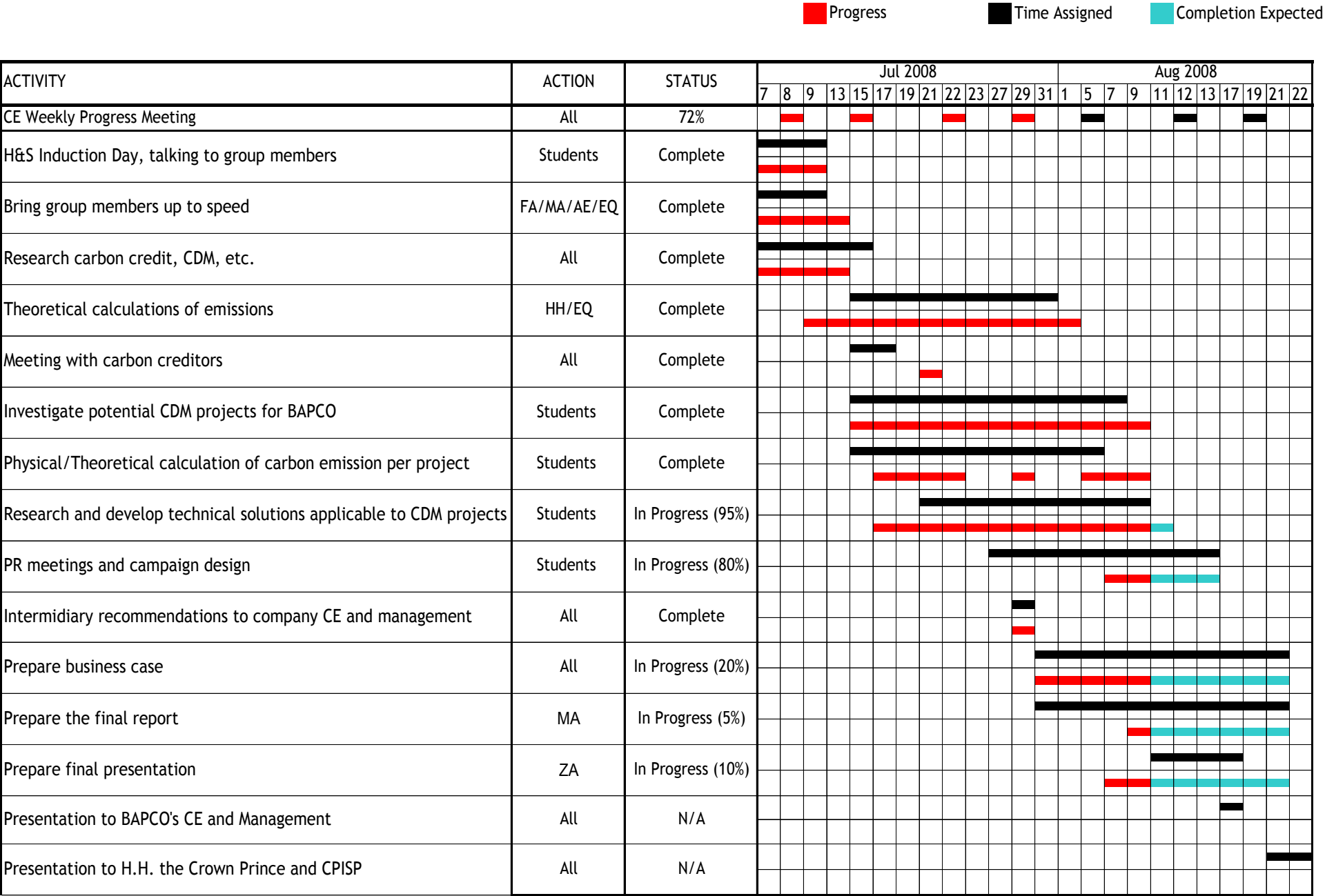
- Cooperate with other CDM appliers in gulf to deliver cooperative CDM campaign.
- Radio station with part-time operator.
- Introduce Bapco & CDM in Environmental Studies curriculum in schools.

Teamwork Dynamics

- Group Process Evaluation
- Self Perception Analysis
- Six Thinking Hats
- Feedback Formula
- Keeping track progress of the whole project



Track Progress



ACTIVITY	ACTION	STATUS
CE Weekly Progress Meeting	All	72%
H&S Induction Day, talking to group members	Students	Complete
Bring group members up to speed	FA/MA/AE/EQ	Complete
Research carbon credit, CDM, etc.	All	Complete
Theoretical calculations of emissions	HH/EQ	Complete
Meeting with carbon creditors	All	Complete
Investigate potential CDM projects for BAPCO	Students	Complete
Physical/Theoretical calculation of carbon emission per project	Students	Complete
Research and develop technical solutions applicable to CDM projects	Students	In Progress (95%)
PR meetings and campaign design	Students	In Progress (80%)
Intermidiary recommendations to company CE and management	All	Complete
Prepare business case	All	In Progress (20%)
Prepare the final report	MA	In Progress (5%)
Prepare final presentation	ZA	In Progress (10%)
Presentation to BAPCO's CE and Management	All	N/A
Presentation to H.H. the Crown Prince and CPISP	All	N/A

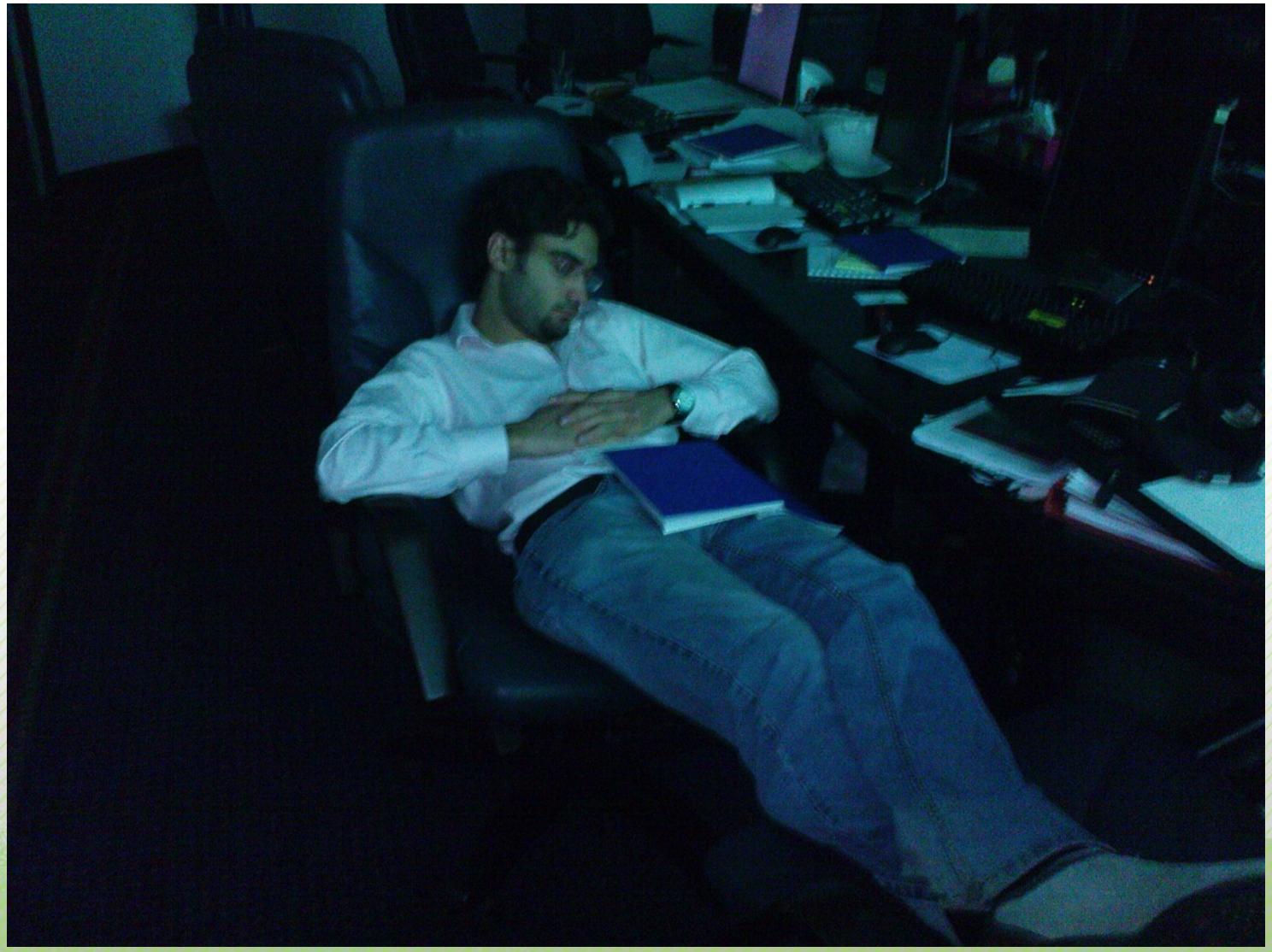
Summary

- Phases 1 & 2 are well established CDM projects that should be implemented immediately.
- Phase 3 has not been certified as a CDM project and will therefore need to undergo registration procedures . However, it is the most lucrative.
- A successful campaign would require effective planning, starting within Bapco and expanding.

Personal Learning & Experience

Our leader in action. Time: 16.25

Personal Learning & Experience



Our leader in action. Time: 17.25

Personal Learning & Experience