**Steam Turbines In Biomass Applications**

CHP Biomass Short Course  
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Gary S. Davis  
Mgr, Industrial Power Generation  
Elliott Group  
901 North Fourth St  
Jeannette, PA 15644

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**Current Observations**

1. Large CHP very Limited – St. Paul, MN Thermal Energy  
   65 MW
2. Ideal Scale:  20 MW and smaller, 5 MW modules, community based:  
   Feedstock Management – different types of fuels  
   Smaller storage & footprint <5 Acres  
   Centralized Processing & Storage (VA – Winter 1000 T)  
   Easier Zoning  
   Key CHP – more easier to find customers near populated areas. PJM – $0.02/Kw-Hr for grid penalty – generate near users.  
   <100,000 Tons/year CO2 – under regulatory Req’ts  

**SMALL SCALE Biomass CHP!!**
Compressor Training
Casing Design

Controlled Extraction Turbine – Large Conventional Scale CHP

70,000 HP 2000# Steam Turbine
Typical Multivalve Arrangement

Typical Multivalve Steam End

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Typical Multivalve – Valve Seat locations

Multi Valve & Part Load Efficiency
Multi Valve & Part Load Efficiency

Valve Lift Curve

Performance

Multivalve Extraction Diaphragm
Multivalve Extraction Diaphragm

70,000 HP 2000# Steam Turbine
Compressor Training
Casing Design

Conventional Single Valve Turbine
Single or Multistage

HP Inlet

V1

Exhaust BP or Condensing

Typical Single Valve Single Stage Turbine
Single Valve Turbine Handvalves

Turbine Power & Part Load Efficiency

Single governor valve, nozzle grouping

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Typical Drilled & Reamed Nozzle Ring

Auto Hand Valve
Single Valve & Part Load Efficiency

Performance Curve
Steam Flow vs Turbine Output

- Both hand valves open
- Hand valve 1 open, Hand valve 2 closed
- Both hand valves closed

Single Valve Single Stage Turbine

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Typical Single Valve Multistage Condensing Turbine

Single Valve Multistage Cross Section
Compressor Training
Casing Design

Conventional Single Valve Turbines
“Poor Boy” Extraction

HP Inlet

V1

Exhaust BP

Conventional Single Valve Turbines
“Poor Boy” Extraction – High BP

HP Inlet

V1

350KW Induction

Exhaust BP

75 psig

16K Lb/Hr

450 psig

16KLB/Hr

345KW Synch

Exhaust BP or Condensing

5psig

5psig
Summary of Single Valve Turbine Pro’s

- Low cost, reliable solution for CHP vs. MV
- Immediate start up, warm up period req’d for MV: supports peaking operation.
- Supports seasonal operation, maintenance with clutch option; no cooling steam/idling steam.
- Leadtime: SV 34-50 vs. MV at 62-70 weeks
- Backpressure up 375 psig
- Condensing Operation – 48”Class 125 LBFF Exhaust, typically up or down orientation.
- No Control Oil required, simplifies LO system

D&S Saturated Steam Operation < 400 PSIG
Superheat is always a plus!
D&S Saturated Steam Operation < 400 PSIG
Superheat is always a plus!

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Simple Induction Generator Package

Simple Synchronous Generator Package
Compressor Training
Casing Design

**CYR, 500 KW Synchronous**
Southern Methodist University, Texas

**DYR, 2100 KW Synchronous**
London Health Sciences Center, Ontario
Compressor Training
Casing Design

DYR8, 5500 KW Synchronous, 42” Exh.
Enwave Energy Corporation, Ontario

QUESTION??
Elliott Group
901 North Fourth St.
Jeannette, PA 15644
724-527-2811
www.elliott-turbo.com

Gary S. Davis
Manager, Industrial Power Generation
gdavis@elliott-turbo.com
724-600-8626

Daniel Vucelich
Sr. Marketing Engineer, STG
dvucelic@elliott-turbo.com
724-600-8595