



You're only as good as what you eat... and how you feel

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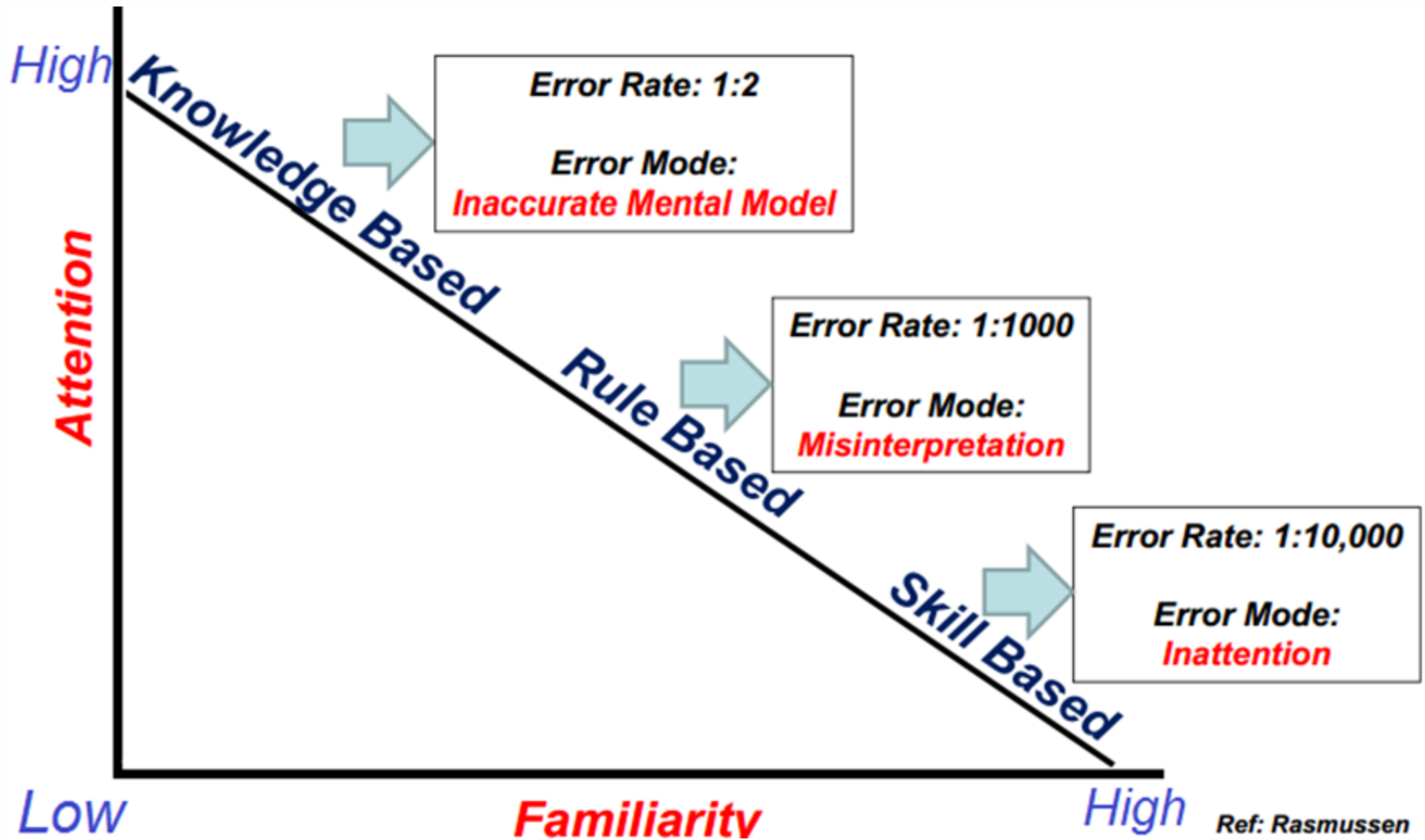
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A brief background

Human errors with experienced operators



Ego depletion

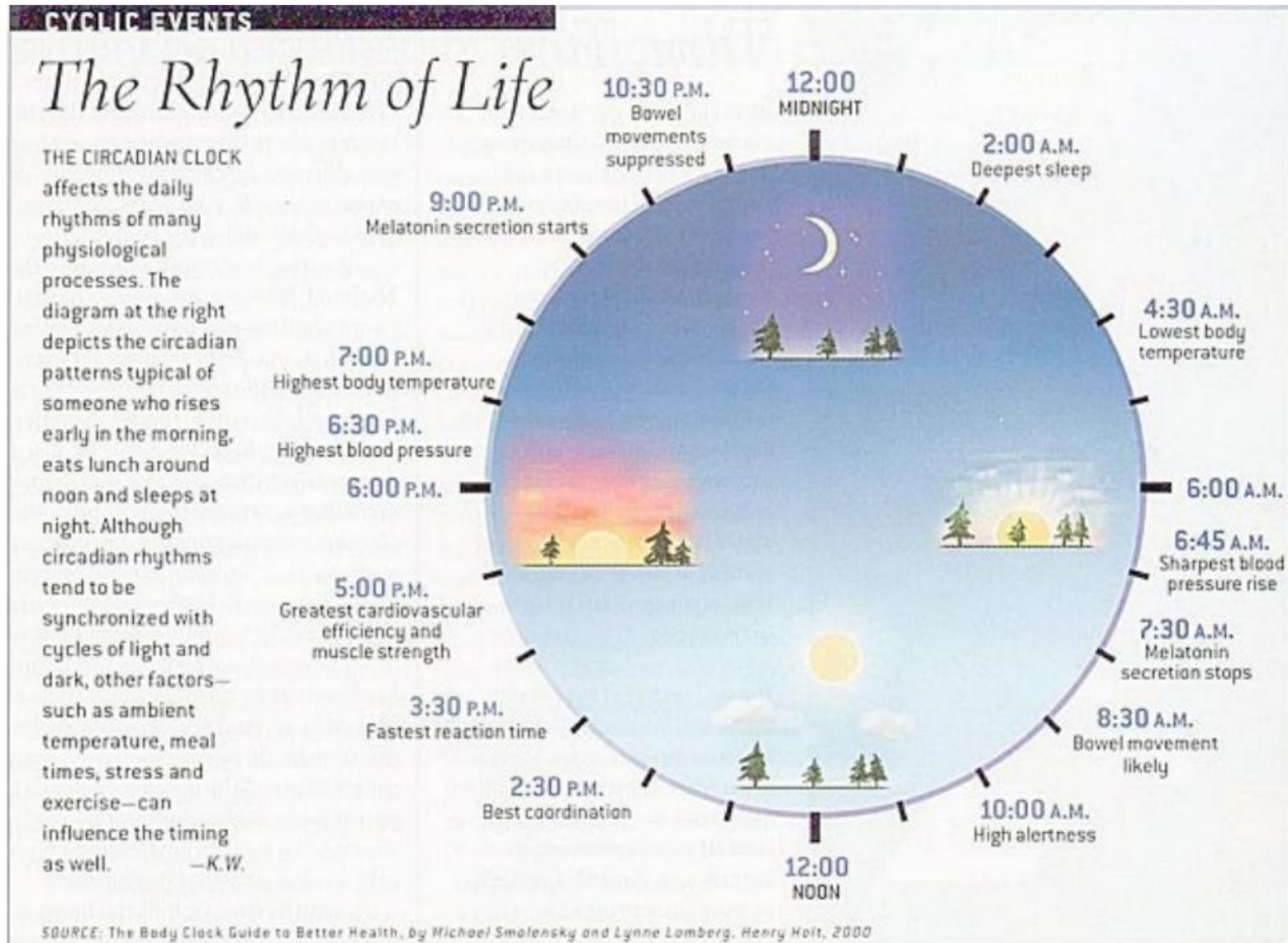
- Self-control is a limited resource, and like a muscle, it tires out (Baumeister et al, 1998)



dreamstime.com



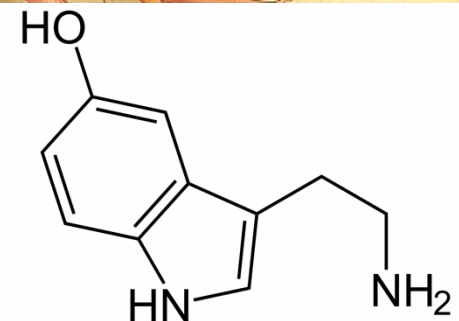
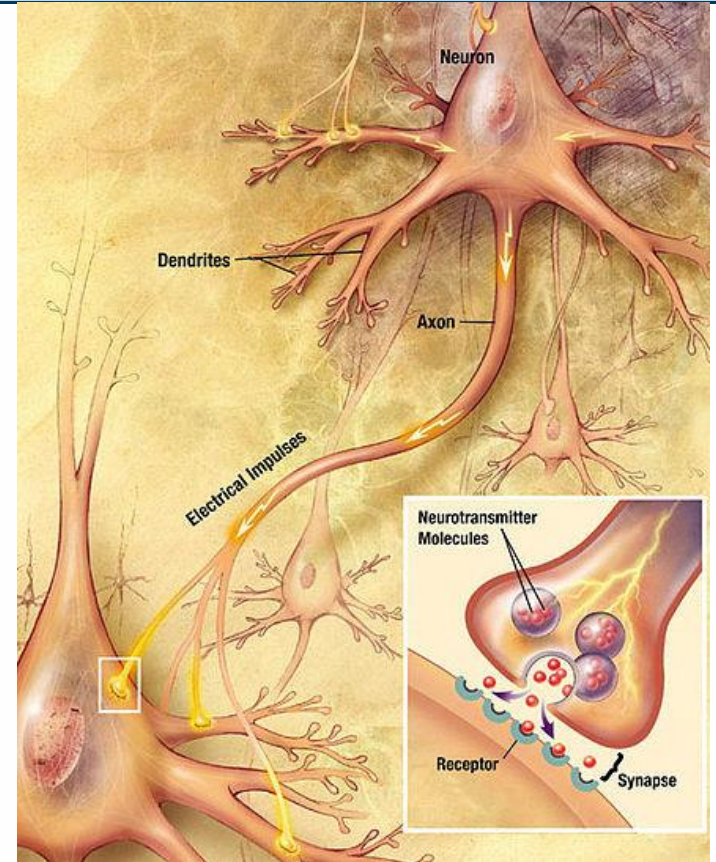
Circadian Rhythms



Source: [Neuroscience Education Institute](#)

Serotonin

- Serotonin is a neurotransmitter (traveling between nerve cells)
- Low serotonin levels lead to clinical depression
- Excessive serotonin leads to extreme feelings of well-being and happiness
 - Serotonin syndrome
 - Serotonergic neurotoxicity



Carbohydrates

- Digesting carbohydrates increases blood sugar, and the body in turn produces more insulin.
- Type 2 diabetes begins when muscle and other cells stop responding to insulin, and eventually you produce insufficient insulin and blood sugar levels stay too high.



Vigilance over time

- Vigilance is: The ability to maintain attention over long periods of time
- Vigilance can decrease due to:
 - Memory load
 - Event rate
 - Adverse environmental factors
 - Changes in motivation
- Maintaining vigilance is stressful, and exhausting (ego depleting), especially under high stress

Studies on fatigue

- Ford Motor Company (1917) found two 10-minute breaks every day produced greater worker output over the whole day.
- Fatigue is not “one size fits all”:
 - Fatigued extroverts perform better in stimulating environments around people, worse in quiet steady-state environments
 - The opposite effect is observed for introverts

Time of day

- Chances of getting acquitted in a criminal trial is higher right after lunch, lower right before (Danziger, Levav & Avnaim-Pesso, 2011).
- Some cultures incorporate early afternoon / post-lunch rest / nap (siesta) to insulate against heat & fatigue.
- In the medical field, a higher probability of human error in the early afternoon (often on long shifts) as opposed to the beginning of a shift.

Diet and Stress

- Many drugs used to treat depression are SSRIs – they lead to more serotonin in the brain
- 95% of serotonin is secreted in the gut in response to food
- Under stress, most people tend to increase “snack food” intake, reduce “meal food” intake (Oliver & Wardle, 1998).

Diet and Stress

- Experimentally, stress tends to shift people towards higher saturated fat, sugar and calorie foods (Zellner et al, 2006).
 - After eating these foods, participants reported feeling better for a short while.
 - People already dieting reported much higher levels of stress during these times.
 - Suppressing the impulse to eat fatty foods, especially under stress, may increase the risk of ego depletion!

Diet and Fatigue

- There is a well-known relationship between what you eat and how tired you feel.
- Eating high-carbohydrate foods can lead to hyperinsulemia (excessive insulin)
- For people engaged in strenuous exercise, high-carbohydrate foods 3-4 hours prior lead to reduced fatigue.
- For people not engaged in strenuous exercise, high carbohydrate foods are associated with lightheadedness, fatigue, and occasional fainting.

Diet and Fatigue

- Fatigue is not just physical; people can also become fatigued mentally.
- The brain uses sugar as a fuel source.
- Complex mental problems (including vigilance and self-control) require increased use of sugar in the brain.
- People given complex mental puzzles tend to also search out high fat / sugar / calorie snacks, compared to people given simple mental puzzles.

Diet and Blood Pressure

- Large food intake requires more blood flow to the gut, in order to support digestion & absorption.
- Carbohydrate intake also leads to decreases in blood pressure.

Diet and Exercise

- Central fatigue hypothesis: Increased serotonin in the brain can lead to decreased sport/exercise performance ([Davis](#), 1996).

Black Start Simulations

Black Start Simulations

- ERCOT Black Start Plan
 - Developed based on the assumption of a complete blackout.
 - Designed to allow the TOs the opportunity to restore identified Islands independently with coordination from ERCOT.
 - Dedicated to building Islands to predefined synchronization points and the restoration of the system as quickly and safely as possible.

ERCOT Roles in Black Start

- Operators have responsibility for specific geographic areas
- Coordination between operators and gas pipeline companies
- Coordination between transmission and generation operators in order to facilitate system restoration

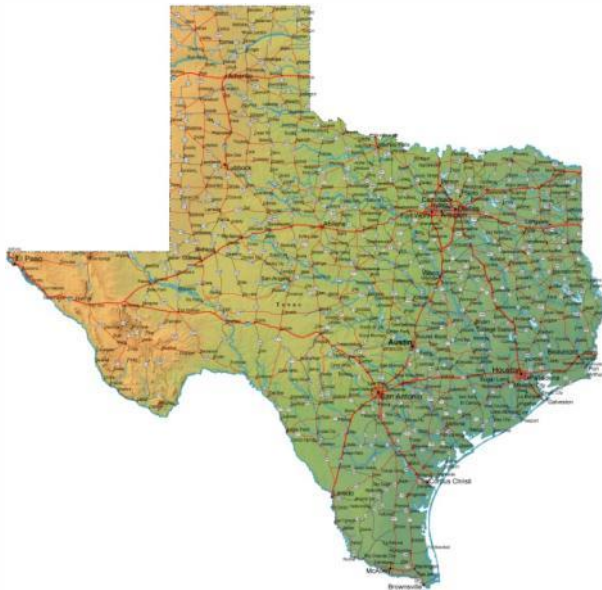
Black Start Restoration Process



Emergency Diesel Generator



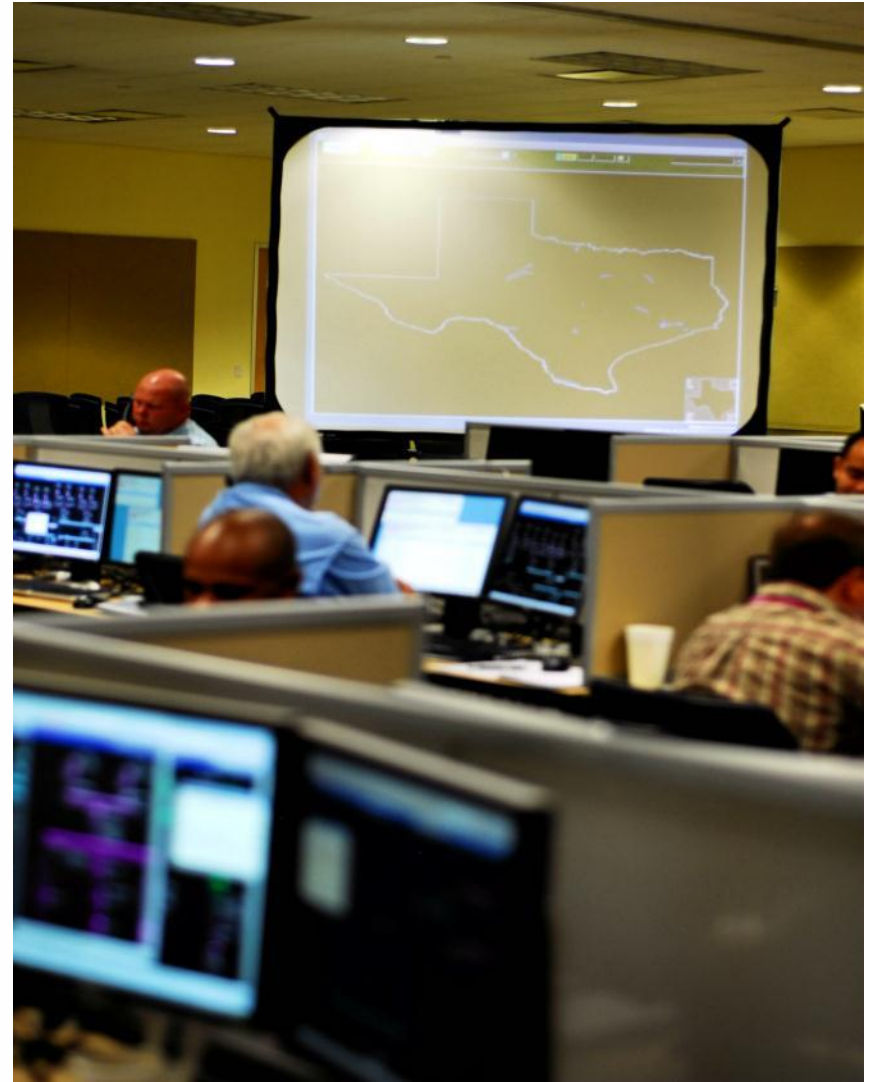
Black Start Gas Turbine



Next Start Units

ERCOT Black Start Training

- ERCOT brings over 700 TOs, QSEs and ERCOT operators together for annual simulations
- QSEs use simplified generation control systems to simulate unit restorations



ERCOT Black Start Training

- TOs and ERCOT operators use Macomber Map to see wide area views and control only their equipment
- Participants each perform their roles against ERCOT's EMS training simulator
- Simulation of severe weather event, many transmission lines unavailable.



Human components of black start

- Fatigue
- Political pressure / media pressure
- Sustained vigilance
- Separation from loved ones
- Unknown event duration
- Cognizance of life-or-death nature, individual and societal
- Poor diet (e.g., high carbohydrate, sugar, caffeine)
- Nicotine withdrawal

Human components of black start

- Communications issues
 - Three-way communications
 - Positive communications
 - Shared telephone conference / need for “net control”
 - Humor to diffuse stress
- “Hurry up and wait”
 - Different areas of responsibility mean many people waiting with little to do while others working

Blackstart Simulations and Training over several years

Early Blackstart Simulations

- Operators used one-line displays and tabular overviews.
- Typical behavior pattern: quickly moving through the system.
- Frequent island collapses, due excessive load close-in and other errors.
- Operators reported difficulties maintaining frequency and voltages due to detailed (one-line) views.

Adding Macomber Map

- Macomber Map began to be used, first by ERCOT operators and projector screens
 - Noticed some reductions in island collapses.
 - ERCOT operators were able to track voltage and thermal issues in a wide-area / situation awareness view.

Bringing the map to transmission

- The map was enhanced to support switching actions, and transmission operators began to use it.
- Definite changes in operator behavior:
 - Corridor rebuilds were slower and more methodical.
 - Highly significant reduction in breaker clearing errors.
 - Intentional load-shedding prior to island tie-ins were observed – a new behavior.

Bringing the map to transmission

- But, a strange pattern emerged:
- It seemed like there were still predictable switching errors shortly after lunch.
- Reviewing logs, and talking with trainers and operators, a trend became clear:
 - On days operators had fried chicken and mashed potatoes, the risk of errors increased between 1 P.M. (right after lunch) and 3 P.M.

Changes for this year

- Updated Macomber Map, including enhanced trending and alerting techniques and responsiveness
- Kelly & Stacy (our training manager and coordinator) ran an experiment during our dry run:
 - Lean pork in a light gravy or stuffed pepper with brown rice
 - Green beans with slivered almonds and light butter sauce
 - Fingerling whole potatoes

Results

- For the first time in training history, ran the full simulation day (7 A.M. – 5 P.M.) without a single identified switching error.
- This was during the dry run – presumed to have had the highest risk of error:
 - It was a year since the last training
 - Operators were not yet observing other operators from their companies attending the training.

Results

- The operators...
 - **HATED IT!**
- Several operators requested to come in early the following morning, so they could leave early and go out for a “proper meal”.
- “You’ve got to be kidding me!” frequently heard.

The rest of the simulation

- Generally, this year's simulation has gone better than previous years
- New total load peak achieved, with one island.

Blackstart Simulation

So...

- “Blackout-fried chicken?”



- Or, what “feels” right under stress may turn us astray

