IWESS, from Here to Where: CMU's Intelligent Workplace Energy Supply System

Power, Cooling, Heating, and Ventilation from Solar Heat and Renewable Fuel

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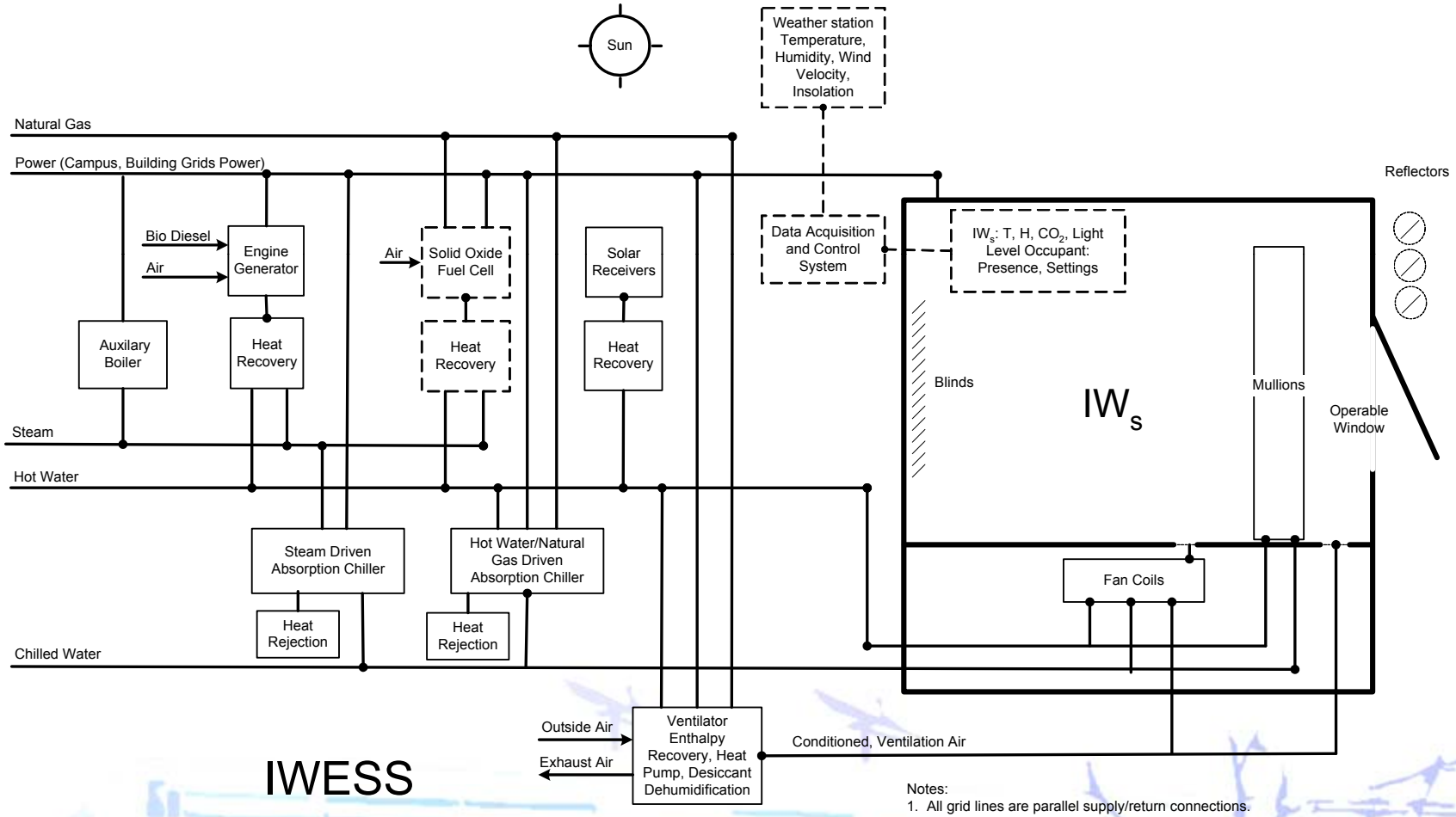
IWESS/BAPP Guidelines

- deliver more useful energy than that used by the space, more than that supplied by external sources, except for solar and renewable sources
- recognize that IW architectural features minimize building power, cooling, heating, ventilation loads
- supply cooling, heating by chilled, heated water
- ventilate by ample fresh air at comfortable temperature, appropriate humidity
- provide energy at an efficiency twice conventional by a system integrated, modularized, controlled

IWESS Components

- steam driven absorption chiller
- solar thermal heat supply with hot water driven chiller, (storage)
- bioDiesel engine generator with heat recovery equipment for steam and hot water
- ($solid oxide fuel cell with heat recovery at high temperature$)
- fan coil cooling/heating units with advanced controls
- radiant cooling/heating units: mullions, radiant panels
- ventilation system with enthalpy recovery, heat pump, and solid desiccant dehumidification
- building grids: power, natural gas, steam, chilled water, heated water

IWESS Components Integrated with IW through Grids

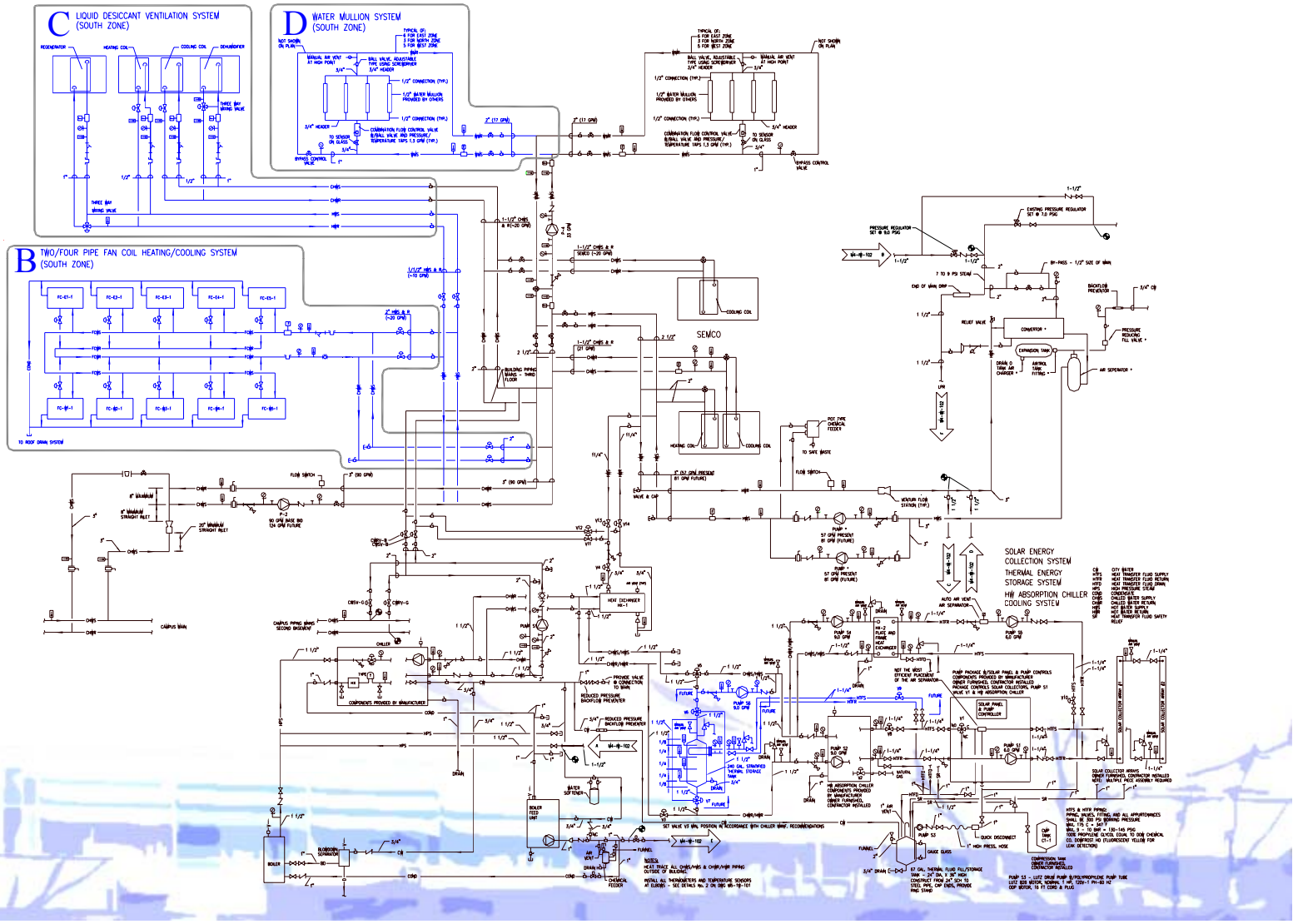


IWESS

Notes:

1. All grid lines are parallel supply/return connections.
2. Electrical, and instrumentation and control connections for the components are not shown.
3. Dashed lines and boxes indicate instrumentation: sensors, actuators, controls, and data processing equipment.
4. Proposed order of installation: mullions (existing), chiller/aux steam (existing), ventilation (existing), solar (October 2006), fan coil and vent diffusers (December 2006), engine generator (December 2006), fuel cell (2007).

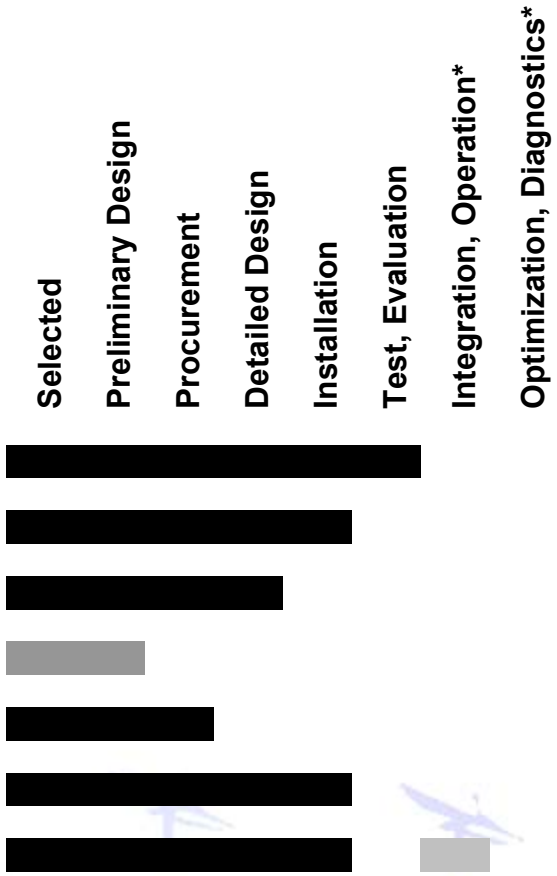
IWESS Components Integrated with IW through Grid Pipes



IWESS Component Status, IWESS Program Steps

- component selection, modeling
- preliminary system design: loads, flow diagram, material and energy balances, instrumentation diagram, equipment specifications/descriptions, operational description, layout
- procurement
- detailed design
- installation
- component test, data evaluation, performance analysis
- component integration into the IW, with other components, test, systems annual performance analysis
- advanced control: optimization, diagnostics
- system design guidelines, procedures, tools, economics, applications
- component redesign, optimization, integration
- education

IWESS Status Table



Component	Cost	Comments
Steam driven chiller	$219 k	Awaits engine provided steam supply
Solar heat, hot water driven chiller	$387 k	Commisioning now underway
BioDiesel engine generator with heat recovery	$644 k	Installation starts December 2006
High temperature fuel cell with heat recovery		Funds $$$ required
Fan coils with advanced control system	$314 k	Detailed design starts October 2006
Radiant cooling/heating units; mullions, panels		Modeling for performance studes
Ventilation, conditioned air supply system	$74 k	Benefits are already obvious
	$1,638 k	

* Require advanced control

IWESS Investment

Component	Equipment	Auxiliary Equipment	Engineering	Instrumentation and Control	Installation	Total Installed Hardware Cost
Steam driven chiller	$12 k	$9 k	$38 k	$63 k	$97 k	$219 k
Solar receivers, hot water driven chiller	$45 k	$5.4 k	$53 k	$62.5 k	$221 k	$387 k
BioDiesel engine generator, heat recovery	$116 k	$31 k	$47 k	$71 k	$379 k	$644 k
High temperature fuel cell, heat recovery	($300 k)					
Fan coils, advanced control system	$27 k	--	$27 k	$200 k	$60 k	$314 k
Radiant cooling/heating units; mullions, panels						
Ventilator, conditioned air	$55 k	$3 k		$0.5 k	$17 k	$75 k
TOTAL	$255 k	$48 k	$165 k	$397 k	$774 k	$1,639 k

IWESS Investment

- components installed as research equipment: extensive instrumentation, data acquisition, test auxiliaries
- components installed in an existing building, not outfitted as a laboratory
- components installed to be integrated with the IW, with the building energy supply grids, and with each other

IWESS Systems Studies

- combine components and IW: determine performance, effectiveness, efficiency, over a day, season, year: Trnsys-Comis modeling platform
  - solar receivers, chiller, fan coils, IW: space cooling/ heating: operational strategies, storage, insulation: annual energy use. Extend to economics, environment, storage alternatives
  - operable windows: cooling, ventilation: strategies, energy use. Extend strategies, economics, environmental
- future studies
  - solar reflectors, blinds, IW: annual energy loads: operational strategies
  - radiant cooling/heating, ventilation, IW: annual energy use: benefits of dehumidification, comparison radiant, convective cooling/heating
  - fan coil (operational and control models) cooling/heating, ventilation, IW, single and multizone: considering temperatures, humidities, occupancy: operational and control strategies: annual energy use
  - engine generator with heat recovery equipment, chiller, fan coils, ventilator: strategies: annual effectiveness, energy use

IWESS to Where

- complete component installation, test, evaluation
- integrate operation with the IW, with other components
- develop operation, control, optimization, diagnostic strategies based on component and system modeling, including economic, environmental aspects
- identify, develop promising applications: residential, commercial, CMU's BAPP
- develop system guidelines, design procedures, tools: component characterization; system synthesis; technical, economic performance evaluation through component, system modeling, CMU's BAPP
- component adaptation, integration for performance improvement, cost reduction
- EDUCATION

IWESS Mission to Educate

- students: graduate, undergraduate
- profession: technical publications, website, WBDG's
- public: promotional literature, website
- conferences, open house tours: architects, developers, building owners/operators, regulators

IWESS Journey Requirements

- another generation of capable graduate students: six students/four years, $1.2 million
- faculty/staff guidance: four persons/four years, $1.2 million
- equipment: fuel cell, modified existing components, $0.8 million

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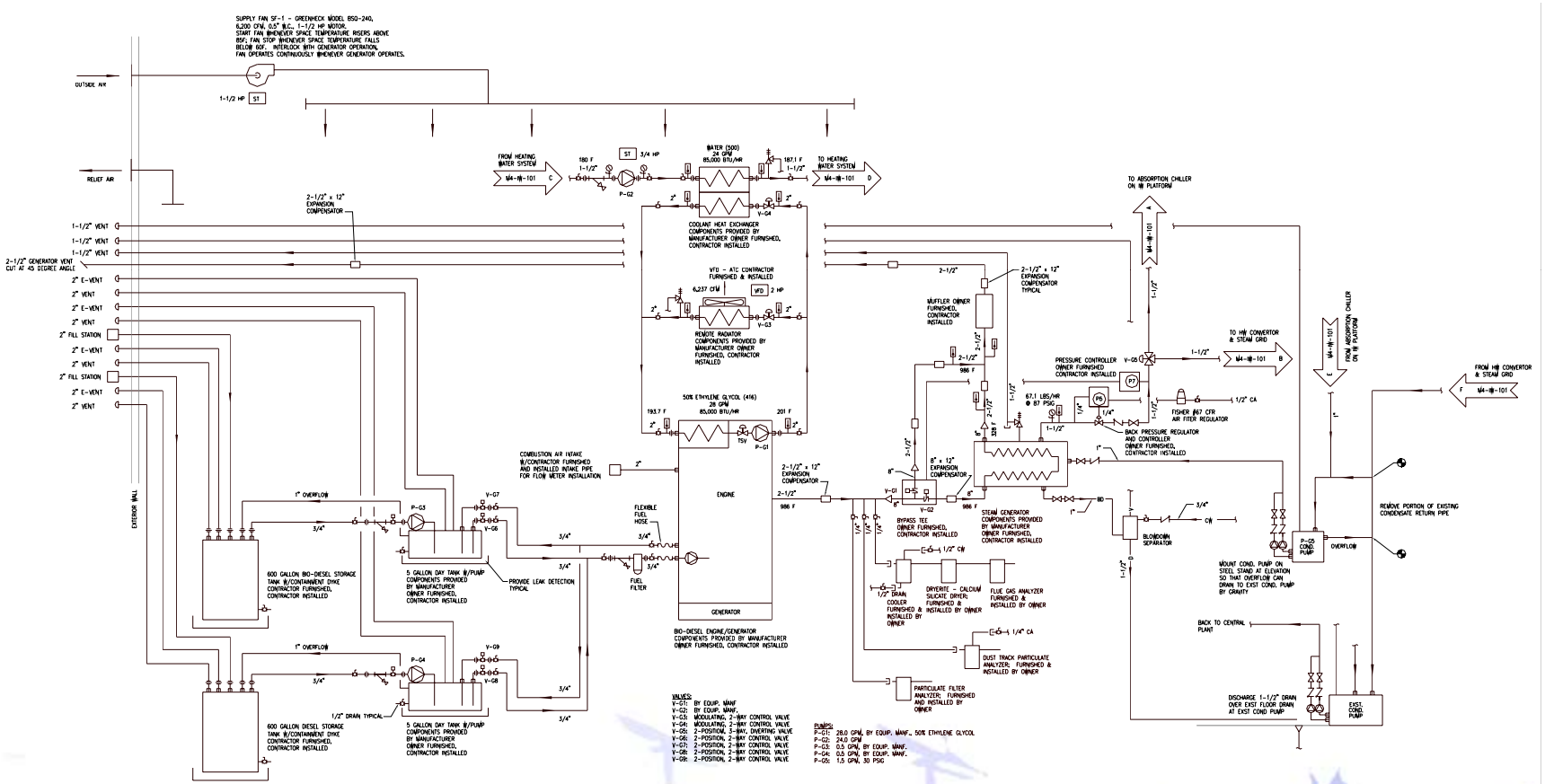
IWESS BioDiesel Engine Generator with Heat Recovery Equipment



IWESS Additional Slides

- Operation, control: fan coil off-on transfer energy as required up to limit; control valve, fan setting supply temperature pressure provides energy
- Equipment modification: ventilator replace heat pump, burner with exchangers
- Equipment integration
- Investment, justification