Mangrove Landfill gas Project

Barbados

CDM and JI Workshop

February 28, 2003

Burnside – Biothermica

Presentation Program

- Review of baseline objectives and outcome
- Feasibility study results
- Next steps

Green Energy Complex

- **What is the Green Energy Complex?**
  - Landfill Gas-to-Energy project including additional green energy generation capabilities through the provision of wind turbines
  - Project to be developed as a CDM Project

Green Energy Complex

- **Proposed Project Stages**
  - Landfill Gas (LFG) Collection and Flaring System
  - Landfill Gas-to-Energy including LFG storage and energy generation
  - Wind farm to be constructed to increase total energy generation capacity

Baseline Study
Objectives

- Estimate potential carbon credits that may be generated through using:
  - Landfill gas (LFG) captured for energy
    - Reduction in GHGs released to the environment
    - Create clean energy from captured landfill gas
  - Wind Energy potential

Green Energy Complex Baseline Study

Approach

- Environmental Impact Assessment (EIA)
- Selected the historical operational procedures assuming no LFG collection system as the baseline scenario
- Estimated GHG emissions that are reasonably expected under:
  - The reference scenario
  - The proposed scenario
- Assessed potential power generation rates from both wind and LFG extraction system

Small Scale CDM Project

- **Small Scale Project Definitions**
- UNFCCC has published a reference document entitled “Further Clarifications on Definitions of Eligible Activities” (2002)
- Describes three project categories including:
  - Type I: Renewable Energy Projects ⇐
  - Type 2: Energy Efficiency Improvement Projects
  - Type 3: Projects that Reduce Anthropogenic Emissions ⇐

Small Scale CDM Project

- **Projects are Mutually Exclusive**
  - Where two categories of projects are combined (i.e. LFG-to-Energy), then both project components must meet the threshold criteria of each project component

Small Scale CDM Project

- **Renewable Energy Projects (Type I)**
- Maximum output capacity equal to 15 megawatts or equivalent
  - Includes LFG-to-Energy and Wind Power Components
  - Maximum expected energy generation rate is 5-8 MW

Small Scale CDM Project

- **Projects Reducing Anthropogenic Emissions (Type III)**
- Project activity directly emits less than 15 kT CO_2e annually
  - Controlled by Project Boundary Definition
  - Project boundary was defined as the methane gas collection system

Environmental Impact Assessment

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Environmental Impact Assessment

- Ensured compatible land-use with proposed Green Energy Complex
- Assessed impact of implementing the Green Energy Complex with respect to:
  - Current site conditions
  - Surrounding properties
  - Natural Environmental Habitats
  - Soil, Water, and Air Quality
  - Existing Infrastructure
  - Impacts of Noise

Environmental Impact Assessment

Results

- **Main areas of concern:**
  - Air quality
  - Leachate generation and risk to aquifers
- **Design requirements**
  - Noise
  - Wildlife (flight path of birds)
- Impact Mitigation: the proposed landfill gas collection system and the resulting final cover materials will reduce the impacts of the landfill on the surrounding property

Assessment of LFG Generation

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Major Factors Affecting Landfill Gas Generation

- Waste input from site opening to closure
- Waste composition (organic matter and humidity content)
- Climate

Impacts of Uncontrolled Landfill Gas Emissions

- Lateral migration in the soil and subsurface bedrock
- Health issues, toxic effects, and public safety:
  - potential fire and explosion hazards
  - Suffocation
  - carcinogenic compounds
- Vegetation stress

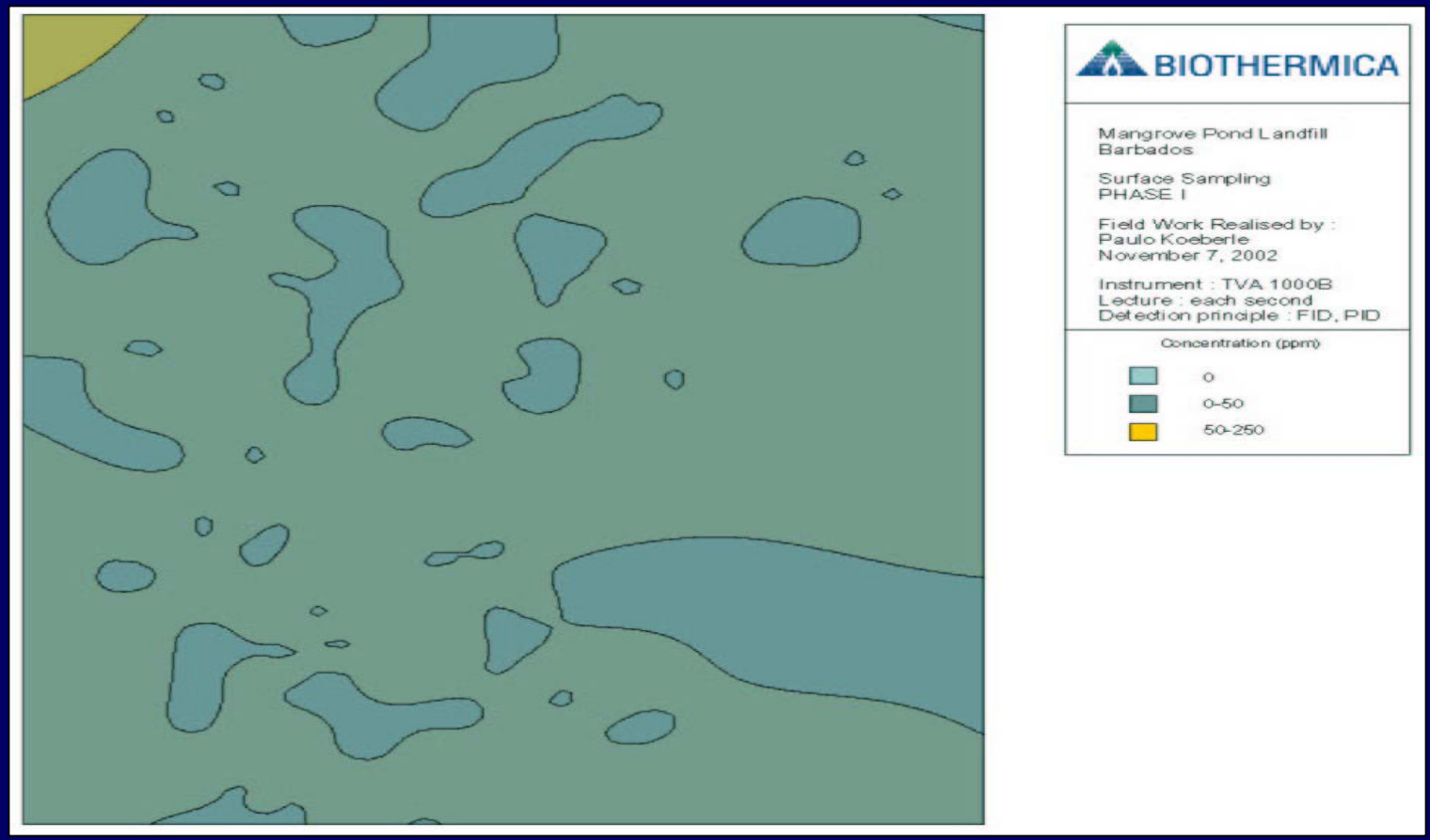
Landfill Surface Sampling

Sampling conducted to determine:

- the methane concentrations at the surface of the landfill site
- areas of a landfill where LFG generation and vertical migration are important (hot spots)
- System requirements of the LFG control system
- Efficiency of existing LFG control systems

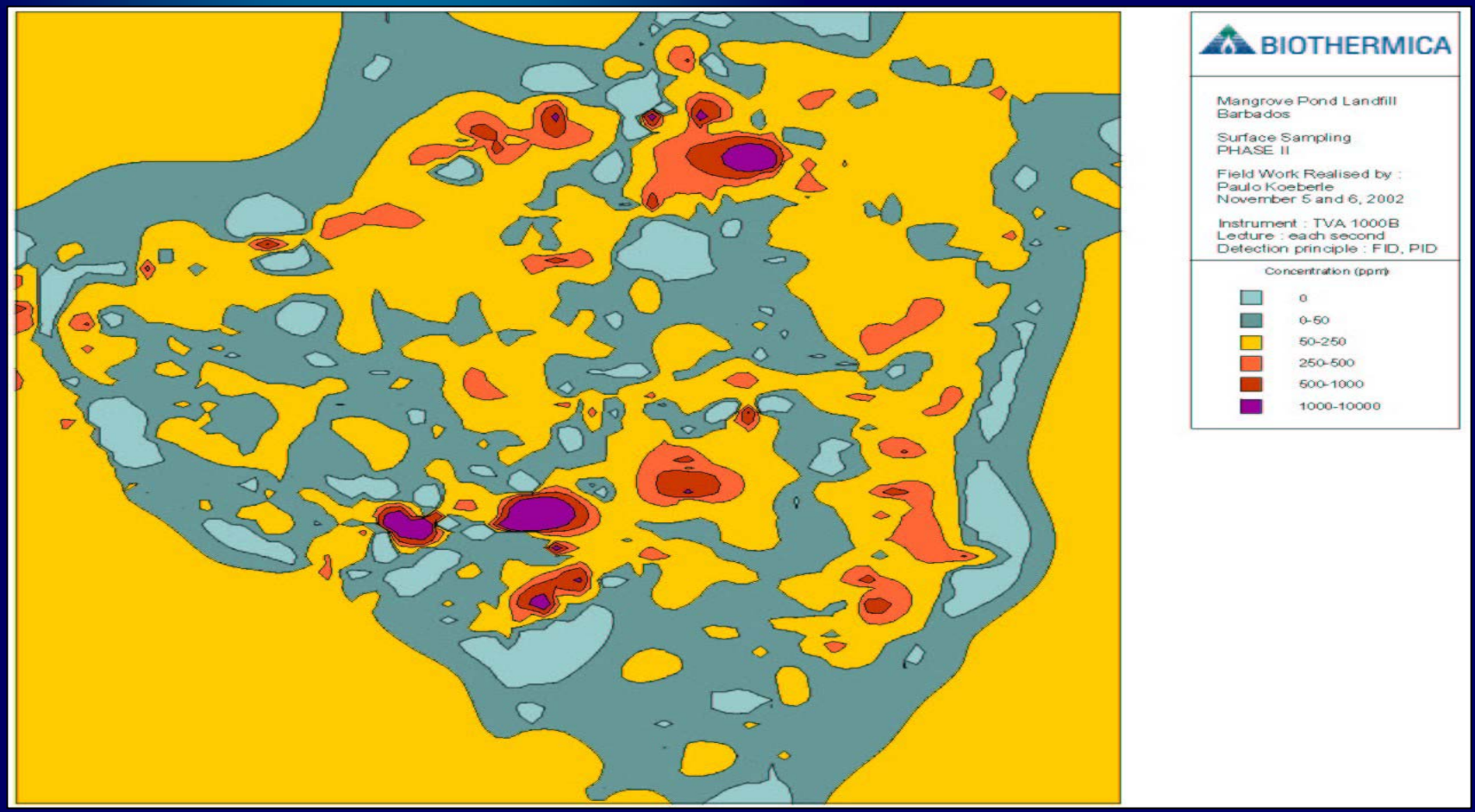
Landfill Surface Sampling

Phase 1



Landfill Surface Sampling

Phase 2



Results

- Modeling efforts: estimated current LFG production rates at 14,000,000 m^3 per year, while peak rates estimated to reach 15,700,000 m^3 in 2006
- Observed conditions: estimated vertical migration of LFG at the landfill surface was limited to 3,700,000 m^3 per year

Landfill gas composition

Sample composition

Nitrogen :	4%
Oxygen :	1%
Methane :	60 % ⇐
Carbon dioxide :	35 %

Other substances

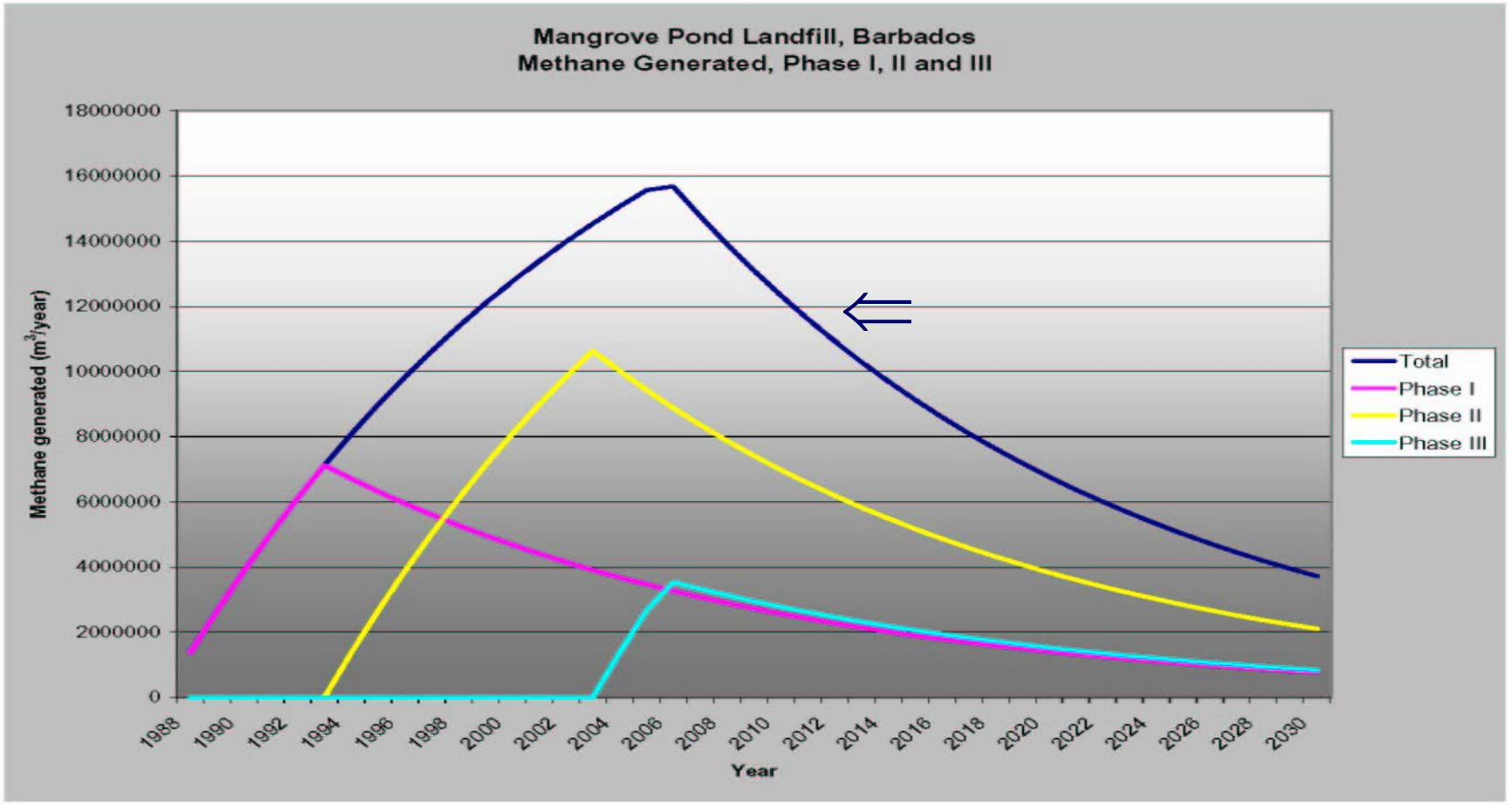
VOCs :	360 ppmv
Total reduced sulfur :	6 ppmv

VOCs composition

Concentration in ppbv

Toluene	14 000	1,2,4-trimethylbenzene	235
m+p-xylenes	3 840	1,3,5-trimethylbenzene	180
Vinyl chloride	1 500	4-ethyl-toluene	150
o-xylene	867	Styrene	122
Ethylbenzene	760	Dichloromethane	70
Freon	380	Trichloroethane	40
Benzene	250	Trichloromethane	20

Estimation of methane generation



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Wind Characterization

Wind Characterization

- Wind energy has potential to offset GHG emissions through adding clean energy to the power grid
- Wind speed at 50 m elevation above ground expected to average 7.6 m/s
- Wind expected to provide approximately 16.5 GWh as annual net electrical output
- Energy produced from wind is expected to reduce GHG emissions by 13,000 tonnes CO_2 per year as compared to existing energy generation methods

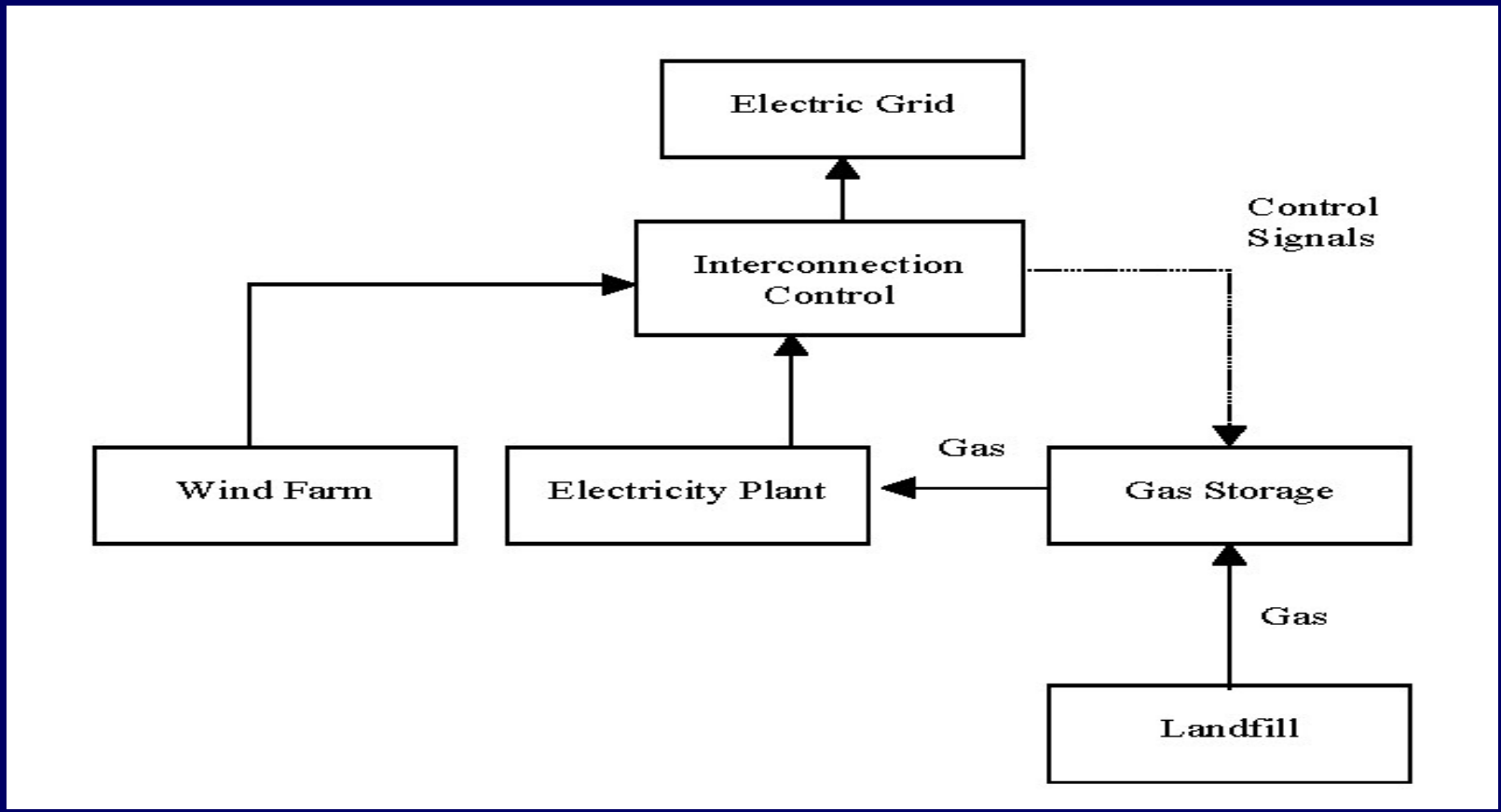
Example of Wind Turbine

System Design

System Design

- On-site LFG collection and storage has been designed to provide for the option of variable demand rates
- Extraction of LFG from the landfill will be completed using a collection network consisting of a pipeline and recovery system
- On-site storage may be provided through liquefaction of methane or high-pressure methane storage
- LFG treatment will be provided in accordance with the desired end use
- The wind farm component will provide 2 to 3 MW of power

System Design



GHG Emission Reduction Credits as an Additional Funding Mechanism

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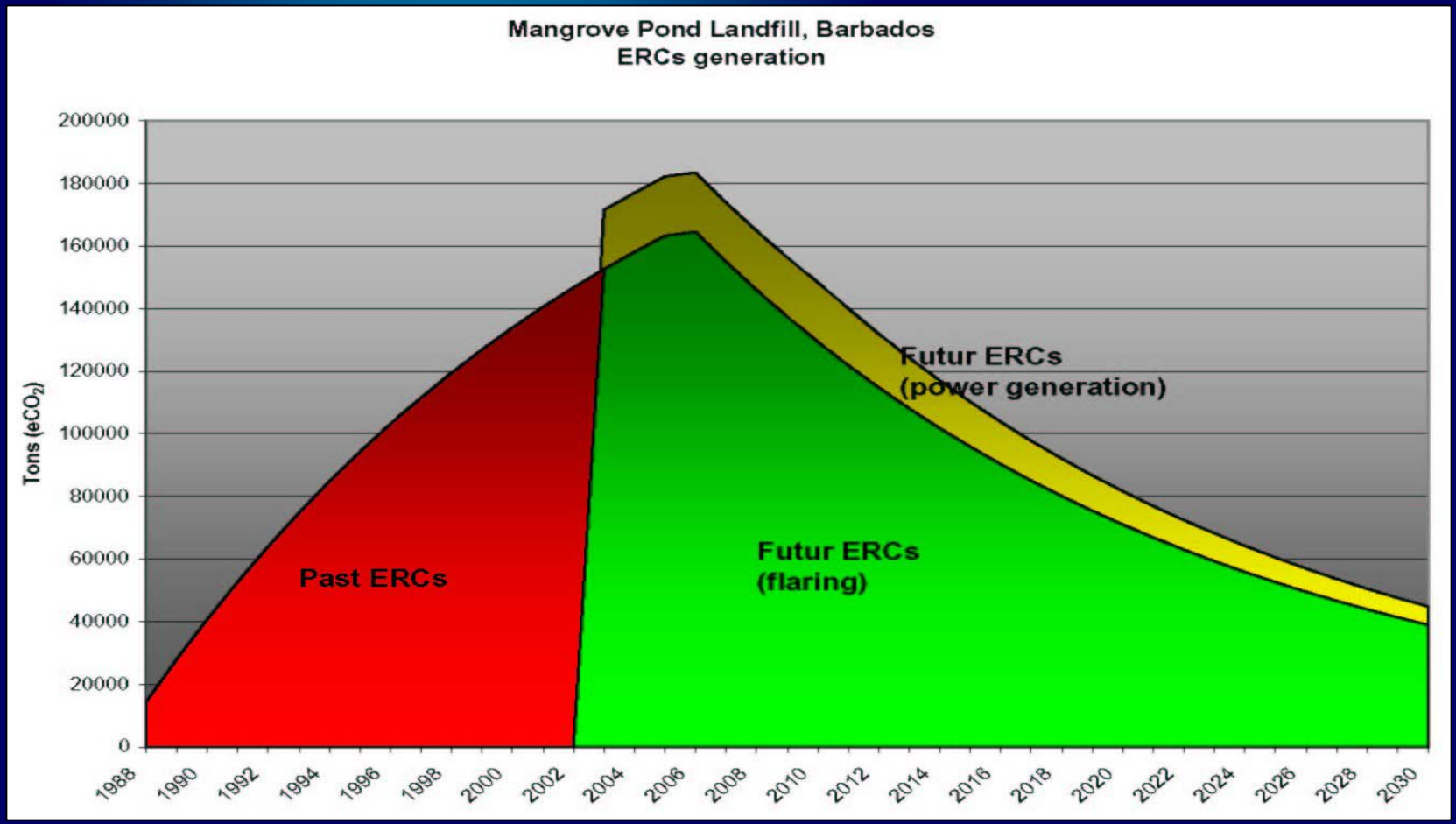
GHG Credits

- LFG emissions are expected to reduce total GHG emissions by:
  - 1.4 million tonnes CO_2e over 10 years through landfill gas collection, and
  - by an additional 190,000 tonnes CO_2e over 10 years through alternate fuel energy generation processes

GHG Credits

- Alternate fuel electrical generation in Barbados is assumed to offset 800 tonnes CO_2e / GWh
- Wind farm electricity generation is expected to offset 43,000 tonnes CO_2e over 10 years

GHG Credits



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Continuing the Project

Next Steps

A phased approach

Phase 1	Landfill collection and flaring
Phase 2	Landfill gas energy utilization
Phase 3	Wind mill and energy integration

FEASBILITY STUDY

1. Detailed landfill gas recovery potential
   - Dynamic pumping tests (2-3 wells)
   - Subsurface integrated sampling
2. Construction costs of phase 1 of the project
3. Financial return for phase 1 of the project
4. Preliminary feasibility of phases 2 and 3
5. identify gains to the Government of Barbados

Project Schedule

PHASE 1 - LANDFILL GAS COLLECTION AND FLARING

- Detailed feasibility study
- Biogas rights agreement
- Project implementation by Biothermica-Burnside on a Built-finance-operate basis
- Registration of CER's under CDM

Deliverables

Report 1: CDM Baseline Study

Accepted in Final Form by the Canadian CDM/JI Office

Report 2: Feasibility study

- Summary of Supplemental Landfill Gas Characterization Study
- Design of required technology to permit construction of landfill gas collection system

Deliverables

Report 3:

- Project design document (PDD) to meet requirements of the UNFCCC Executive Board and to permit for the verification of Certified Emission Reduction Credits to be issued for this Small-Scale CDM Project

- Required in order to claim financial reimbursement for CDM Credits

Thank You