# IceCube Mid-Term Review Q&A

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NSF Mid-Term Review
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IceCube
South Pole Neutrino Observatory

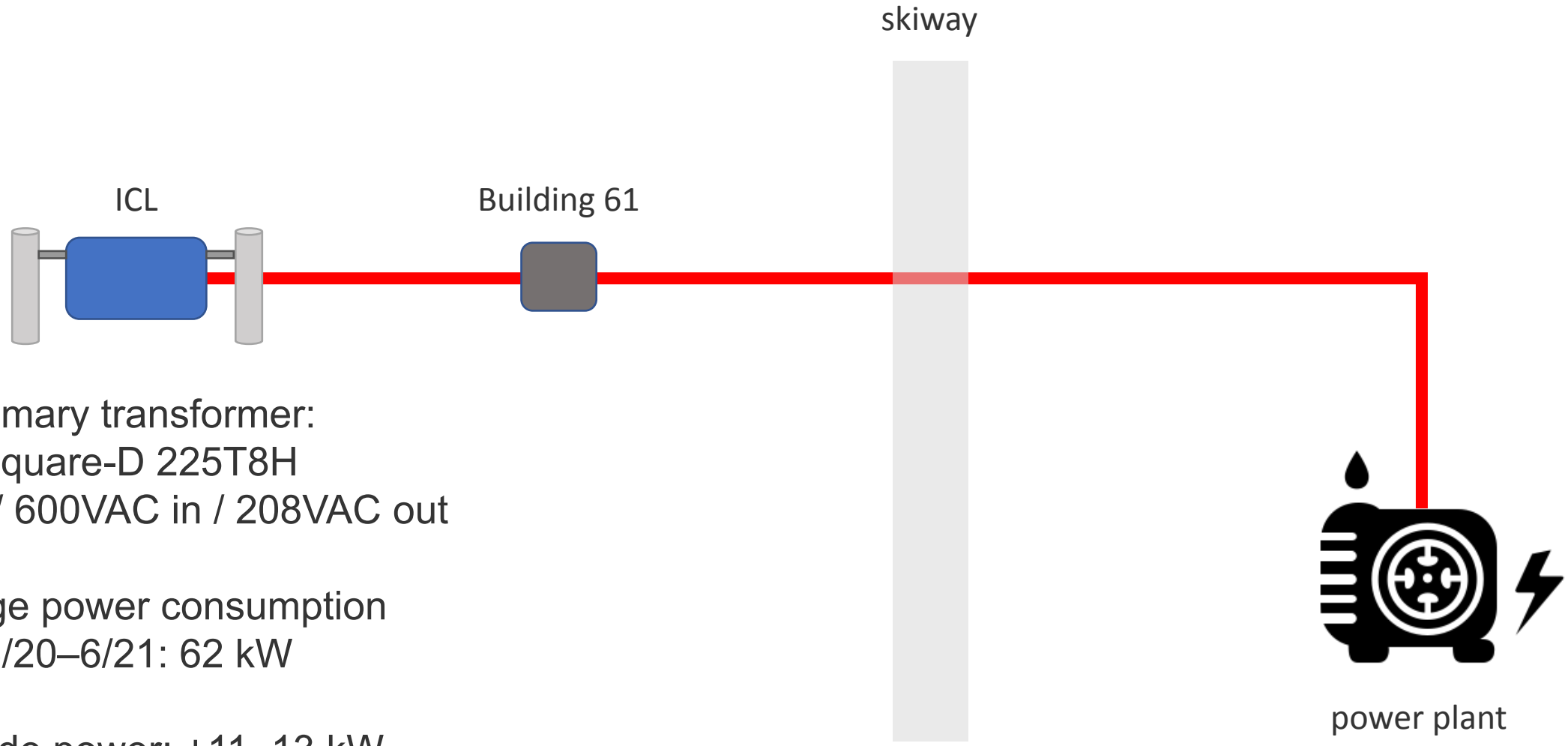
# Questions

- Is the additional required power for the Upgrade of 11–13 kW an issue given the current power usage at South Pole?

- What is the current breakdown of Gen1 and Upgrade power consumption, and what are some opportunities for power savings?

- Has there been or will there be coordination with the other major South Pole science groups on power usage?

# South Pole Power Delivery




primary transformer:
Square-D 225T8H
225 kVA / 600VAC in / 208VAC out

average power consumption
6/20–6/21: 62 kW

Upgrade power: +11–13 kW

# Power Plant Excess Capacity (Unofficial)

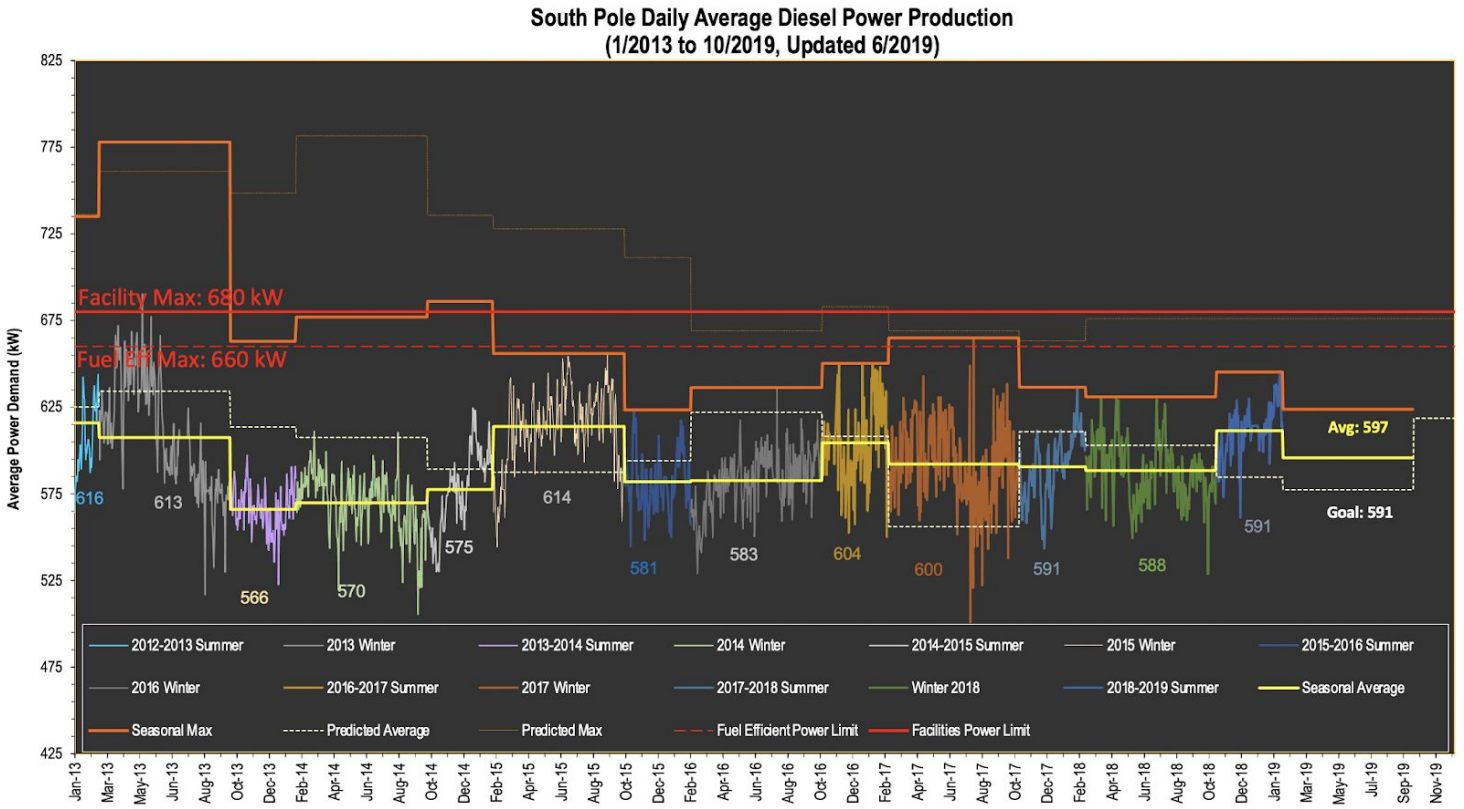
- South Pole power provided by AN-8-fueled generators
  - 1 primary generator + 1 peaking generator
  - 1 backup generator
  - 1 generator under service

- "1MW capacity" with some caveats
  - primary generator efficiency drops above 660 kW
  - **max recommended for continuous operation: 680 kW**
  - peaking generator kicks in at 712 kW but cannot be run continuously due to insufficient cooling capacity

- Current power usage average 600 kW
  - max sustained 625–650 kW

- Excess capacity estimated to be 30–50 kW
  - **overhead is sufficient for the Upgrade**

- **NB:** these are our own conclusions, compiled with information from ASC experts




South Pole power, 2013–2019

# Gen1 Power Estimated Breakdown

| Component | Power / ea. (W) | Quantity | Total power (kW) |
|---|---|---|---|
| DOMs | 5.7 | 5404 | 30.6 |
| DOMHubs | 128 | 97 | 12.4 |
| Core servers | 200 | 8 | 1.6 |
| Data Acquisition and Control servers | 250 | 6 | 1.5 |
| Monitoring / Verification | 200 | 5 | 1.0 |
| Processing / Filtering master | 270 | 1 | 0.27 |
| Processing / Filtering slaves | 300 | 20 | 6.0 |

**Table 1:** Power usage of key IceCube components. Total power usage is approximately 53 kW. Figures include efficiency and transmission losses.

- Power numbers from a 2013 analysis of emergency power-down contingency plans
- Surface array, ARA, IceACT etc. 1–2 kW
- Coarse estimate: ICL environmental is an additional 8–10 kW

# Upgrade Power Estimated Breakdown

Nominal Upgrade power estimates

| | | NOMINAL | |
|---|---|---|---|
| **Item** | **Power (W)** | **Quantity** | **Total (kW)** |
| String power | 1251 | 7 | 8.76 |
| DOM supply AC-DC losses | 963.27 | 1 | 0.96 |
| UPS | 4 | 2 | 0.01 |
| PDU | 10 | 2 | 0.02 |
| network switch | 350 | 2 | 0.70 |
| weather goose | 20 | 1 | 0.02 |
| FieldHub | 75 | 7 | 0.53 |
| WR switch | 80 | 1 | 0.08 |
| **Total** | | | **11.07** |

Estimate an additional ~1 kW from DAQ servers

# Opportunities for Power Savings

- Upgrade the primary ICL transformer
  - raw increase in efficiency: 97.8% -> 99%
  - more savings expected because of better handling of non-linear loads (e.g. our many switching power supplies)
  - when we investigated this in 2014:
    - estimated savings was 2–3 kW
    - cost was ~$20k, payback time in fuel costs was 2 years
  - upgrading this would be an ASC task / responsibility

- Transition servers to ARM64 architecture (esp. PnF)
  - expect will be more power efficient, but savings would need to be quantified
  - estimate 1–3 kW

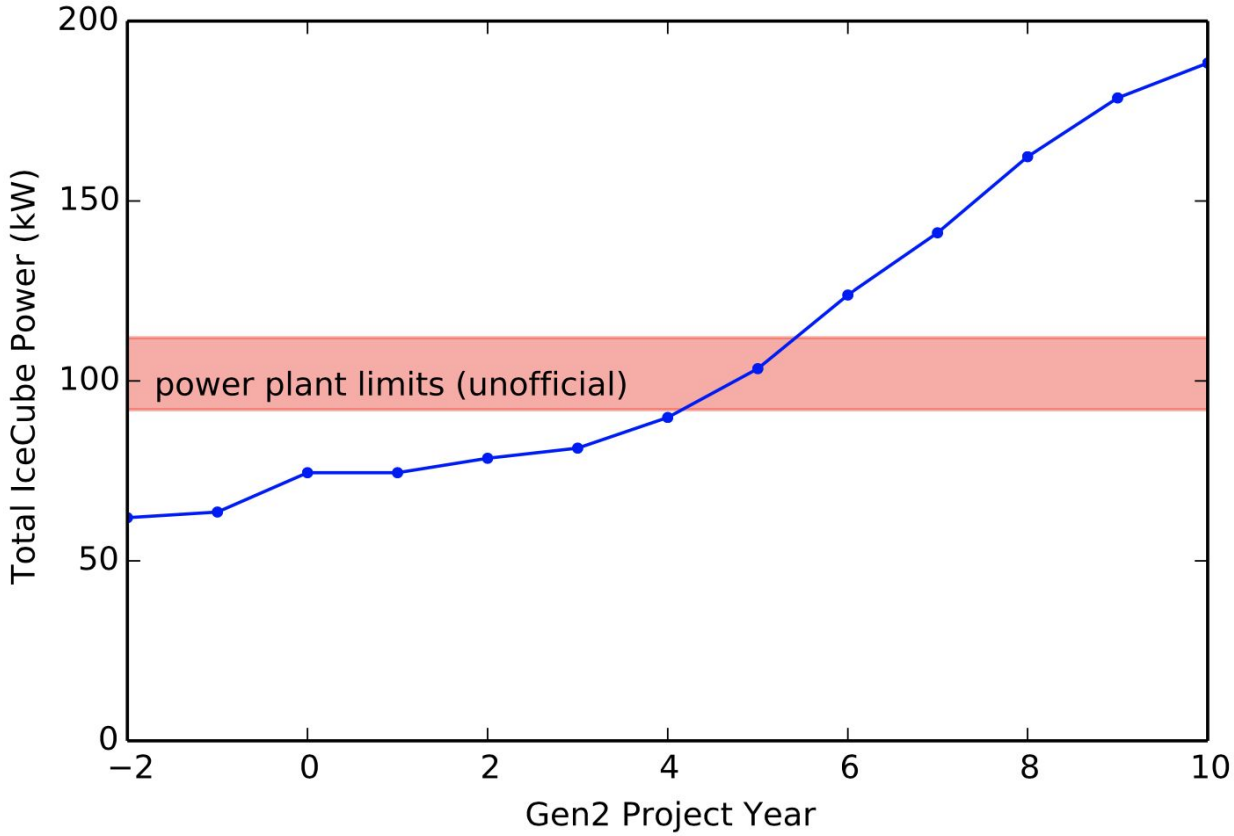
- Accelerating waveform unfolding with GPUs
  - efficiency gains possible, but longer-term effort — research is underway

- Gen1 DOMHub to FieldHub replacement
  - first estimate: 6-7 kW savings (lower power / hub and half as many hubs)

# Coordination with Other Science Groups

- Long term: ongoing discussions with CMB-S4 regarding renewable energy generation at South Pole
  - in preliminary discussions about a joint workshop
- We are anticipating a stable long-term power draw from SPT+BICEP and CMB-S4
  - CMB-S4 AoA plan fits within current SPT+BICEP power envelope
- We regularly coordinate with SPT and BICEP groups on several topics
  - joint satellite bandwidth planning exercise
  - EMI activities in the Dark Sector (radio, WiFi usage during Upgrade construction)
  - Starlink testing at South Pole
  - we can expand this to discuss short- to medium-term power usage
- Regular updates from NSF and ASC on power generation / usage would be most welcome
  - we will still rely on NSF and ASC for coordination and guidance

# IceCube-Gen2




from the Gen2 Technical Design Report (plus unofficial limit band)