

A person wearing a yellow hazmat suit and a gas mask with a filter, standing with arms crossed in a hazy, outdoor setting. The person's hair is tied up. The background is a blurred, hazy landscape.

Doomsday Prepping at the University of Iowa

Ben Fish

<http://channel.nationalgeographic.com/doomsday-preppers/>

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ABOUT US

Basic Facts

On any given day at UI Hospitals more than 9,000 employees, staff and volunteers collaborate to provide health care to our patients while their expectations with excellent

We are a 730-bed hospital that admits more than 32,000 patients for in-patient hospital care. In addition, in fiscal year 2014, we accommodated more than 56,000 emergency department visits. We also represent more than 200 outpatient clinics and care areas receiving just over 914,300 clinic visits at our main campus and community and outreach clinics.

Also in fiscal year 2014, we employed 1,617 physicians, residents, and fellows, and 6,730 non-physician employees, including 1,904 professional nurses. We're assisted each year by a dedicated corps of more than 1,300 volunteers.

We are a 730-bed hospital that annually admits more than 32,000 patients for in-patient hospital care. In addition, in fiscal year 2014, we accommodated more than 56,000 emergency department visits. We also represent more than

ADDRESS

101 Jessup Hall
Iowa City, IA 52242-1316
(319) 335-3500

WEBSITES

[University homepage](#)
[Financial Aid website](#)

ACCREDITATION

[NCACS/THLC](#)

-  80.23% Admission Rate
-  25.69% Enrollment Rate
-  69.62% Graduation Rate
-  85.84% Retention Rate

Three quarters of the University of Iowa's R&D expenditures went toward life science-related research in 2012 – but considering Iowa's role as a major contributor of farmed products, it's interesting to note that none of these funds support studies or projects in the field of agricultural science. The school derives virtually all of its R&D budget from either the federal government or institution funds; businesses, nonprofit organizations, and other donors provided only 6.7%.

Total R&D Expenditure: \$446,429

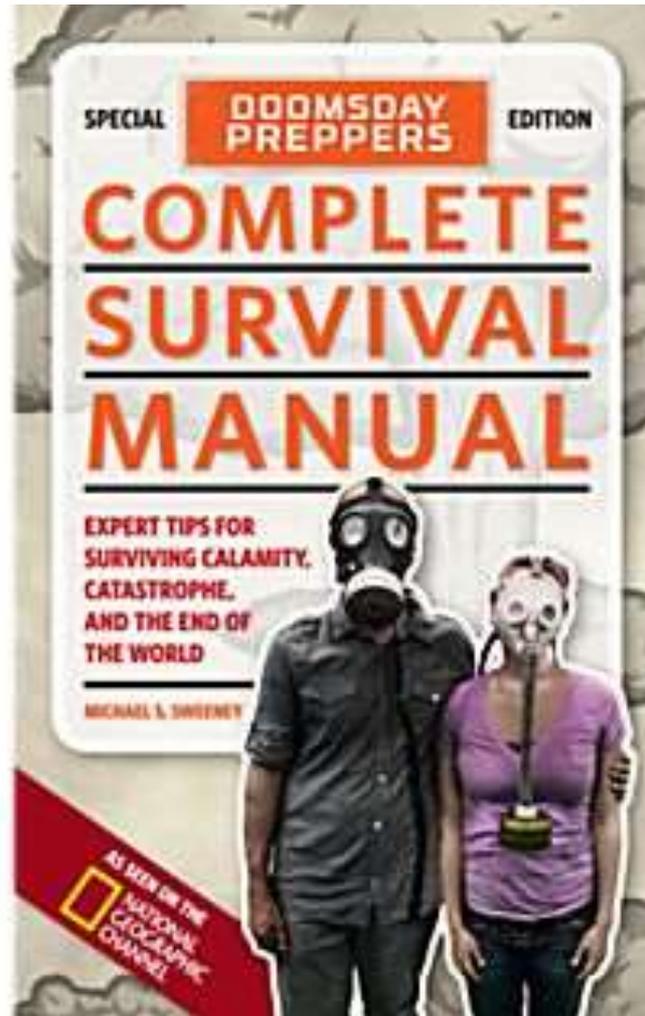
- Engineering: \$132,180
- Other: \$48,658

Funding Sources (thousands of dollars):

- Federal government: \$636,348
- State and local government: \$36,465
- Institution funds: \$80,878
- Businesses: \$62,918
- Nonprofit organizations: \$79,074
- Other donors: \$7,555



What's the worst that could happen?



<http://shop.nationalgeographic.com>





Today's talk: How has the University of Iowa prepared for an extended electrical grid outage?



Automatic switching to island mode provides reliability – the highest priority



Purchased Power 41.6MW

- Return to Menu
- Stm O'view
- Sub U
- Sub U TX 6
- Sub U TX 7
- Elec O'view
- EMERGENCY

Substation L

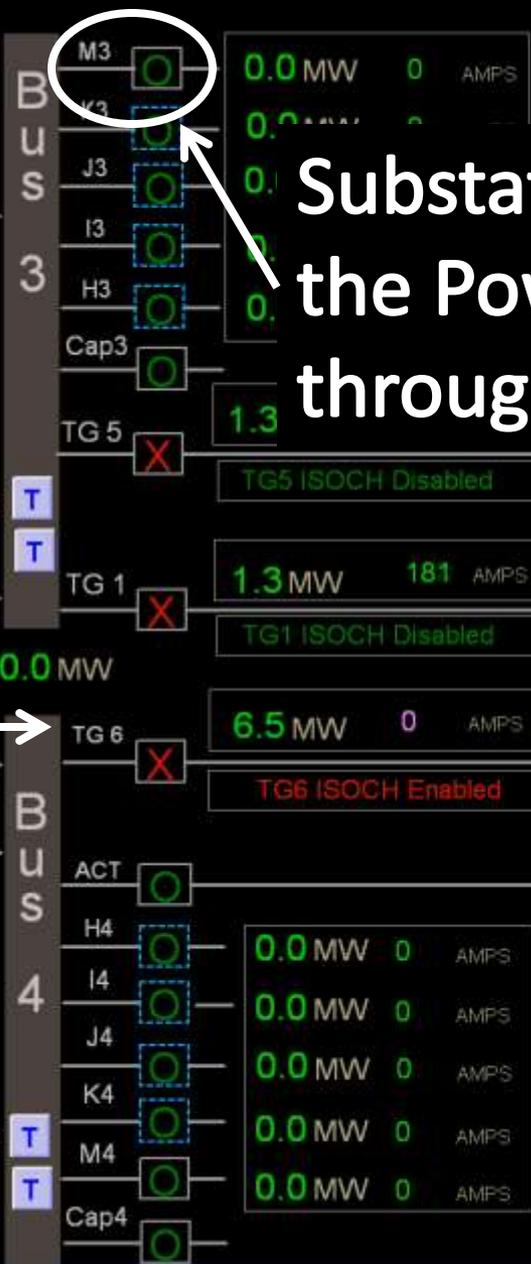
TX 3

7.4 MW

326 AMPS

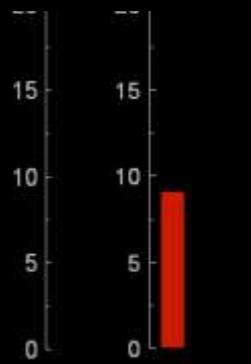
13716 VOLTS

PI



Substation feeding the Power Plant through "M" loop

TG from the previous picture



TX 4

0.0 MW

0 AMPS

13722 VOLTS

PI

DG7 OFF

0.0 MW

0 AMPS

0 VOLTS

0.0 HZ

0.00 pf

If the tie to the utility opens - loss of grid power

Substation L

TX 3 T

0.0 MW

Sub U TX 6

Sub U TX 7

Annotations: A red 'X' in a box is circled with a white arrow pointing to it from the top. The '0.0 MW' value is circled with a white arrow pointing to it from the bottom.

The 7.4 MW purchased goes to 0 MW

SUB L Totals

0.0 MW

9.1 MW

Legend

- UF off (white box)
- UF on (blue dashed box)
- unprot load (yellow box)
- gen level (red box)

So the islanded TG tries to pick up the load, frequency drops, and loops open via relays

BUS 3

K3 0.0 MW 0 AMPS

J3 0.0 MW 0 AMPS

H3 0.0 MW 0 AMPS

Cap3 0.0 MW 0 AMPS

TG5 1.3 M

TG1 1.3 M

TG6 6.5 MW 0 AMPS 0.00 pf 0.0 HZ

ACT 0.0 MW 13 AMPS

H4 0.0 MW 0 AMPS

I4 0.0 MW 0 AMPS

J4 0.0 MW 0 AMPS

K4 0.0 MW 0 AMPS

M4 0.0 MW 0 AMPS

Cap4 0.0 MW 0 AMPS

Annotations: A white oval circles the bus status indicators (K3, J3, H3, Cap3). Another white oval circles the 'TG6 ISOCH Enabled' status. A white arrow points from the text 'The ISOCH Enabled generator switches to "island mode"' to the 'TG6 ISOCH Enabled' status.

The ISOCH Enabled generator switches to "island mode"



<http://www.vladi-private-islands.de>

SHIFT REPORT

6PM-6AM	XXX
6AM-6PM	XXX

CREW #1

Chief Operator:	Billman	Asst. Chief:	Gilmore
Boiler Operator:	Rogers	Utility Worker:	Billman
Start Date:	1-23-2008	End Date:	1-24-2008

EQUIPMENT ON/OFF

BLR 7	St. Bank	BLR 8	St. Bank	TB 1/2	On/On	BLR 10	Auto
BLR 11	Flow Control	TG 1	Air Layup	TG 5	On	TG 6	On

PERSONNEL ATTENDANCE INFORMATION:

Name	Time Of Call	Explanation (Well/Late/Sick/Etc.)	Result (Time Of Arrival, Etc.)	Abs. Rep. Submitted

ON-THE-JOB-INJURIES:

Name	Time	Injury	How It Happened

GAS	EAST	WEST	BLR, TG OUTAGES, SIDELINE DEPRESSURE: CALL PLANT / OPERATION MANAGER!!
9 AM			

TIME:	REMARKS:	
6:00 PM	Biomass truck finishing up with unloading.	
7:15 PM	Began regeneration of DI train #1.	
7:30 PM	Blew soot on #10 boiler.	
8:10 PM	Lit #8 boiler.	
8:50 PM	#8 boiler on line for load reasons.	
9:10 PM	Biomass truck unloading.	
11:10 PM	Blew soot on #11 boiler.	
11:25 PM	Finished with regeneration of DI train #1. Dumping neutral tank to sewer.	
12:00 MID	Gas readings: East - 2685866, West - 4761629.	
1:45 AM	Got alarm for "low condensate receiver" for Oakdale. Got a hold of Dave Swartzendruber, and he is going to check it out.	
2:15 AM	Biomass truck unloading.	
2:25 AM	Lost TX3 and H4, I4, and J4. TG #6 went into ISOC and picked up the load reasonably smoothly. MidAmerican said they lost a 69-KV feeder (I think?) and that caused the problem. Called Electrical Distribution, Ed Alcock, Ben, Steve, and Ferman. At Ferman's direction, I also called Dan Heater.	
2:45 AM	TB #1 tripped on low gas pressure at burner.	
3:30 AM	Plant back on MidAmerican feed through TX4. Power restored to H4, I4, and J4 also. Ben and Steve tried to get TB #1 going, but low gas pressure problems persist. Will button up boiler as needed and look at the problem first thing in the morning. TX4 selected and ISOC is enabled for this feed. TX3 is "fried" and OOC until further notice.	
3:45 AM	Blew soot on #10 boiler a second time.	
4:35 AM	Mike called from Oakdale. A line on the dealkalizer broke that resulted in the low condensate receiver alarm. The plant is stable. Mike and Dave are on site working on repairs.	
4:50 AM	Biomass truck unloading.	Ferman
5:30 AM	Got TB #1 to relight. TB #2 tripped about 5 minutes later.	Jerry
		Ben
*****	Blew down water columns on all operating boilers.	Joe
*****	Greased feeders on #10 boiler.	Hal
*****	Attempted to cycle isolation valves for #11 boiler's bottom ash system.	Mark
	Neither valve is working.	Tom
*****	Stack obstruction lights working correctly throughout our shift.	Bob
	See next page	Office

SHIFT REPORT

CREW #1

6PM-6AM	XXX
6AM-6PM	XXX

Chief Operator:	Billman	Asst. Chief:	Gilmore
Boiler Operator:	Rogers	Utility Worker:	Billman

2:25 AM	Lost TX3 and H4, I4, and J4. TG #6 went into ISOC and picked up the load reasonably smoothly.
	MidAmerican said they lost a 69-KV feeder (I think?) and that caused the problem. Called Electrical

PERSONNEL ATTENDANCE INFORMATION:				
Name	Time	Explanation	Result	Abs. Rep.

Low temp that night: -13 F

GAS	EAST	WEST	BLR, TG OUTAGES, SIDELINE DEPRESSURE: CALL PLANT / OPERATION MANAGER!!
9 AM			
TIME:	REMARKS:		
6:00 PM	Biomass truck finishing up with unloading.		
7:15 PM	Began regeneration of DI train #1.		
7:30 PM	Blew soot on #10 boiler.		
8:10 PM	Lit #8 boiler.		

Island mode has been used 5 more times since this incident in 2008

	MidAmerican said they lost a 69-KV feeder (I think?) and that caused the problem. Called Electrical Distribution, Ed Alcock, Ben, Steve, and Ferman. At Ferman's direction, I also called Dan Heater.	
2:45 AM	TB #1 tripped on low gas pressure at burner.	
3:30 AM	Plant back on MidAmerican feed through TX4. Power restored to H4, I4, and J4 also. Ben and Steve tried to get TB #1 going, but low gas pressure problems persist. Will button up boiler as needed and look for this feed. TX3	
3:45 AM	Blew	
4:35 AM	Mike receive	rw condemate
4:50 AM	Biom	Ferman
5:30 AM	Get T	Jerry
		Ben
		Joe
		Hal
		Mark
		Tom
		Bob
		Office
	***** Blew	
	***** Grinders secured on #10 boiler.	
	***** Attempted to cycle isolation valves for #11 boiler's bottom ash system. Neither valve is working.	
	***** Stack obstruction lights working correctly throughout our shift.	
	See next page	

Reliability first, then resilience

If reliability fails.....

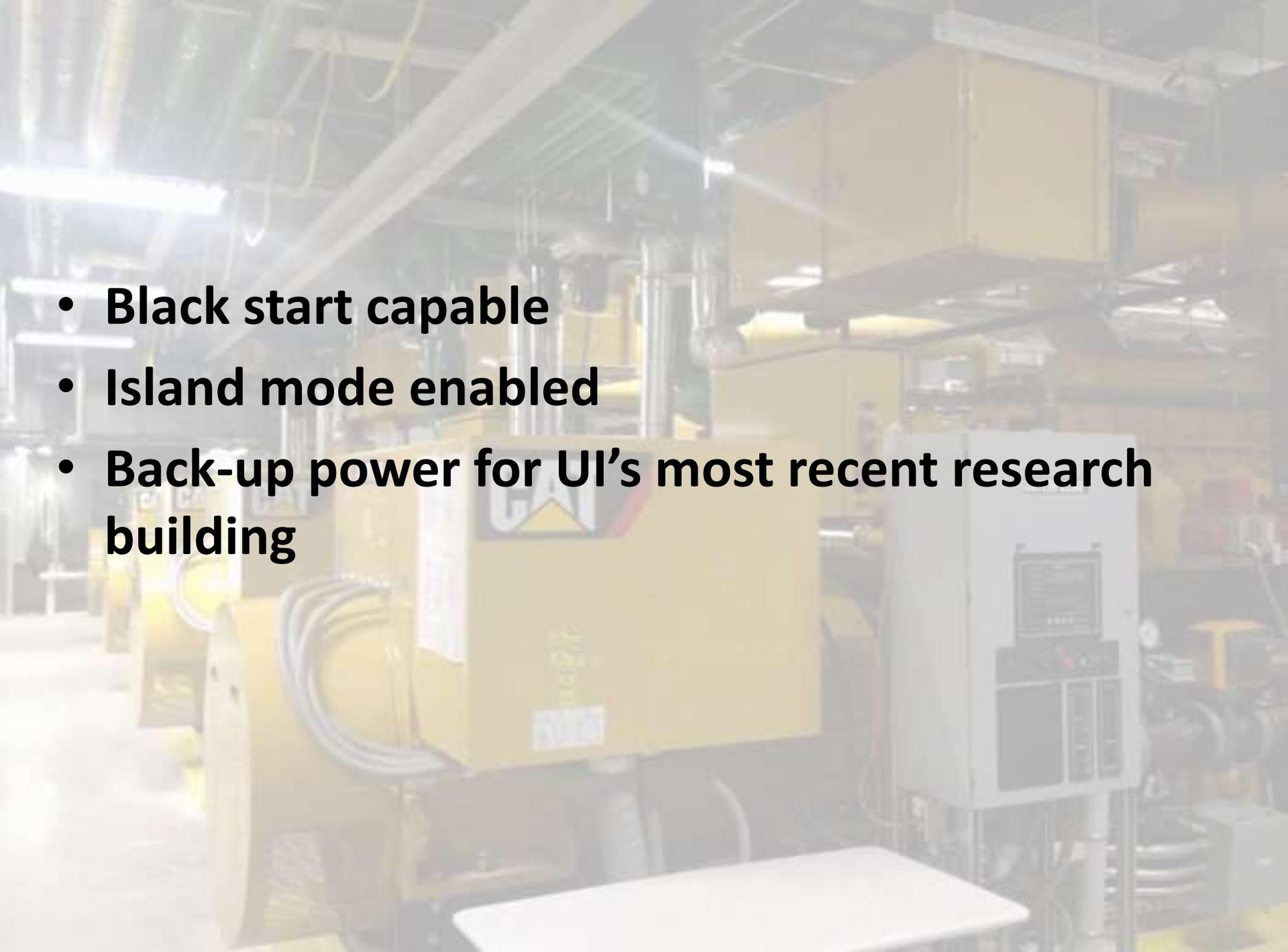
- Diesels in buildings will start up and power emergency circuits
- Problem with this scenario: no steam and no chilled water
- UI response.....

4 x 2MW Natural Gas Recip Engines Foundation of the UI microgrid





500 year flood level

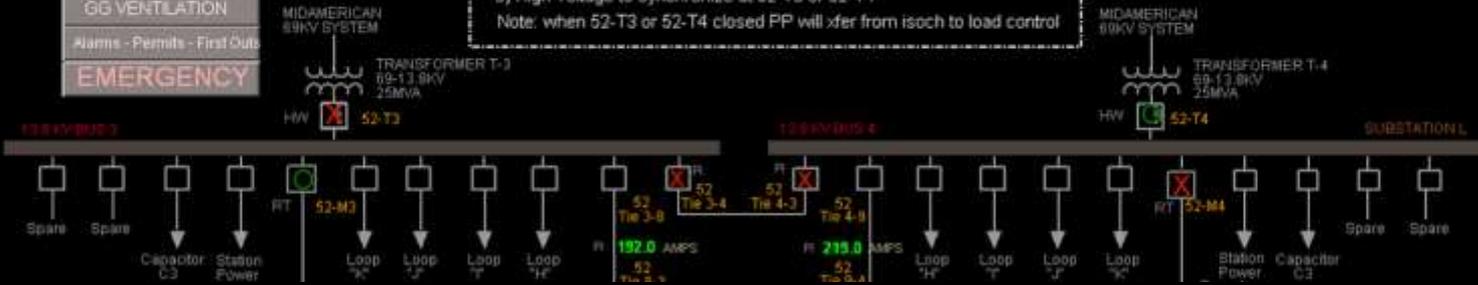
- 
- A photograph of a laboratory or industrial setting. The scene is dominated by yellow cabinets and equipment. In the foreground, there is a white table. To the right, a grey control panel with a screen and various buttons is visible. The background shows more yellow cabinets and a complex network of pipes and wires. The lighting is bright, and the overall atmosphere is technical and professional.
- **Black start capable**
 - **Island mode enabled**
 - **Back-up power for UI's most recent research building**

- **Automation is a key component of the microgrid system**

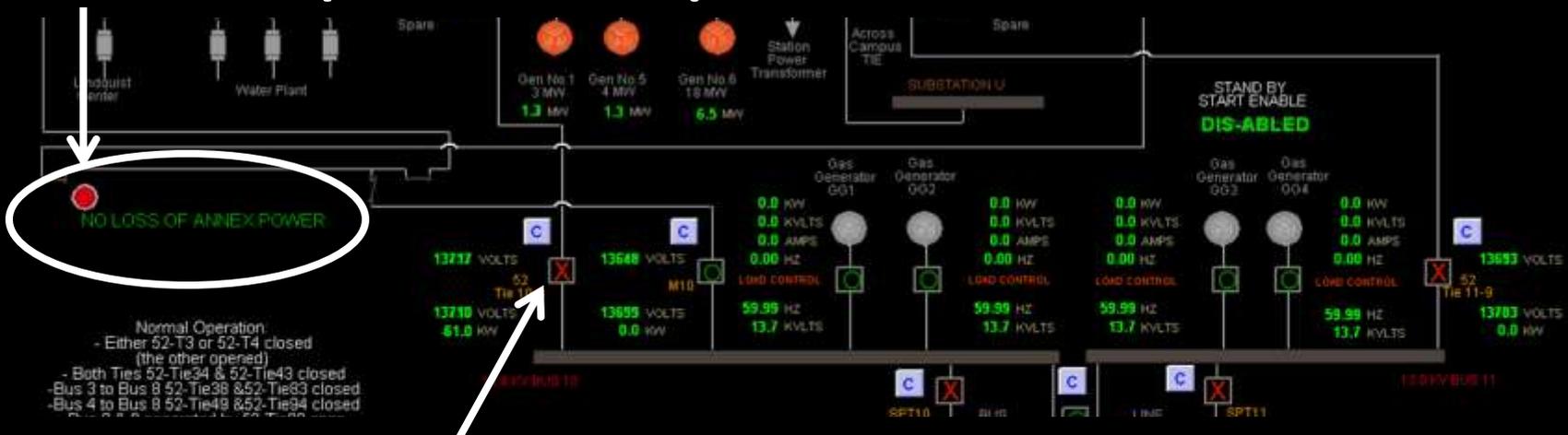


Return to Menu
 GG MENU
 GG VENTILATION
 Alarms - Permits - First Out
 EMERGENCY

Procedure for restoring MEC 13.8kV power to Sub L
 1) High Voltage to isolate loops from Bus 3 and Bus 4 as required
 2) High Voltage to close 52-M3 and/or 52-M4 as required
 3) High Voltage to synchronize at 52-T3 or 52-T4
 Note: when 52-T3 or 52-T4 closed PP will xfer from isoch to load control



Auto start upon loss of power to the Power Plant



NO LOSS OF ANNEX POWER

Normal Operation
 - Either 52-T3 or 52-T4 closed (the other opened)
 - Both Ties 52-Tie34 & 52-Tie43 closed
 - Bus 3 to Bus 8 52-Tie38 & 52-Tie83 closed
 - Bus 4 to Bus 8 52-Tie48 & 52-Tie94 closed

Automated switching to restore power to the Power Plant

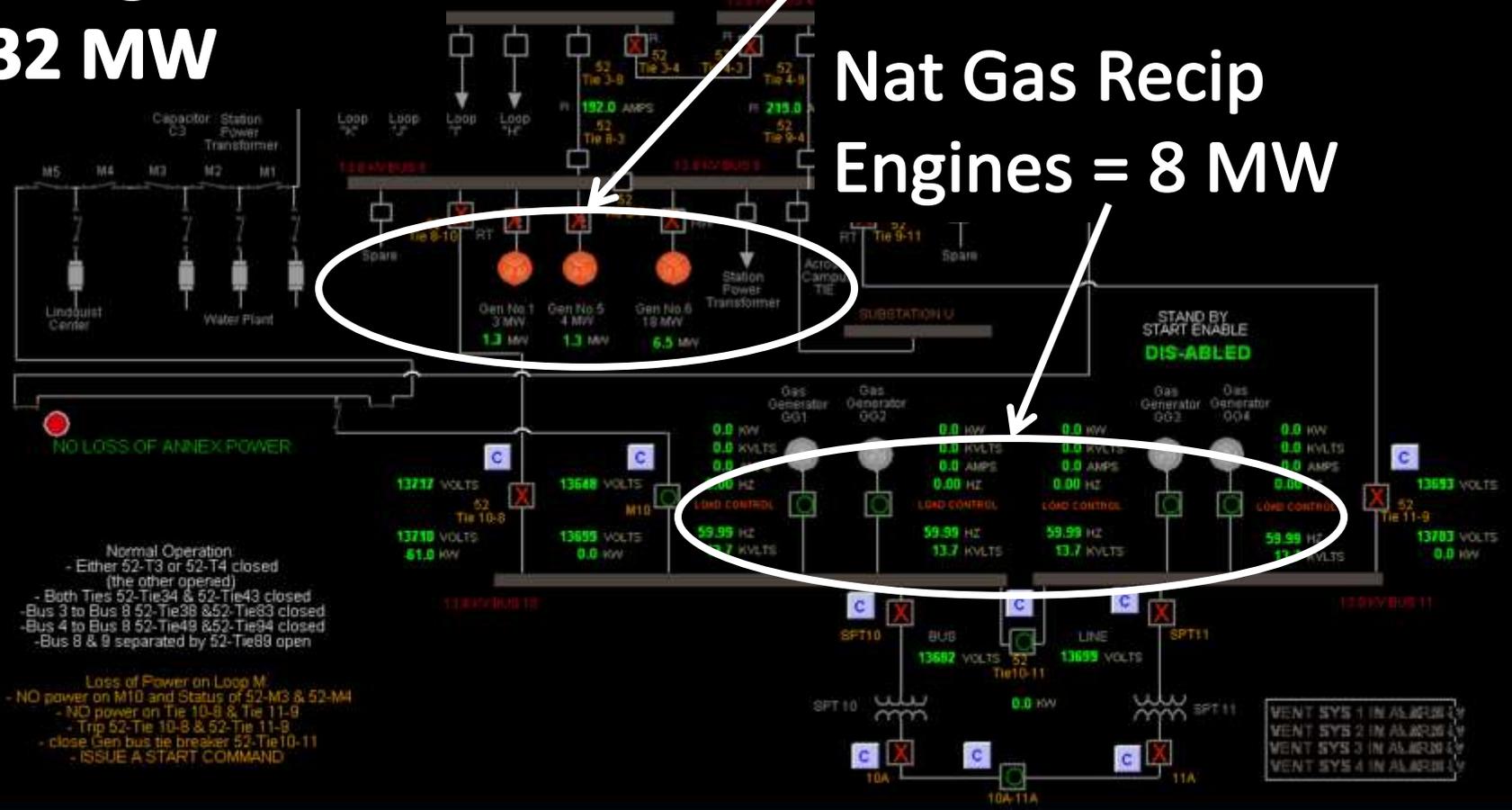
Time	Area	Event	Alarm	Description
6/12 10:24	7	Area 103	HI Alarm	BLR 10 SUPERHEATED STEAM
	1	Area 92	HI Alarm	GG2 START FROM WE START TO GCB C
				13:06:55 6/9/2015 CON32 Node COM18 restarted

Return to Menu
GG MENU
GG VENTILATION

Procedure for restoring MEC 13.8kV power to Sub L
 1) High Voltage to isolate loops from Bus 3 and Bus 4 as required
 2) High Voltage to close 52-M3 and/or 52-M4 as required
 3) High Voltage to synchronize at 52-T3 or 52-T4
 Note: when 52-T3 or 52-T4 closed PP will xfer from isoch to load control

**Microgrid total
= 32 MW**

**Steam TG's = 24 MW
Nat Gas Recip
Engines = 8 MW**



Normal Operation
 - Either 52-T3 or 52-T4 closed (the other opened)
 - Both Ties 52-Tie34 & 52-Tie43 closed
 - Bus 3 to Bus 8 52-Tie38 & 52-Tie83 closed
 - Bus 4 to Bus 8 52-Tie48 & 52-Tie94 closed
 - Bus 8 & 9 separated by 52-Tie89 open

Loss of Power on Loop M
 - NO power on M10 and Status of 52-M3 & 52-M4
 - NO power on Tie 10-8 & Tie 11-9
 - Trip 52-Tie 10-8 & 52-Tie 11-9
 - close Gen bus tie breaker 52-Tie10-11
 - ISSUE A START COMMAND

VENT SYS 1 IN ALARM
 VENT SYS 2 IN ALARM
 VENT SYS 3 IN ALARM
 VENT SYS 4 IN ALARM

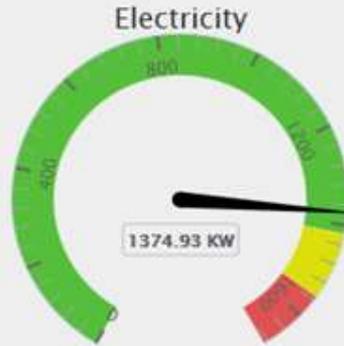
**Next Step – Include building
generators in the microgrid**





Select A Building ▾

Bowen Science Building



\$128.34 per hour



\$281.59 per hour

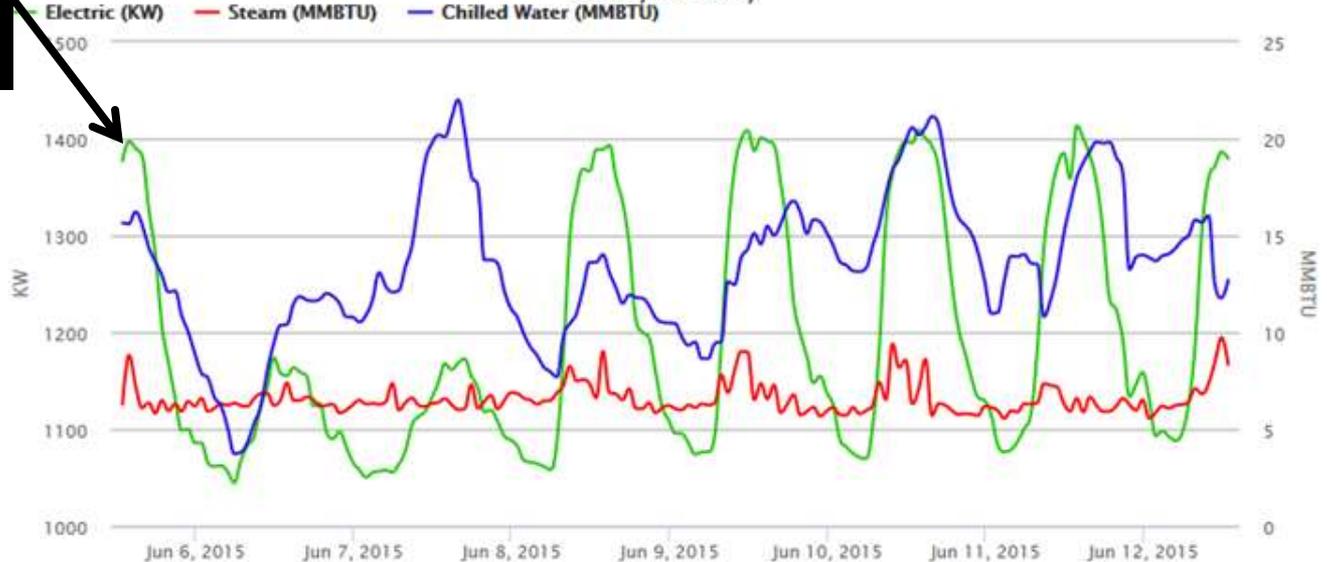


\$127.65 per hour

Total Utility Cost: \$537.58 per hour

*Ranges are based on hourly prediction. Green=0-105% Prediction; Yellow=105-115% Prediction; Red=115% and up

Utility History



Normal electric usage 1.4 MW

Building generator 1.5 MW



5 emergency diesel generators will be added to the micro grid

Capacity of 6.6 MW

Microgrid summary

- Power Plant steam turbine generators 24 MW
- Power Plant natural gas reciprocating engine generators 8 MW
- Building diesel generators 6.6 MW
- Total microgrid capacity 38.6 MW



Thank you for your attention.

Ben Fish
University of Iowa

Begin deleted slides

Water supply

- Back-up plans for water supply
 - RO system
 - Wells, with back-up power
 - Cross tie with local utility

Steam/Chilled Water

- Boilers to restart after gas gens come up
- West side plant planned to assist in restart of steam
- UIHC boiler saved evacuation in 2008

Electrical back-up

- Across campus tie-two subs are a benefit
- UIHC has back-up gen
- Power plant normally operational TG's
 - Hope to keep these on
 - Trip off loops as island mode goes into effect
- Back-up power plant
 - Used if power is lost to restart
- Micro grid
 - Gives additional power to restart more buildings

- Return to Menu
- Stm O'view
- Sub U
- Sub U TX 6
- Sub U TX 7

Substation L

TX 3 T

7.4 MW

0.0 AMPS

25 20 15

25 20 15

BUS 3

M3	0.0 MW	0	AMPS
K3	0.0 MW	0	AMPS
J3	0.0 MW	0	AMPS
I3	0.0 MW	0	AMPS
H3	0.0 MW	0	AMPS
Cap3	0.0 MW	0	AMPS

Purchased Power 41.6MW

DG8 OFF T

0 AMPS

0 VOLTS

0.0 HZ

0.00 pf

BUS 5

35	1.3 MW	0	AMPS	0.00 pf	0.0 HZ
TG5 ISOCH Disabled					
G 1	1.3 MW	181	AMPS	0.96 pf	60.0 HZ
TG1 ISOCH Disabled					
G 6	6.5 MW	0	AMPS	0.00 pf	0.0 HZ
TG6 ISOCH Enabled					

“Storm Mode” Increase generation so purchased electric is > 1MW

Legend: unprot load (yellow), gen level (red)

TX 4 T

0.0 MW

0 AMPS

13722 VOLTS

0.0 PI

25 20 15 10 5 0

25 20 15 10 5 0

mWatts

Amps

BUS 4

ACT	0.0 MW	0	AMPS
H4	0.0 MW	0	AMPS
I4	0.0 MW	0	AMPS
J4	0.0 MW	0	AMPS
K4	0.0 MW	0	AMPS
M4	0.0 MW	0	AMPS
Cap4	0.0 MW	0	AMPS

Sub U TX 6 Bus 5

0.0 MW

13 AMPS

DG7 OFF T

0 AMPS

0 VOLTS

0.0 HZ

0.00 pf