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CETC Field Trials of Microturbine CHP Systems

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Presentation Outline

- Background
- Program Design
- Microturbines used for Combined Heat and Power Applications
- Discussion and Conclusions to date

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What is CANMET and Why are we doing this kind of work?

- The CANMET Energy Technology Centre (CETC) is the main energy laboratory of the Canadian Federal Government, located in Ottawa
- The power generation sector in Canada contributes 15% of Canada's Greenhouse Gas emissions
- The use of combined heat and power in both large district energy systems and individual buildings is a significant way to reduce greenhouse gas emissions in urban areas
- Reduction in waste gas flaring has positive environmental benefits

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CETC's program started in 1998 and concentrated on Heat Recovery from Microturbines

Prototype Heat exchanger Testing at Ontario Hydro Facility on a 30 kW Capstone Prototype
4Q 1998

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CETC's CHP Program Vision

- To assist in the development of a packaged microturbine Combined Heat and Power unit that can be installed by a HVAC contractor with little or no consulting engineering requirement.

OR PUTTING IT ANOTHER WAY

- A commercial package boiler that produces electricity.

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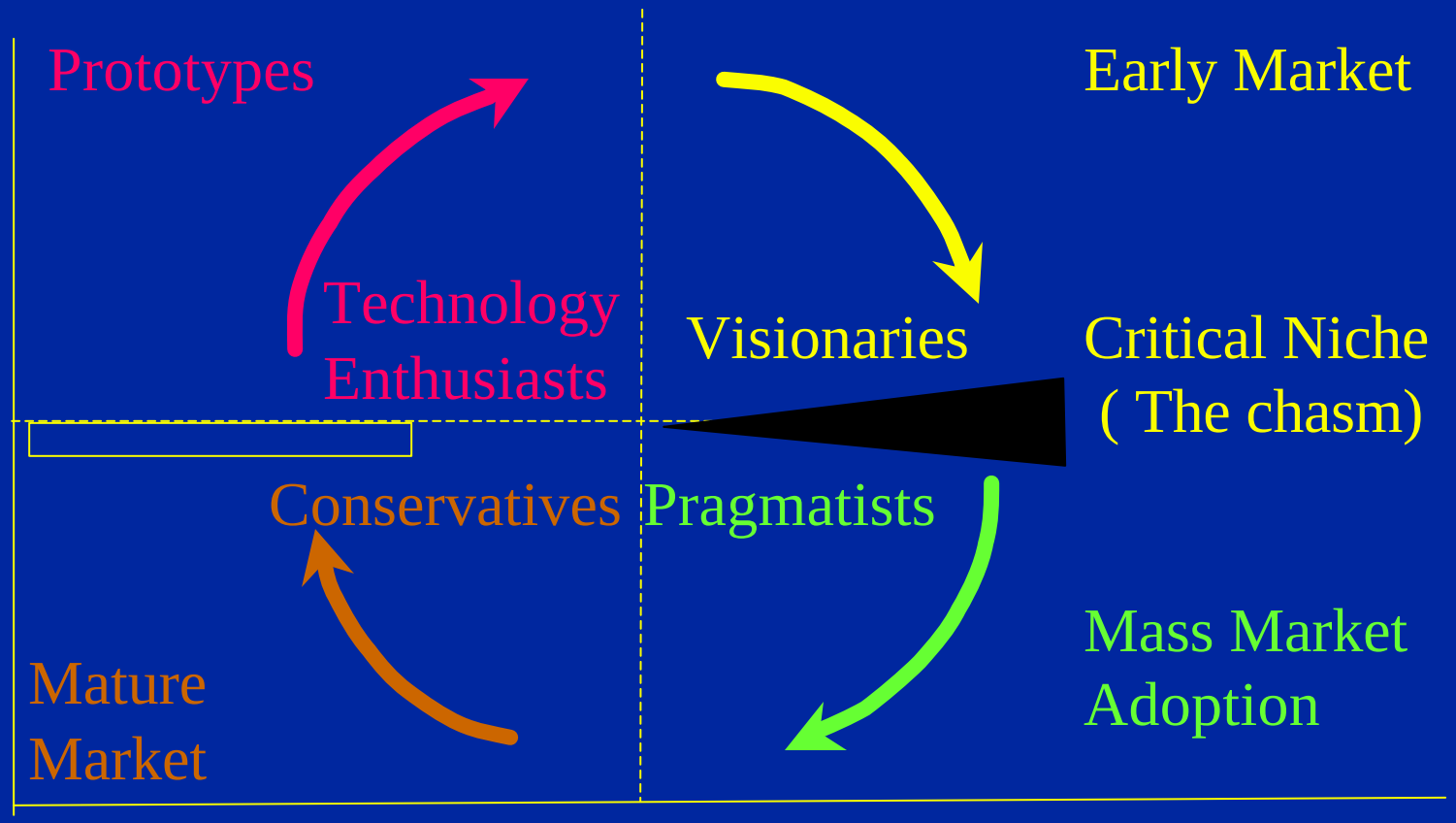
Technology Adoption Life Cycle



Adapted from G.A Moore
"Inside the Tornado"

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Field Trial Program

- Collaborate with Gas and Power Utilities to Field early Microturbine CHP systems. Getting Utilities familiar with the technology is important.
  - Three Honeywell 75 kW projects got some limited experience
    - Locations Toronto, Calgary and Vancouver
  - One oil fuelled Capstone 30 kW CHP under test in Halifax
  - One gas fuelled Capstone 30 kW CHP has been significantly delayed due to regulatory issues (gas compressor)

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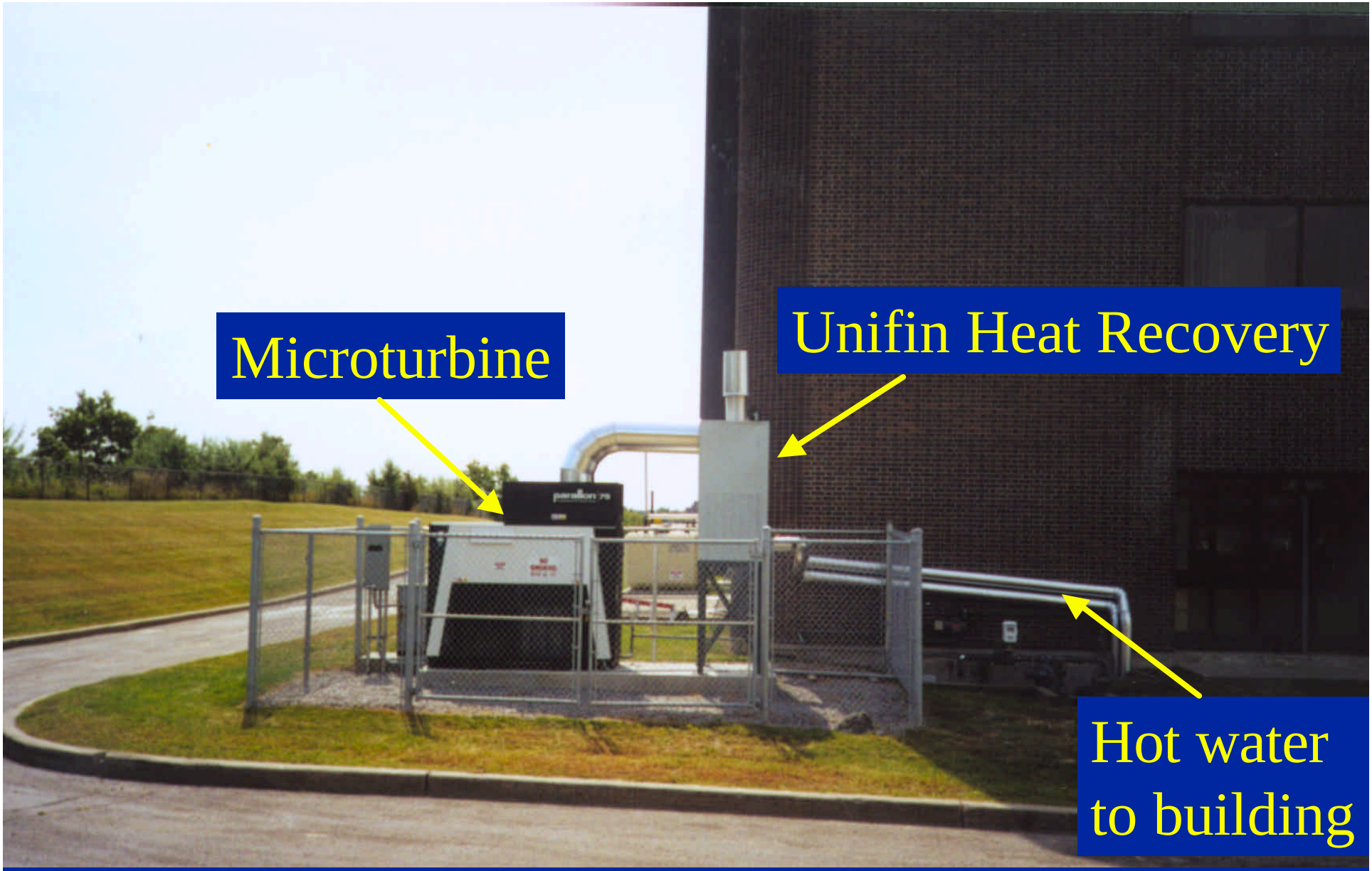
Field Trials

Toronto	Calgary	Vancouver	Halifax	Ottawa
CETC, Enbridge Public Works Ontario Hydro	ENMAX CETC	BC Hydro CETC	NS Power CETC	CETC Enbridge Toronto Hydro Bldg Owner
Honeywell 75 1st Production Unifin CHP	**Honeywell 75** Unifin CHP	**Honeywell 75** Unifin CHP	**Capstone 30** Mariah CHP	**Capstone 30** 2nd Gen Unifin CHP
START UP June 2000	Sept 2000	Sept 2000	April 2001	(Feb 2002)
5400 hrs ISSUES	2500 hrs	1000 hrs	1500 hrs	Not yet Installed
Gas Compressor	Utility Connection	Utility Connection	Power Electronics	Gas Regulatory Issues



Honeywell 75 kW and Heat Recovery unit
Midland Rd, Toronto. 5400 hrs operation

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Issues/Concerns

- Component failures or preventative change outs (gas compressor, igniter) affected availability.
- In Ontario non acceptance at this time by the code authority of UL 2200 is an issue requiring special site approval from the gas safety regulator
- Support from Mercury Electric, the local Honeywell organization and Honeywell Power Systems was good.
- Thermal losses from uninsulated exhaust components has reduced heat recovery performance. Note that outside installations will see reduced heat recovery performance in cold conditions

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Issues/Concerns

- Two turbine core replacements and two gas compressor failures in the one year time period
- On the positive side, the performance of the power electronics was good.
- Customer acceptance and a building heat recovery system that does not use a glycol loop in a low temperature (-30 deg C) environment has worked well to date.

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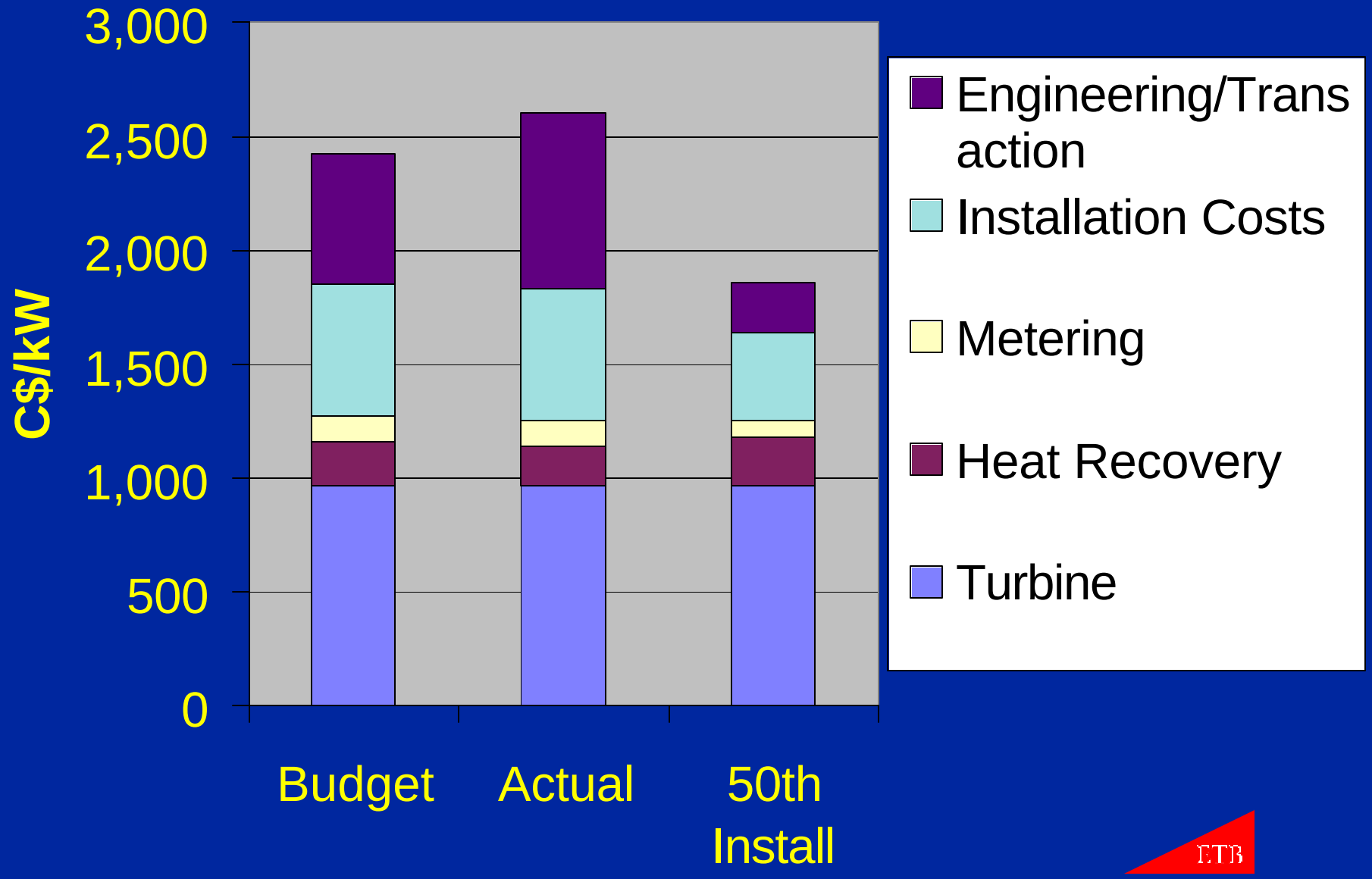
Midland Rd Installed Cost Analysis



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Midland Rd
Replacement Plan

- Enbridge/Consumers Gas, Public Works Canada and CETC plan to install a Capstone 60 at the site.
- Project will be sized for 2 Capstone 60 kW units
  - Will use a Compair compressor
  - Will use a second generation Unifin HX sized for 2 Capstone 60 kW units
  - Installation should be operational by end of 2nd Q 2002

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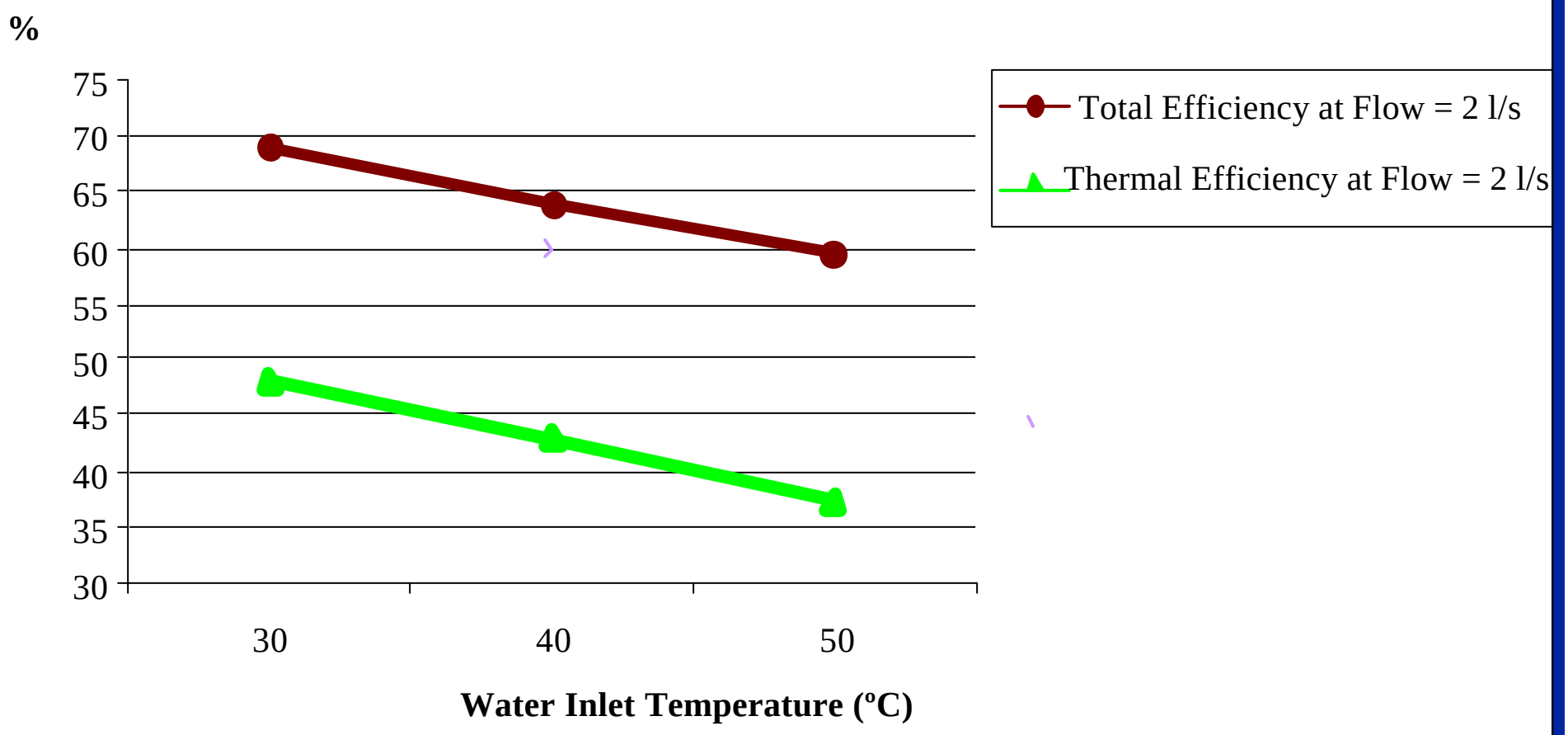
Oil Fired Mariah
CHP Unit at CETC.
600 hours of operation

Operational Issues

•Installed a circulating oil pump system with a pressure regulator

• Battery charge before shutdown might be a problem with CHP over temperature situation

Variation in Thermal and Total Efficiency with Inlet Water Temperature



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Mariah CHP Unit at Tufts Cove Power Plant, Halifax, Nova Scotia

Microturbine heats a very small fraction of plant's boiler feed water

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Mariah CHP Experience in Halifax

Operating Hours (total)	1500 hrs
Number of Starts (total)	190
Electrical Energy Produced	21.55 MWh
Peak Power recorded	30.2 kW
Thermal Energy Produced	37.7 MWh
Peak Thermal Power recorded	47.5 kW
Fuel Oil used	9000 L
Electrical Efficiency (LHV)	25.53%
Overall Efficiency (LHV)	70.2%
Normal water flow	5000-6000 l/hr
Normal inlet water temperature	30 deg C

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Installation and Operating Experience

- Lack of a Registration Number on the HX resulted in delays in installation with the Boiler inspection branch.

<u>Early Start up Problems</u>

- Failures of igniter,exciter circuit, fuel pump, Digital Power Controller and Liquid Fuel Controller.
- Brought in Capstone service representative who identified and replaced defective components
- Unit started long term operation on October 3rd 2001

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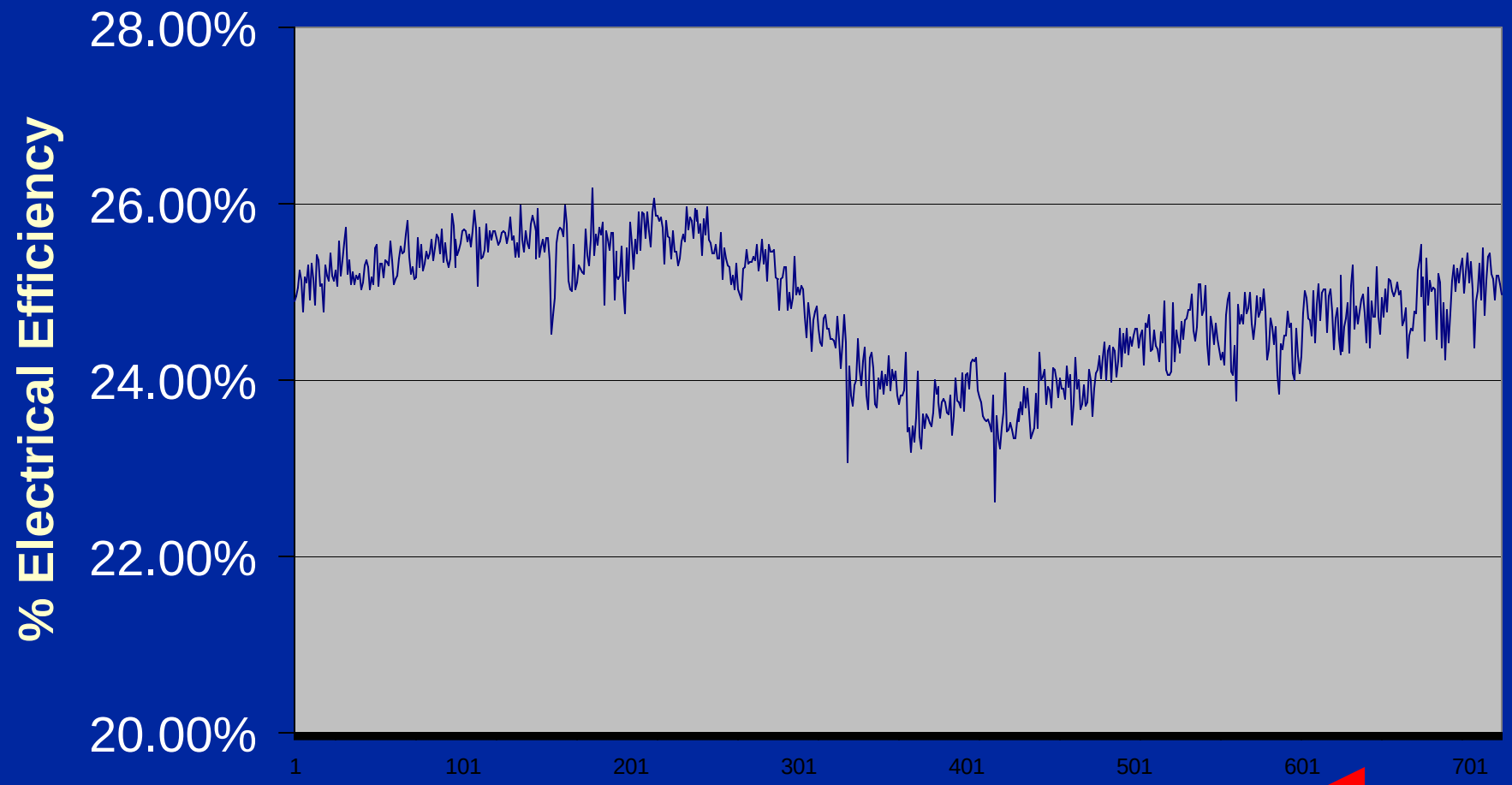
Microturbine Electrical Efficiency Nov 17 2001
Note effect of ambient temperature on efficiency



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Project Plan

Phase 1

- Test of Heat Recovery System at CETC
  Completed

Phase 2

- Test of Electrical Performance and endurance test at Tufts Cove

  Underway

Phase 3

- Installation of unit at a institutional/commercial customer.

  2Q 2002

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ENMAX Parallon Installation in Calgary

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Issues/Concerns

- Installation took some time to complete
- Original heat recovery unit had to be replaced
- Currently has 2000 Hours of operation
- Modest demand for heat during summer at the utility building location
- Internal utility discussion re interconnect issues

(location and type of disconnect switch)

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LFG Utilization

- Honeywell 75 kW unit installed at Trail Rd, Ottawa
- Most issues to date involve fuel gas supply
- Using propane to start unit
- Limited operating hours to date due to low methane content in LFG (35%)

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Discussion

- Gas compressor remains a weak link in the system technology.
- Initial projects need at least three value propositions to be economic at current capital costs

  1) On site power substitution (no export)

  2) Heat Recovery (High utilization,low return temperature)

  3) Prime Power, or Waste Fuel, or Carbon Dioxide

  or **?**

- Larger units (200-500 kW) will reduce specific cost

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Discussion

- Capstone reliability and availability has been reasonable(but needs improvement).
- The Honeywell withdrawal will make market pragmatists more cautious but good performance from other suppliers can compensate
- Microturbine reliability and solid customer support will be key to the next market phase, Visionaries have to have a good experience with the technology even if the economics are marginal.
- What is the key niche market segment to get across to pragmatic customers?

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CETC's Future Focus

- Increase thermal load factor by developing low capital cost chilling concepts
- Improve power conversion efficiency, (30-35%)
- Try to identify key niche market and assist in market development by working with others to remove barriers www.micropower-connect.org

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Questions?