Algonquin Power:
Fast Track CHP Plant

IDEA 2015: June 30, 2015

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Project Background

- Facility Started Operation in 1990
- Supplies electricity & steam to adjacent paper mill
- Original Configuration
  - 40 MW GE Gas Turbine
  - 16 MW Extraction / Condensing Steam Turbine
  - (2) Packaged Boilers
  - 115 kV Interconnect
  - Supplies steam to mill at 300 PSI + 90 PSI

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Project Scope

- Project start October 2012
- Install Solar Titan 15 MW gas turbine
- New HRSG
- New Gas Compressor
- Steam Turbine Controls upgrade
- Facility approved for multi-million dollar grant under CT Energy Independence Act
- Grant required system be interconnected and approved by local electric utility, July 2013
- 8 Month Schedule – Turbine only component which had been procured

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Site Constraints

- Existing equipment to remain
- Rigging + constructability drove design options
- Evaluated multiple turbine / boiler configurations
- Site is peninsula between Windsor Lock and Connecticut River
- Access for heavy lift components only possible across one bridge
- Trestle with mill power and steam in the way
- River Water Lines pass under turbine location
- Facility to remain operational 24/7 during construction

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Schedule Concerns

- Boiler procurement and erection time identified as critical path
- Schedule for boiler installation and turbine installation required units be constructed concurrently
- Eliminated Boiler Turbine configurations where construction could not be concurrent
- In order to meet grant deadline, construction schedule needed to be reduced
- At project inception Team / Owner felt likely not possible to be operational by Grant Deadline

Once Thru Steam Generator (OTSG)

OTSG Identified as potential technology that offered several advantages:

- Vertical Boiler fit well in space
- Efficient 45,000PPH (unfired) 625PSIG, 750F
- Significantly reduced boiler erection time, manufacturer claimed 30% fewer man-hours required
- Simplified operation
- Quick start-up (15 min) – ability to operate dry – No bypass stack
- Equipped with SCR anhydrous NH3

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OTSG

- Simple boiler design
- Boiler feed water introduced into coil section – Feed water valve modulates to maintain superheat and pressure
- No boiler blow down
- No level control
- Boiler requires brief venting period on start-up
- HRSG I&C Scope greatly simplified. 50 fewer I/O points
- Requires higher feed water pressure than conventional boilers
- Water treatment requirements stringent, however existing plant water treatment required only minor modifications for compliance with boiler manufacturer standards

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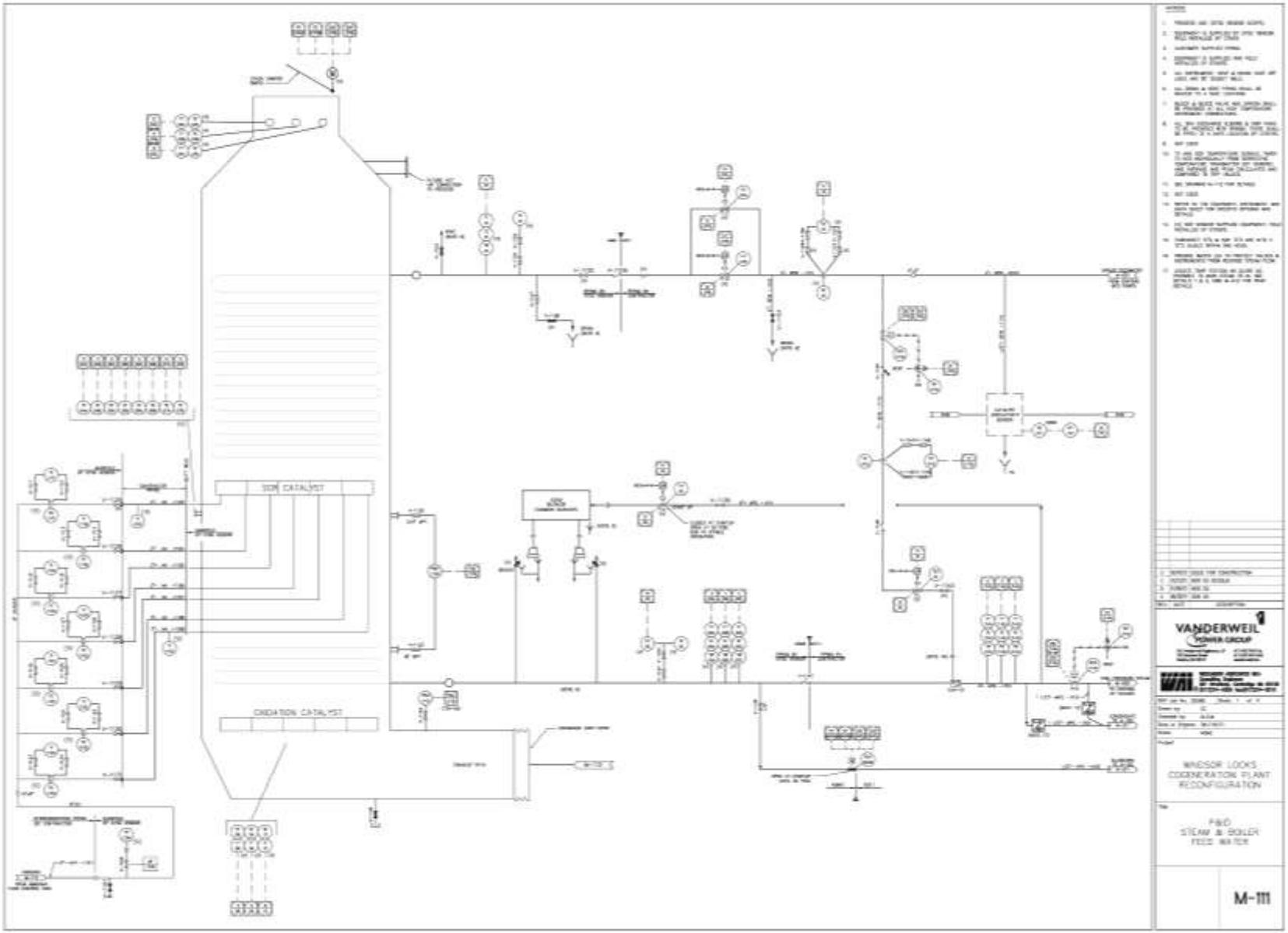

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Boiler / Turbine Rigging Challenges

- Boiler Turbine to be rigged in through end of building on rail system
- Construct boiler outside building on temporary platform and roll in as complete unit
- Need to erect 600 ton Demag Crane on piles between building and riverbank

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Trestle Relocation

- Trestle carrying thermal and electric services to paper mill had to be relocated to rig equipment in
- Accomplished during 3 day shutdown
  - Electric Shutdown – 1 day

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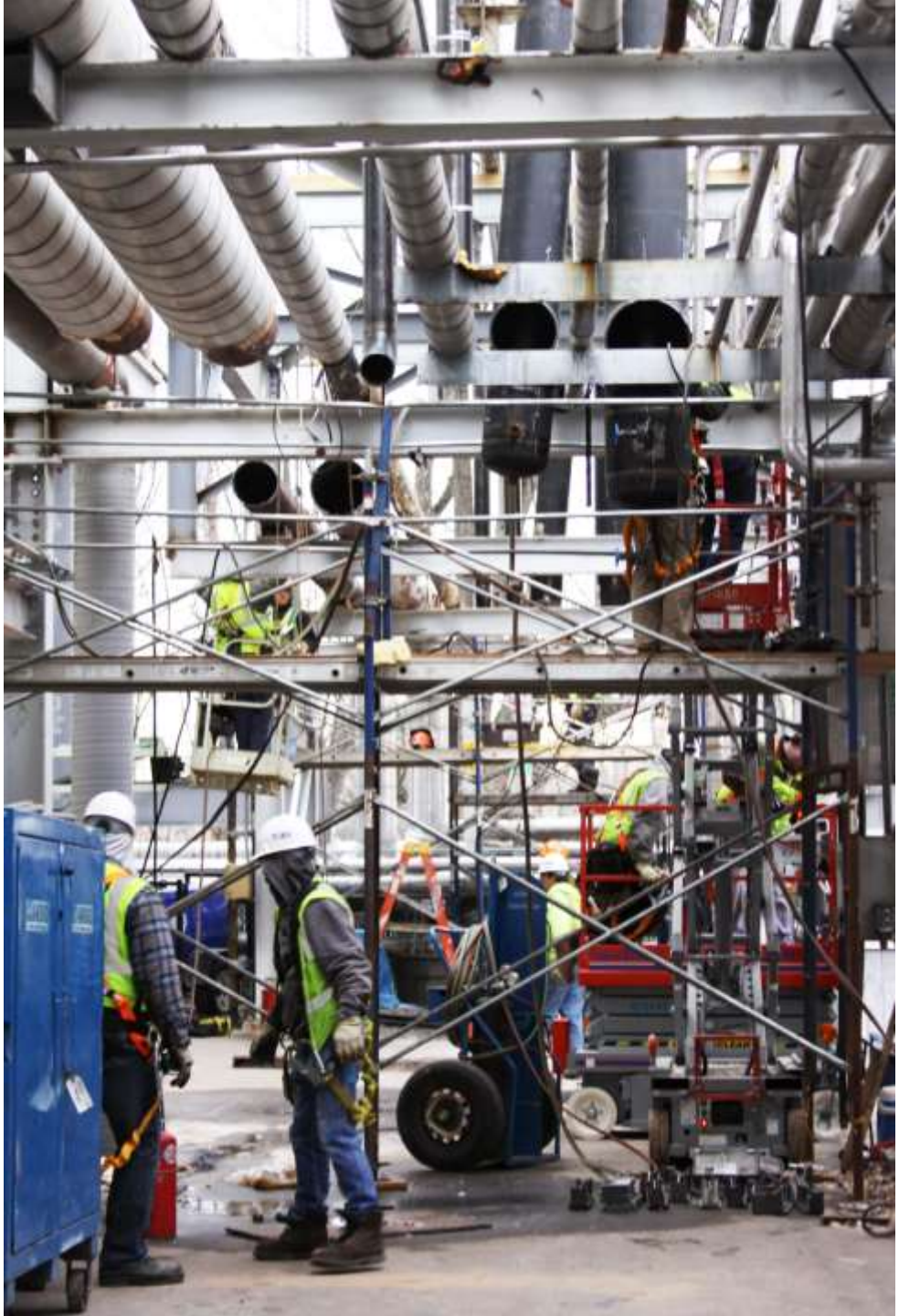

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Boiler Erection

- Four (4) stacked boiler modules
- Boiler field erection completed in two (2) weeks
- Boiler rolled in completed single assembly (less stack)
- Turbine followed same rigging provisions

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CHP Performance Data

Algonquin Power Windsor Locks - Titan CHP

CHP Performance Data - 2014

Location: Windsor Locks, CT

System Performance Data

Month	Operating Hours	Input Fuel LHV (MMBtu)	Output Electricity (kWh)	Recovered Output Thermal Energy (MMBtu)	Fuel Conversion Efficiency (%)	Electrical Percentage (%)	Thermal Percentage (%)
Jan	719	106,351	10,503,658	50,030	81%	42%	58%
Feb	672	98,797	9,692,461	47,114	81%	41%	59%
Mar	744	105,627	10,186,236	51,582	82%	40%	60%
Apr	543	74,023	7,107,926	36,930	83%	40%	60%
May	660	90,753	8,803,162	46,132	84%	39%	61%
Jun	720	93,750	8,879,186	48,250	84%	39%	61%
Jul	744	95,458	8,552,168	48,444	81%	38%	62%
Aug	736	93,837	8,369,573	47,156	81%	38%	62%
Sep	720	96,329	8,854,289	48,196	81%	39%	61%
Oct	683	88,237	8,372,963	44,017	82%	39%	61%
Nov	720	95,869	9,195,048	46,534	81%	40%	60%
Dec	696	88,547	8,216,250	44,215	82%	39%	61%
Total	8357	1,127,578	108,732,920	558,602	82%	39%	61%

Breakdown of Recovered Thermal Output

Month	Process Heating (MMBtu)	Process Cooling (MMBtu)	Space Heating (MMBtu)	Space Cooling (MMBtu)	Domestic Hot Water (MMBtu)	Other (MMBtu)	Total (MMBtu)
Jan						50030	50030
Feb						47114	47114
Mar						51582	51582
Apr						36930	36930
May						46132	46132
Jun						48250	48250
Jul						48444	48444
Aug						47156	47156
Sep						48196	48196
Oct						44017	44017
Nov						46534	46534
Dec						44215	44215

Note:
electrical output from ION meter reads
thermal results from steam flow meters

Base Data

Month	Hours	Fuel CCF
Jan	719	1,143,560
Feb	672	1,062,330
Mar	744	1,135,770
Apr	543	795,960
May	660	975,840
Jun	720	1,008,060
Jul	744	1,026,430
Aug	736	1,009,000
Sep	720	1,035,800
Oct	683	948,780
Nov	720	1,030,850
Dec	696	952,120
Total	8357	12,124,490

- Plant monitors performance and provides quarterly reporting to CT DPUC
- Metered fuel conversion efficiency for 2014 – 82%

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Project Highlights

- On Time / On Budget
- Project Team Collaboration
  - Owner
  - Contractors
  - Engineering Team
- **Project Award:**

Associated Builders and Contractors, Inc. CT Chapter 2012 "Best In Show" Award

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Questions & Answers

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Thank you.

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