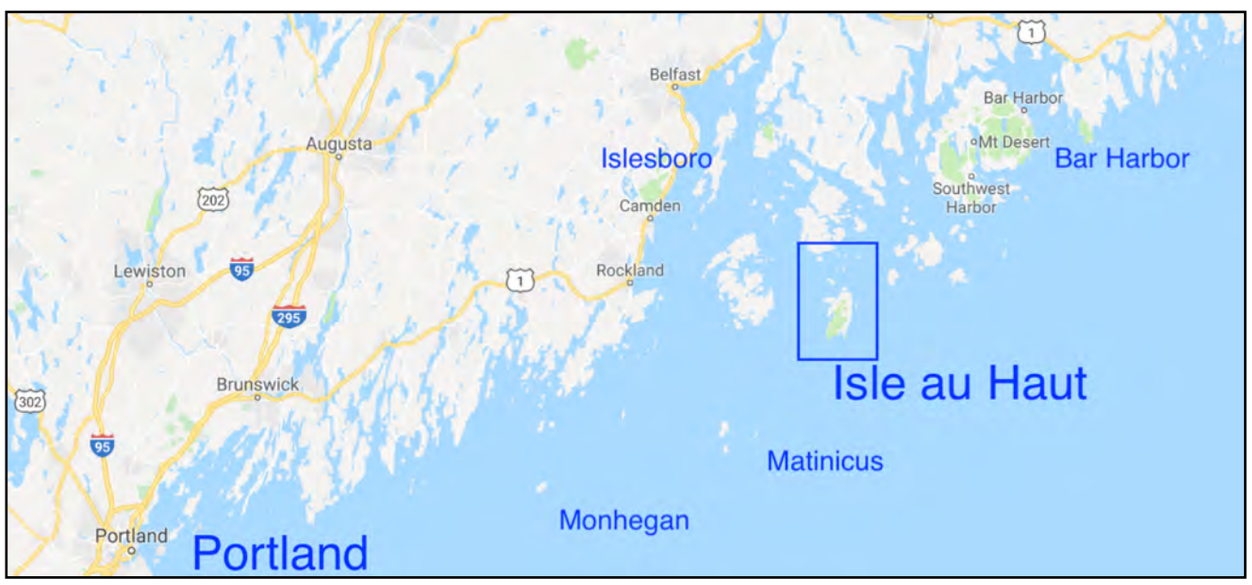
Our problem is a 35 year old cable, if it fails it will be very expensive to replace.

- Built in 1983, expected life of 15-20 years
- If it fails today our only immediate alternative is diesel
- Diesel will more than double average cost of electricity to about 70¢/kWh
- Even with our current high subscriber rates we'll run about $75,000 in debt each year. (revenue is only ~$120,000/yr)



Isle au Haut Electric Power Co.

We need to prepare for failure of the cable.

Have considered several alternatives -
new cable, solar, wind, diesel, micro-turbines.

We chose to go with solar.

Solar has low capital costs, low maintenance, most economical

- We should be able to transition to solar without raising our rates
- Will build the solar project in two phases:
  - first — while cable is still operational,
  - second — when cable fails and we are truly ‘islanded’

Three issues we've had {so far}

1. **Early community buy-in,** not waiting until the problem was too big.

2. **Getting a large single phase inverter** slowed us down, a market not a technological problem.

3. **Managing a complicated renewable energy microgrid.**

- Finding ways to use excess power produced every afternoon but in different amounts each season.

- Balancing power distribution using battery and thermal energy storage.

This is and will be a continuing challenge

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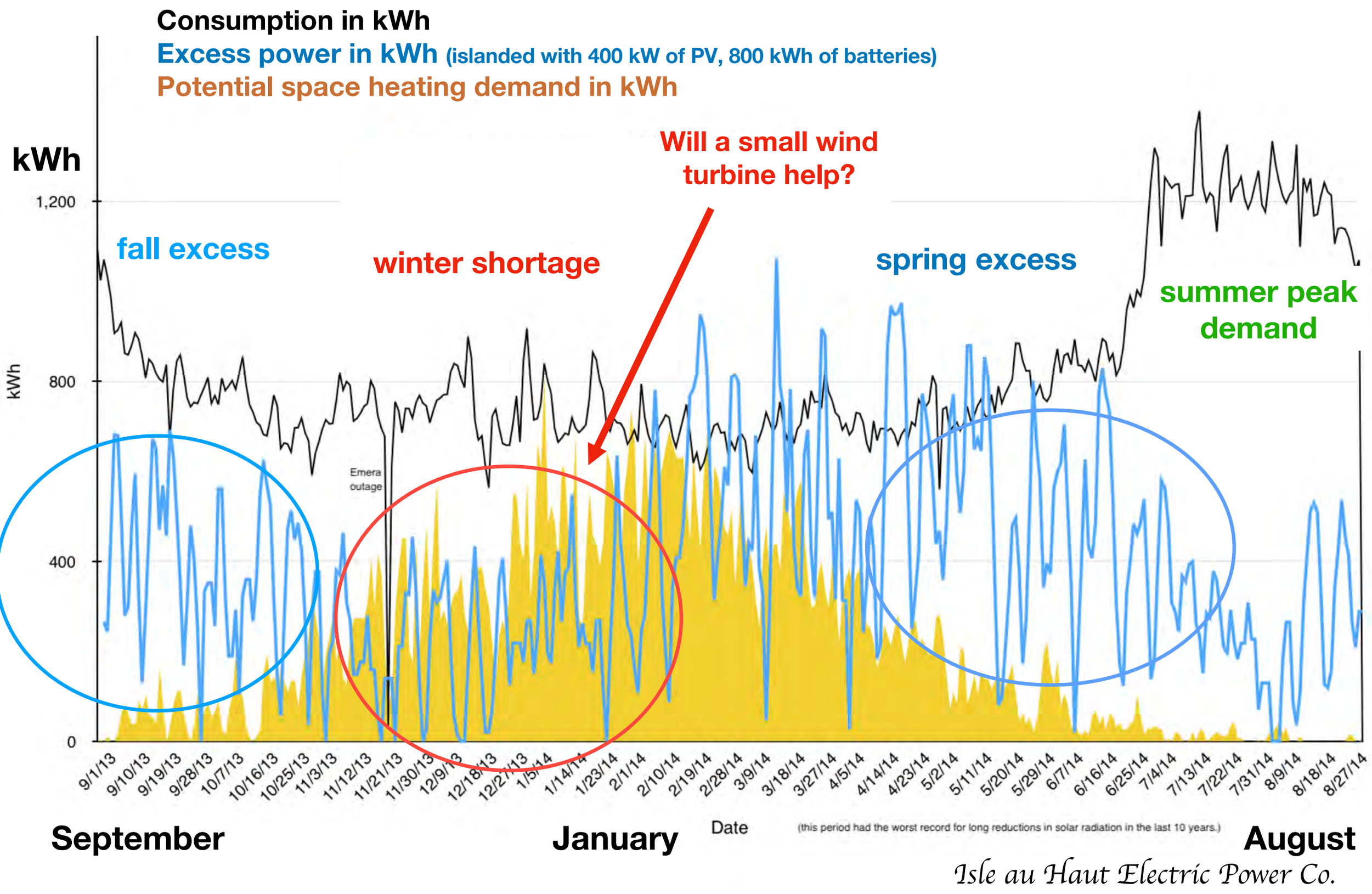
Every afternoon the solar array will produce excess power; but the amount of excess also varies with the season



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Excess power is

a problem that is a <u>real opportunity</u>

An efficient renewable system has to capture and store EXCESS POWER

- electrochemical storage (e.g., lithium-ion) is essential, but expensive,

- hot water stores energy at 10 to 15% of the cost of lithium.

THE OPPORTUNITY

Air to hot water heat pumps can be used for space heating.

large water tank is heated when there is excess solar power; the water is used later for space heating, replacing fossil fuels.

Currently the island spends about $100,000/yr. on fossil fuels.

10 heat pumps will reduce fossil fuel expenditures by about $40,000/yr., or 40% of current island expenditures.

a special 16¢/kWh rate will generate $20,000 new revenue for the power company, and

will reduce the heat cost for heat pump users by about $20,000.

Additionally, when we are islanded we will no longer spend about **$33,000/yr for power** from the mainland grid.

All these savings stay on the island and make the solar approach affordable - very important for a small year around community.

THE PROBLEM

{This where we could all get our annual dose of Nerdism.}

- System will have multiple sources of power, and changing loads
  - Solar, cable, batteries, diesel, heat pumps, line breaks, etc.
- It will have fluctuations, transients - the effect is magnified in a small system.
- Finding an efficient way to balance these different influences is the role of the microgrid controller.

Microgrid controller

- **The controller** Introspective Systems is developing **is unique** because it does this **from the bottom up, kind of like a market.**
- The controller will understand whether energy is abundant or scarce at any moment and will send out a signal, i.e., a virtual price.
- Heat pumps, batteries and other loads will react by deciding to turn on or off according to preferences of the owner.
- VERY DECENTRALIZED. No need for the ‘central controller’ to actually control.

We've had absolutely essential help from:

Steven Strong — Solar Design Assoc.,

Kay Aikin — Introspective Systems,

Morgan Casella — Dynamic Organics,

Tom Gocze — American Solar Technics, and

Hans Albee — ReVision Energy, and, of course,

Island Institute introduced us to the market.