

Hamon Companies



Integrated solutions for a clean environment

- *Hamon et Cie is a Belgium based global group specializing in pollution control, heat recovery and cooling technology and related manufacturing for the utility, petrochemical and heavy industries*
- *Hamon's core businesses in thermal and environmental systems have been in operation for >100 years.*

Cooling Systems

Air Pollution Control

Process Heat Exchangers

Chimneys

HRS&G & Waste Heat Boilers

- Hamon has operating companies in Europe, Asia, Africa, South America and the U.S.
- In Asia, Hamon has engineering offices in India and China, specialized manufacturing in China, and sales/project/service offices in Korea, China, Indonesia, Singapore, Australia, Malaysia, Thailand and Vietnam.



- Plant
- Office
- X Service center



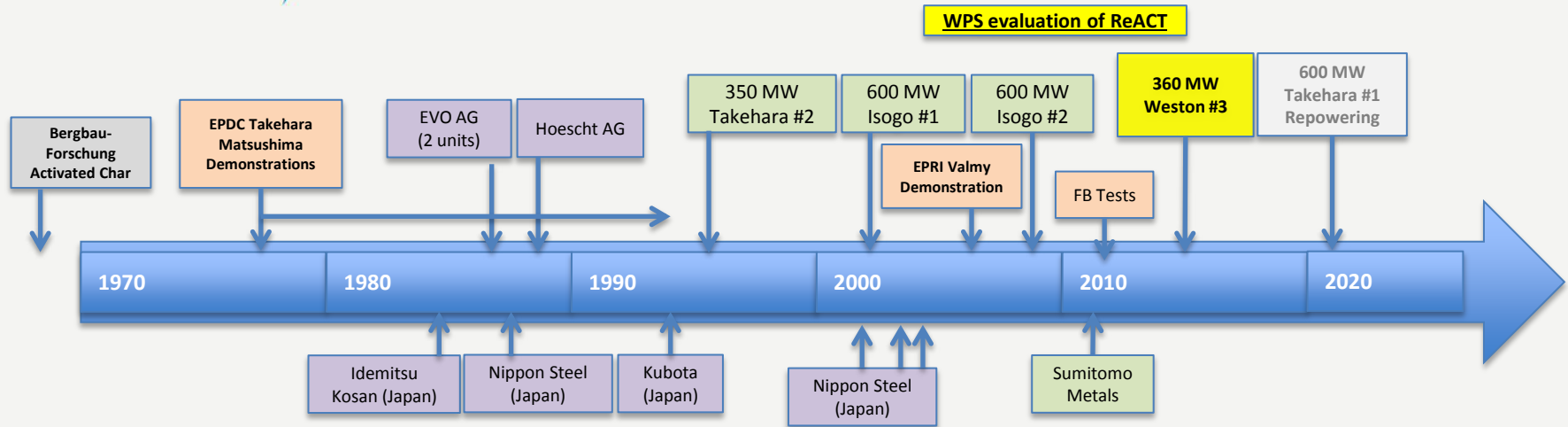
Integrated solutions for a clean environment

Regenerative Activated Coke Technology

ReACTtm

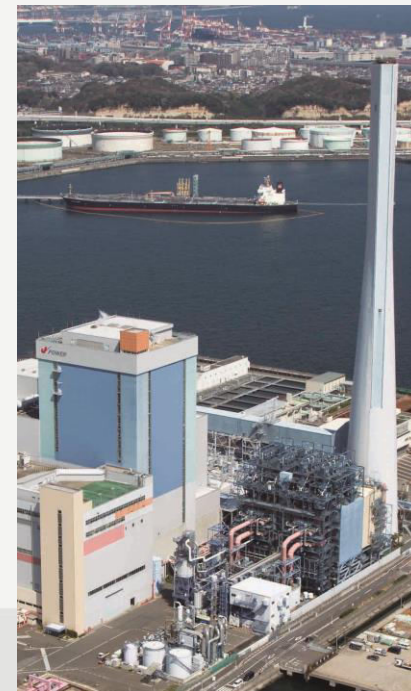
Advanced
Integrated Multi-Pollutant
Control Technology

Isogo 600 MW Unit #2

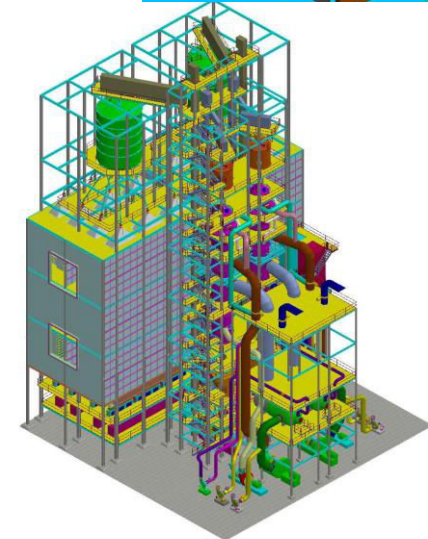
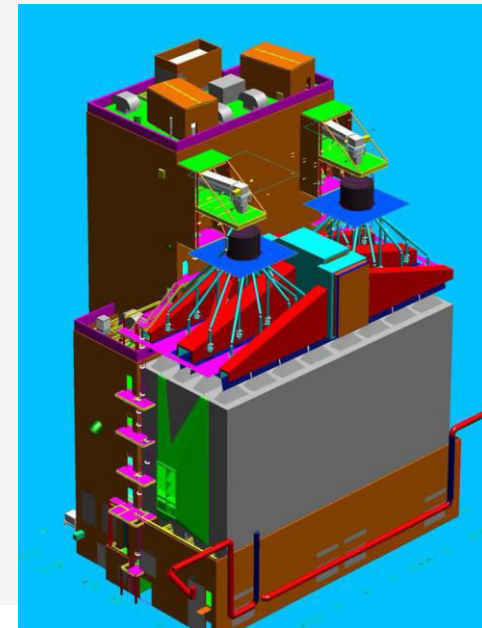


Development of advanced multipollutant technology

- Bergbau-Forschung – <1970s – Activated Char Process
- EPDC(J-Power)/Mitsui/Sumitomo – 1970s-1990s development
- Mitsui BF – 1980 – commercial projects in Europe & Japan
 - Coal utility and other industrial applications
- J-Power – 2000s – acquisition/implementation
 - 2 x 600 MW implementation at Isogo – world’s cleanest coal fired power
 - Planned for next repowering project at Takehara
- EPRI confirming demonstration tests at Valmy
- Hamon Research-Cottrell – 2010 – license from J-Power
 - U.S. utility - fixed bed parametric tests at high performance
 - U.S. implementation at 360 MW (321 MW net) WPS/Weston Unit 3



- **Fully dry process based on moving bed adsorption on activated coke**
 - No water evaporated into flue gas, (water usage at 1% of WFGD, DFGD)
 - No sprays, no wet/dry interface, no moist material fouling, no slurry preparation
 - No increase in water vapor plume, no acid plume
- **SO₂ and acid gases**
 - >>95% SO₂ control
 - Near zero SO₃ emission
 - Carbon steel flue gas path including stack
- **NO_x control design options**
 - Co-benefit NO_x control at 20-40%
 - Enhanced NO_x control to 40-60% with NH₃ dosed AC regeneration
 - Higher NO_x control to 80% available with two-stage adsorption
- **Hg control with waste volume minimization**
 - 95% control of both elemental and oxidized forms as co-benefit
 - Hg waste volume minimized (<0.1 ton/MW/year)
- **Regenerative system for activated coke adsorbent**
 - Reduced reagent and disposal material volume
 - Sulfur rich gases are feedstock to production of byproduct sulfuric acid
- **Operational through start-up and shutdown**
 - Flue gas is treated over 100% of the boiler operation
- **Well suited as retrofit technology**
 - Installation downstream reduces station outage requirements
 - Dry operation allows use of existing stack/liners

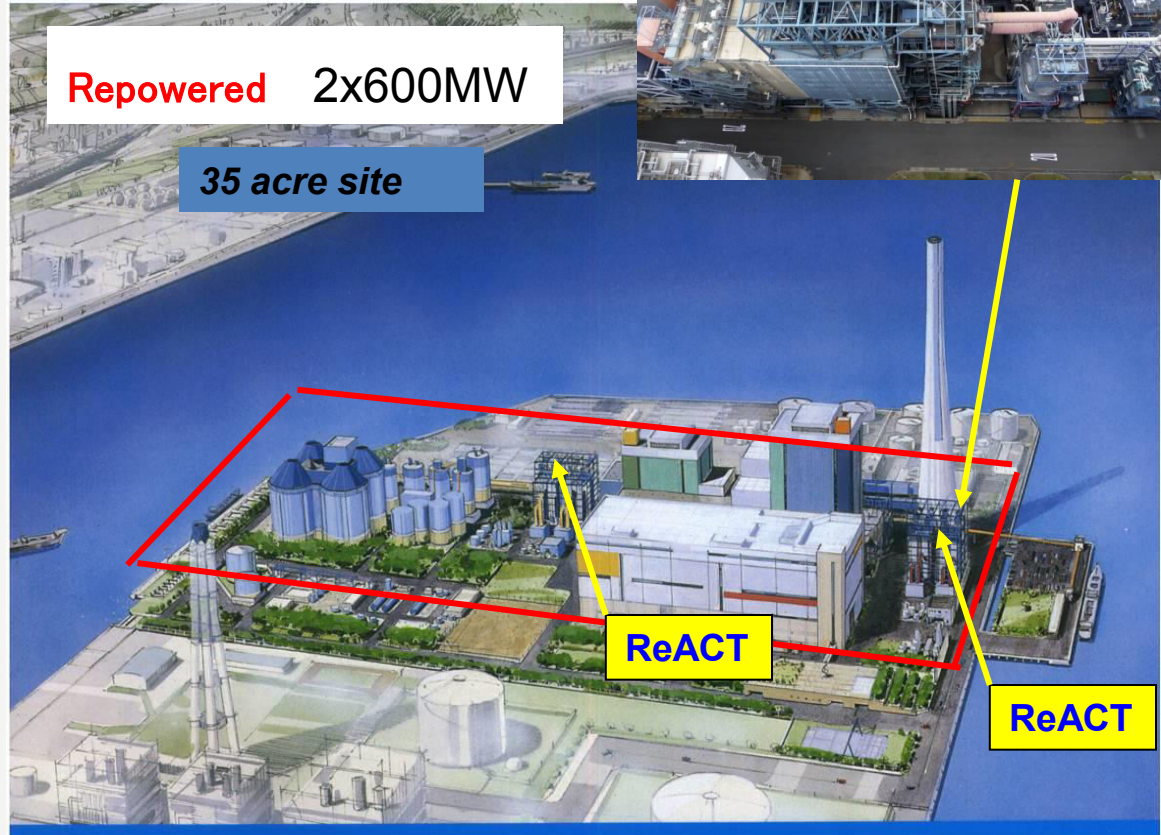


Original 2x265MW



Repowered 2x600MW

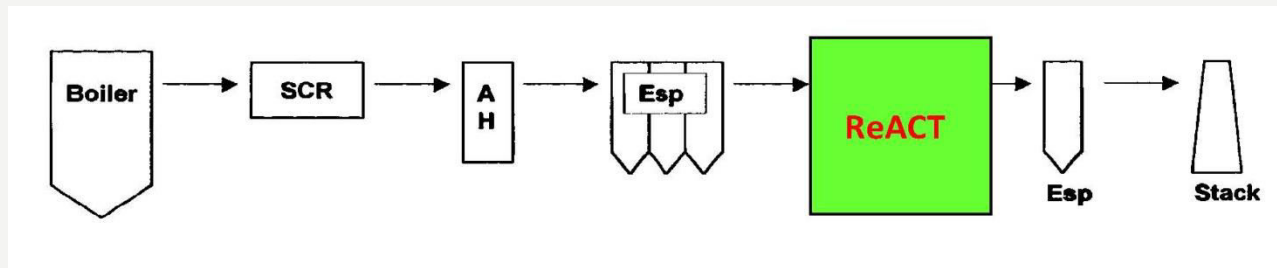
35 acre site



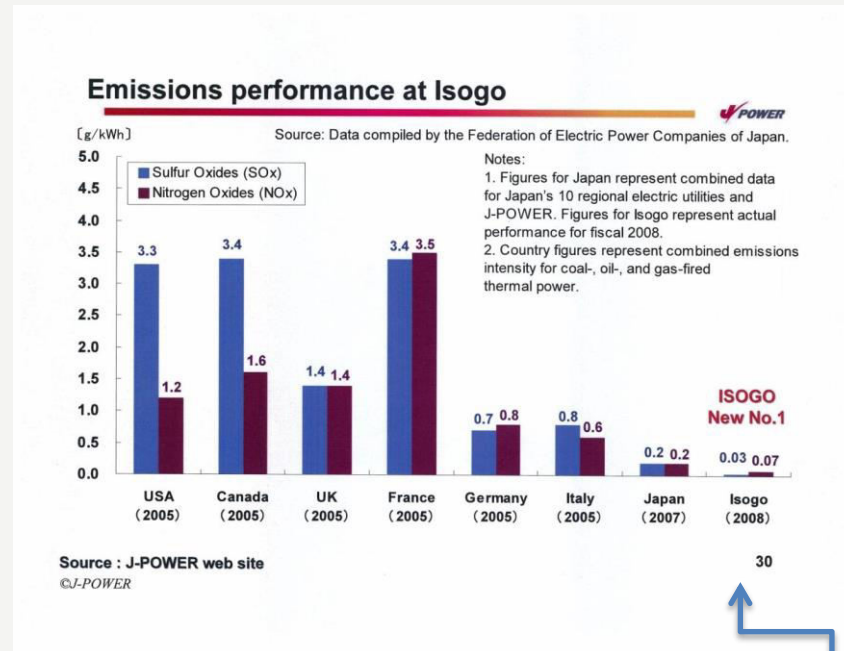
Isogo Power Station

(2002 and 2009 start-ups)

J-Power facility among world's lowest emissions power plants



- Ultrasupercritical boiler fired with low sulfur coal
- SCR for primary NOx control
- Air Heater
- Cold side ESP for primary particulate control
- ReACT system
 - primary SO2 control
 - co-benefit Hg reduction
 - co-benefit NOx reduction
- Polishing ESP
 - to meet 5 mg/Nm3 permit
- Stack
 - Negligible acid gases, no plume



Lowest emissions – worldwide for SO2 and NOx – Isogo #1 and Isogo #2 are the world's cleanest coal fired power plants

The emissions results at J-Power's Isogo power station have been reported in comparison with their permit requirements as follows:

Results at Isogo #2	Permit	Inlet to ReACT	Typical Stack Emissions	Control Level indicated
SO2	10 ppm	~410 ppm	~ 1 ppm	>>98% in ReACT
NOx	13 ppm	~20 ppm (after SCR)	~7 ppm	~90% in the SCR ~50% ReACT co-benefit
Particulate	5 mg/Nm3	< 100 mg/Nm3	<3 mg/Nm3	>98% in the primary ESP
	~0.004 lb/MMBTU	<0.1 lb/MMBTU (downstream of primary ESP)	<0.002 lb/MMBTU (downstream of secondary ESP)	~97% in the polishing ESP >>99.9% overall
Mercury			<2.5 ug/Nm3 <0.2 lb/TBTU	>>90%

J-Power installed ReACT on Takehara in 1995 (20 years operation)

- 380MW Unit #2 - 1,163,000 Nm³/hr @ 140C
- Takehara is an AFBC with limestone
- J-PowerPower reports typical operation since 1995

Results at Isogo #2		Inlet to ReACT	Typical Stack Emissions	Control Level indicated
SO₂	Limestone AFBC is primary SO ₂ control	~50-100 ppm after AFBC	ReACT removes 99% of 50 ppm	~70-80% in FBC Overall 99+% reduction <i>SRG is returned to boiler after 25% bleed in small scrubber</i>
NO_x	ReACT is primary NO _x control	~250 ppm after AFBC	<50 ppm	~ 80% in ReACT as primary NO _x control
Particulate	AFBC with ESP	~200 mg/Nm ³	<30 mg/Nm ³	ReACT accepts modest particulate load and effects some reduction

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Hamon Group **Confirming EPRI demonstration**

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Performance ranges reported by EPRI (MEGA Symposium 2008) for ReACT demonstration program conducted by EPRI at Valmy Station.

EPRI test at Valmy	Range of Inlet conditions	ReACT tested performance	Note
SO ₂	500 to 1400 ppm	97.6 to 99.96%	Flue gas space velocity and activated coke residence time parameters were varied in typical ranges to demonstrate performance
NO _x	100 to 200 ppm	25.7 to 48.35%	co-benefit NO _x only
Particulate	0.02 to 0.03 lb/MMBTU	0.007 to 0.01 lb/MMBTU	<u>Without</u> downstream ESP
Mercury	0.02 to 0.21 ug/m ³	97.1 to 99.6%	High Hg % removal was shown at low inlet Hg levels

Wisconsin Public Service – due diligence on ReACT

Detail review of ReACT operating characteristics for Weston 3

- ReACT system is specifically configured to meet compliance and flexibility requirements for range of Weston 3 operating conditions

Comparison with other available control technology – DFGD, WFGD, ACI, DSI, SNCR, SCR

WPS notes to the Wisconsin PSC that ReACT operating characteristics for Weston 3

- Provides performance for SO₂, SO₃ and Hg that were equal or higher WFGD and DFGD/ACI
- Provides additional NO_x control not available from WFGD or DFGD
- Provides flexible NO_x control at levels sufficient to avoid added cost of SCR
- Operational during start up and shutdown periods
- Avoided water consumption and wastewater discharge issues
- Avoided solid waste disposal issues
- Preserved flyash sales
- Provided a positive revenue stream from marketable by product sulfuric acid