



# Best Tracks for Hydrail

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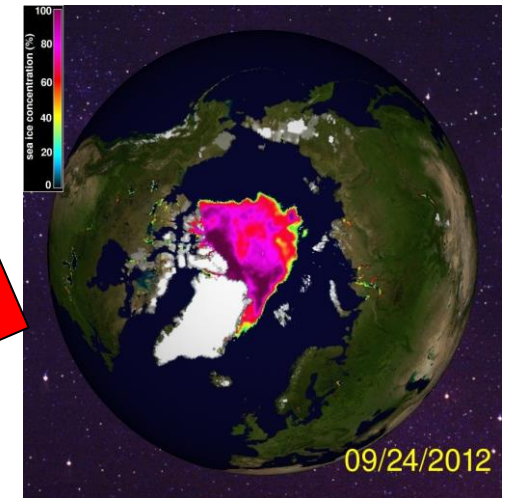
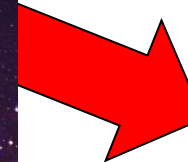
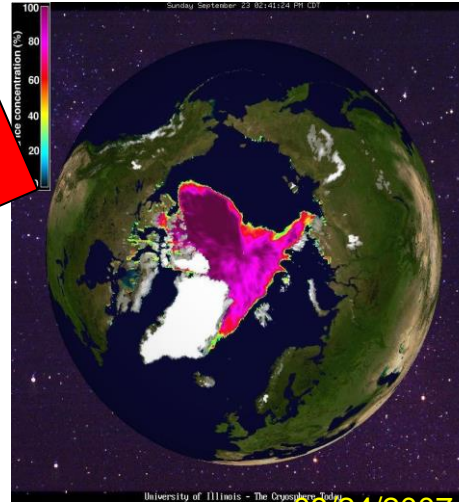
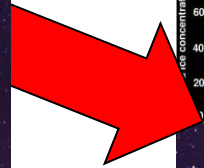
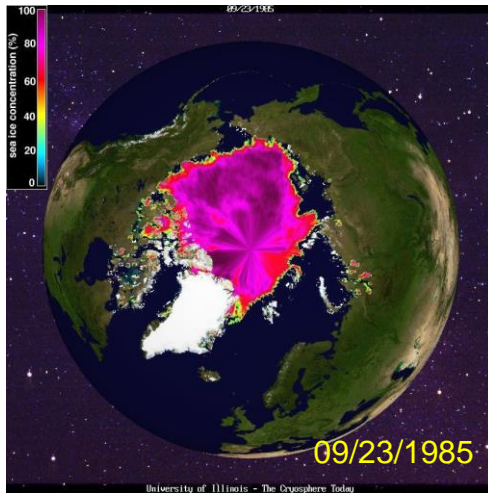
Chief Scientist Office / Hydrogen Isotopes Technology Branch



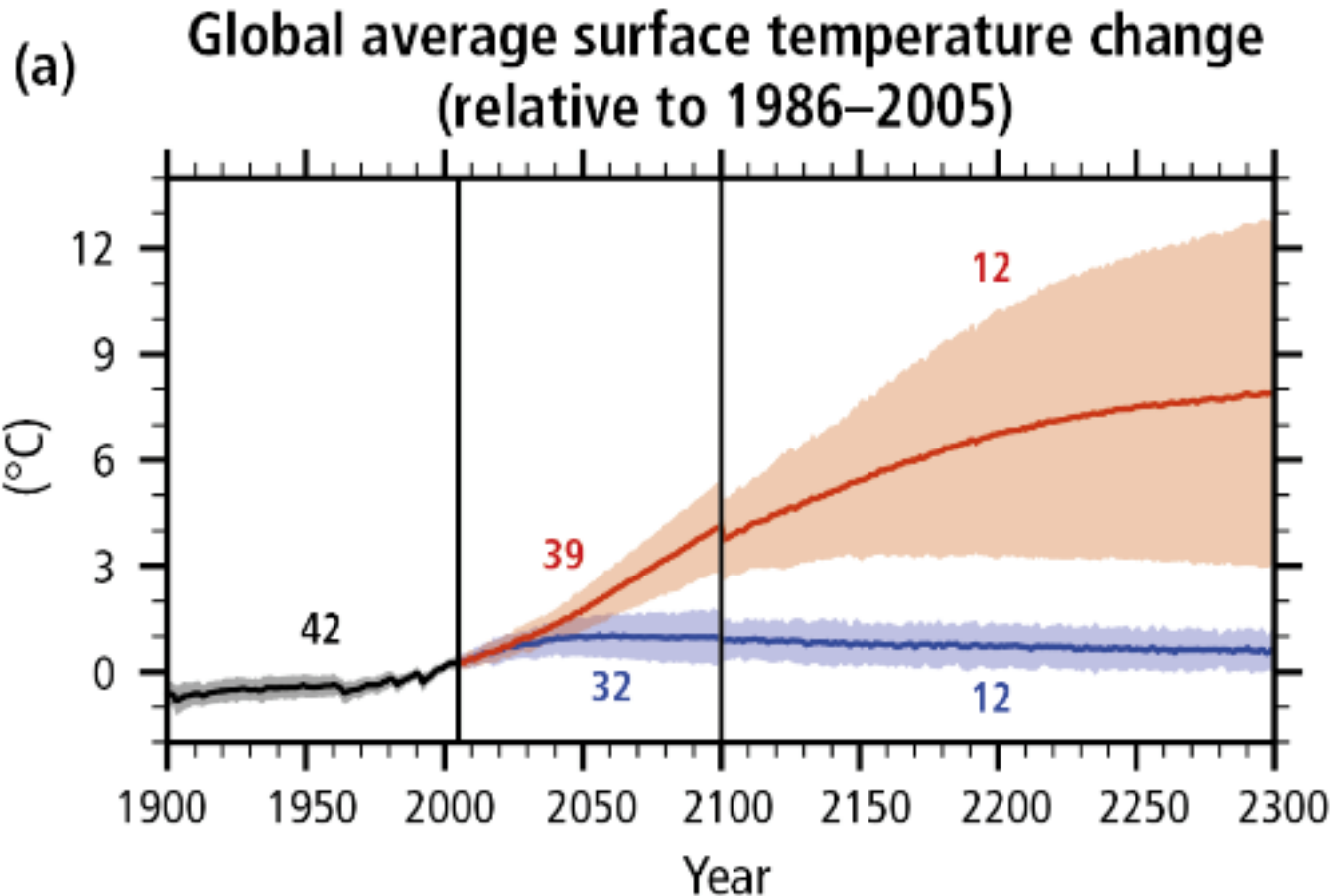
# Why?



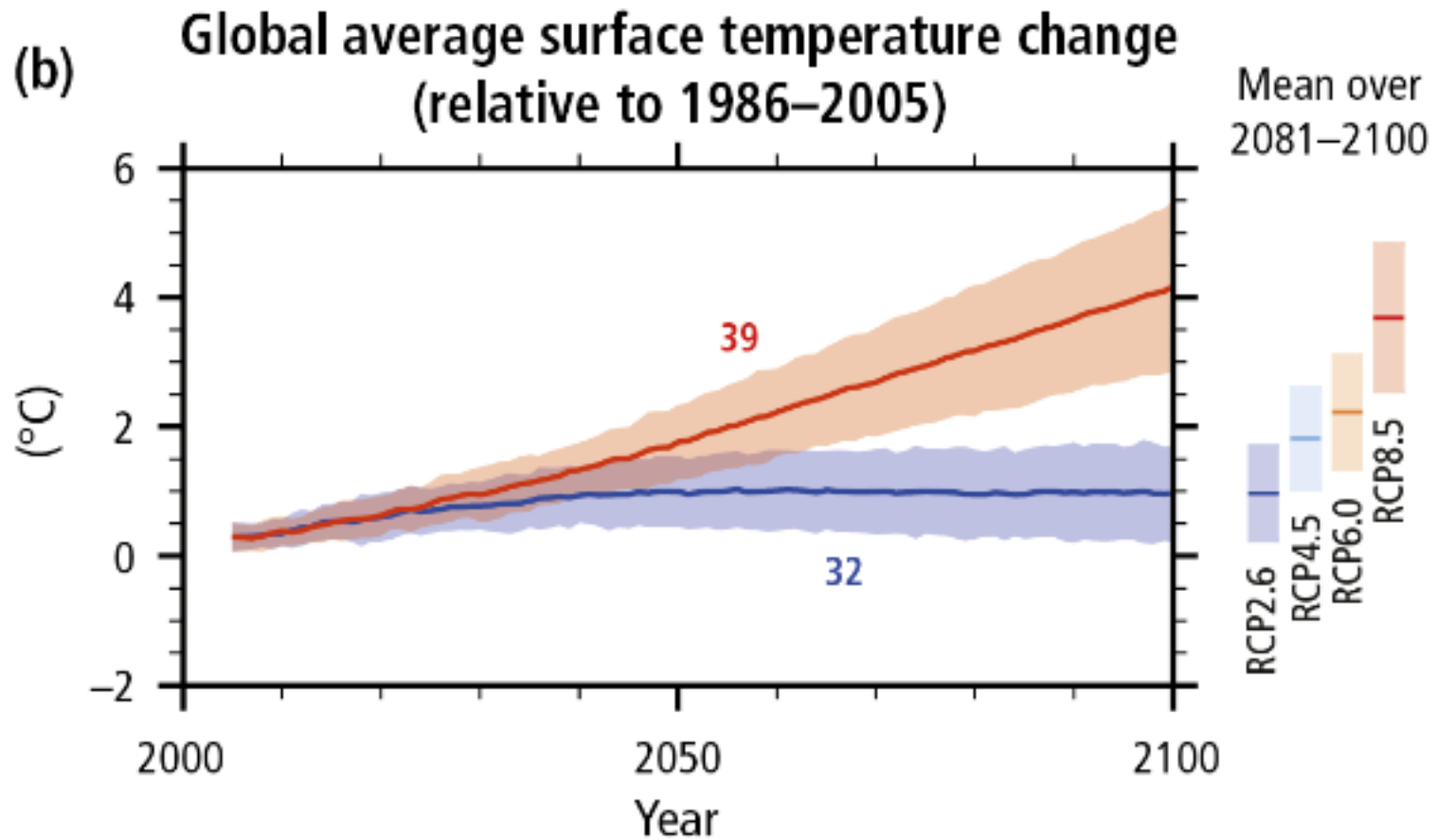
# A Message from the Arctic



# RCP 2.6 (Stringent Mitigation) vs RCP 8.5 (Business more or less as usual)

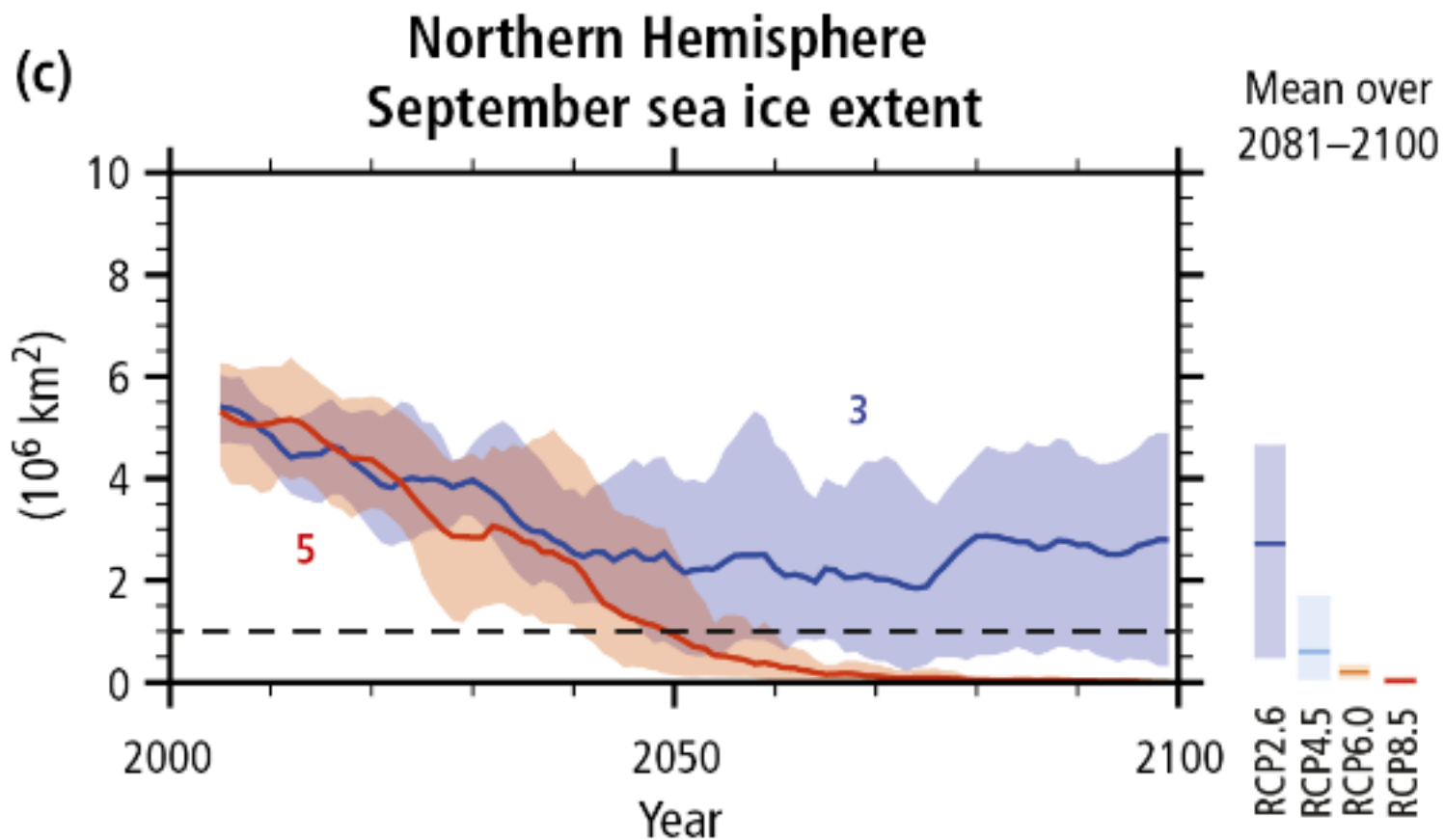


# RCP 2.6 vs RCP 8.5

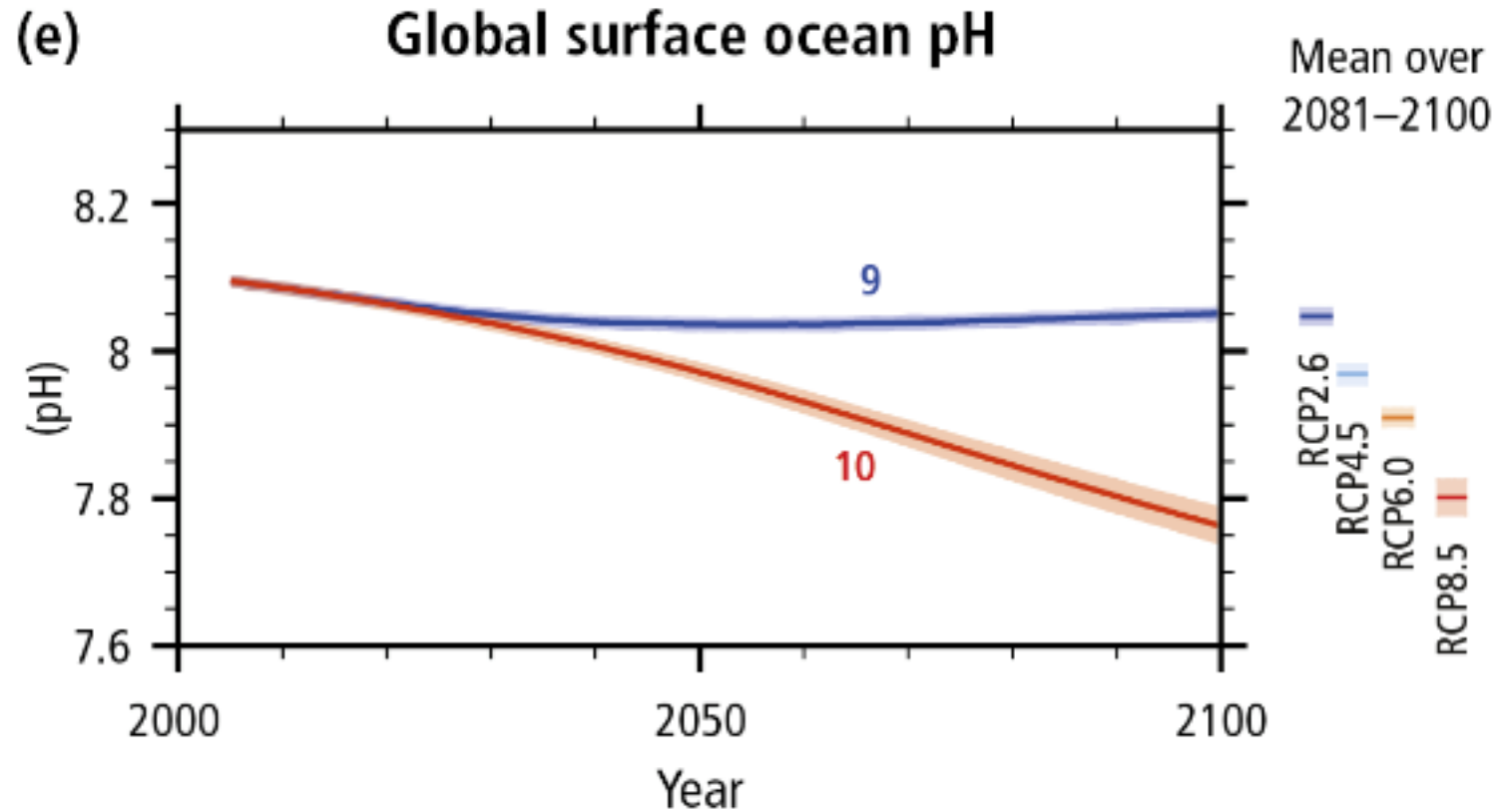




# RCP 2.6 vs RCP 8.5



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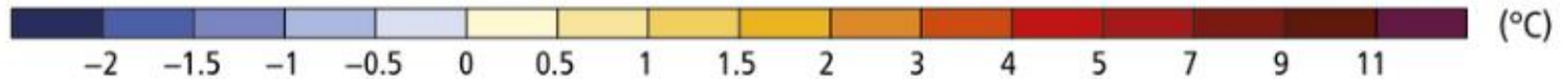
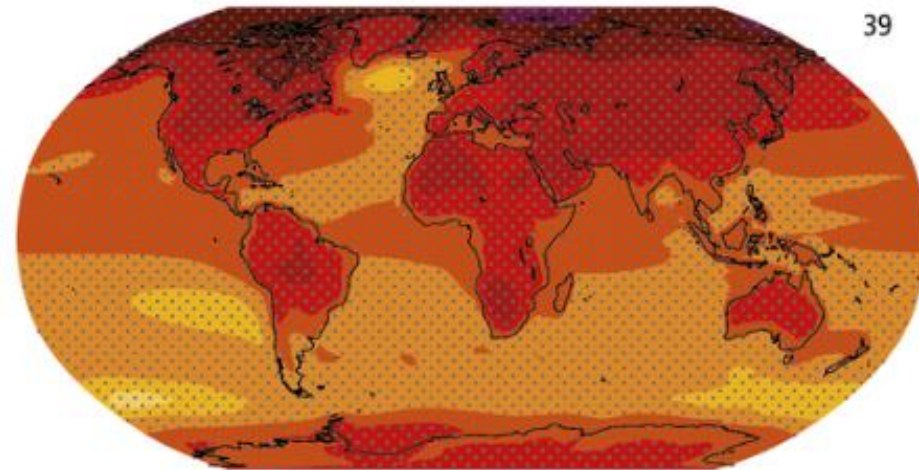
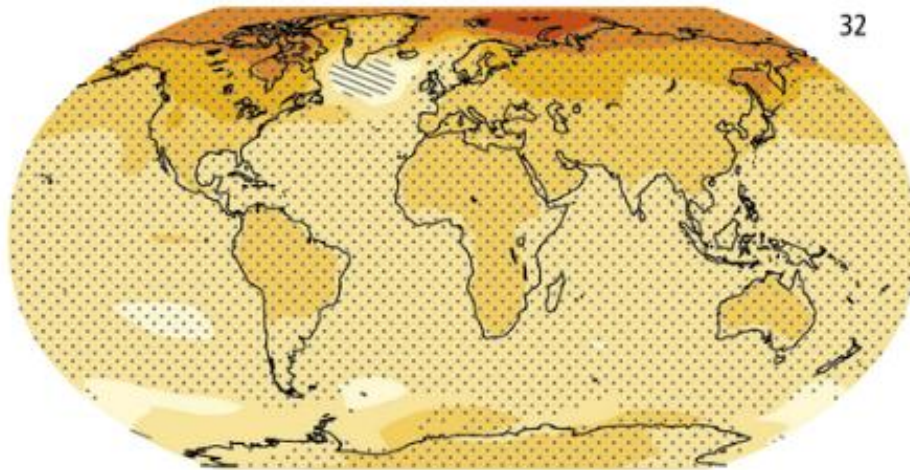
# Warmer or Hotter?

RCP2.6

RCP8.5

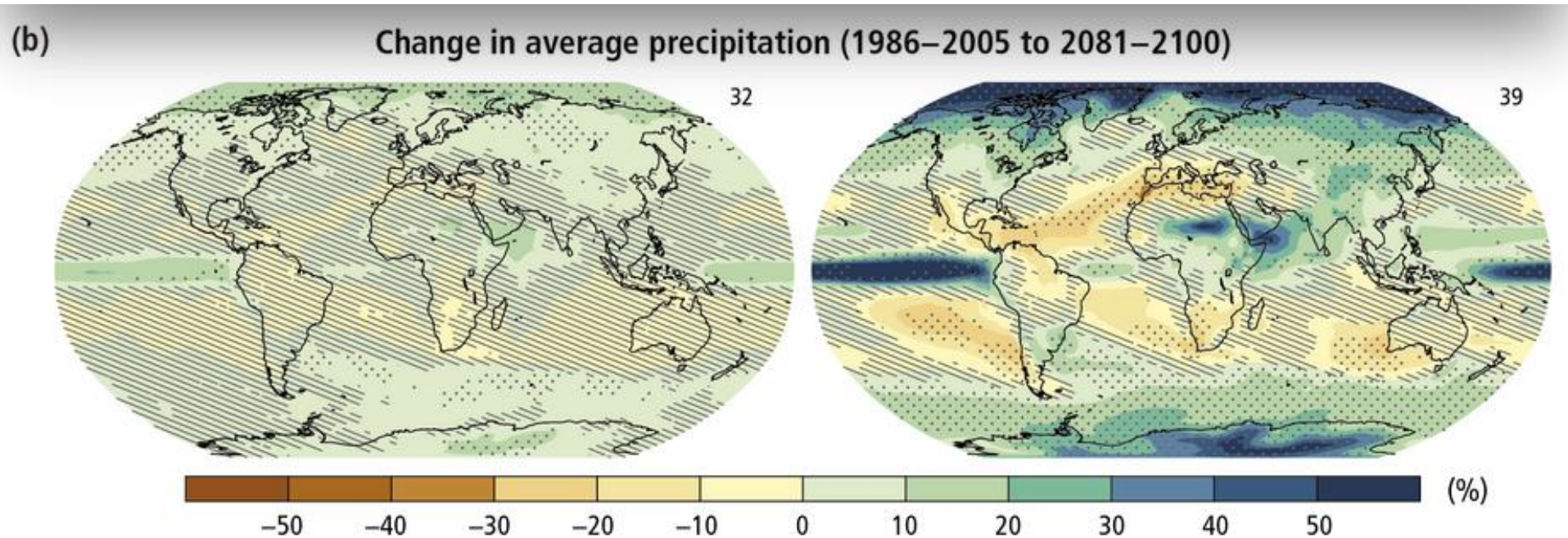
(a)

Change in average surface temperature (1986–2005 to 2081–2100)





# Pluvial Excesses

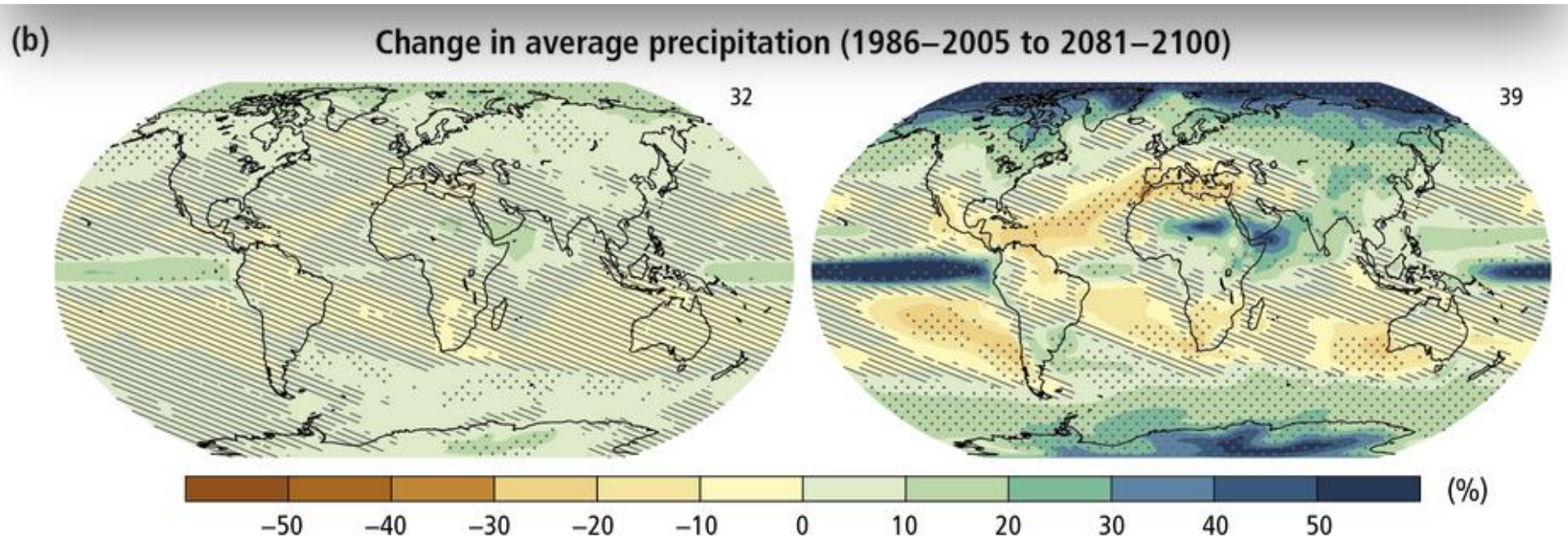


# Getting onto the RCP 2.6 Track

- Needs at least an 80% reduction in GHG emissions
  - Disdain any policy delivering less
- Ontario is remarkably well-placed

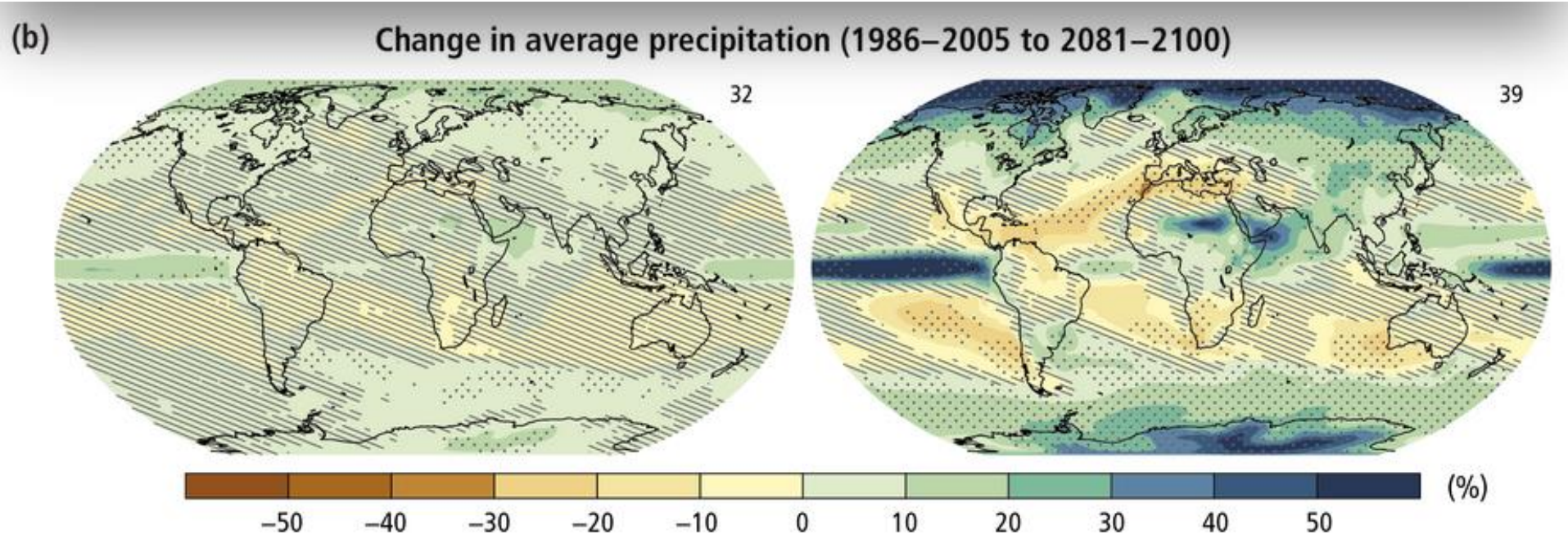


# Pluvial Excesses





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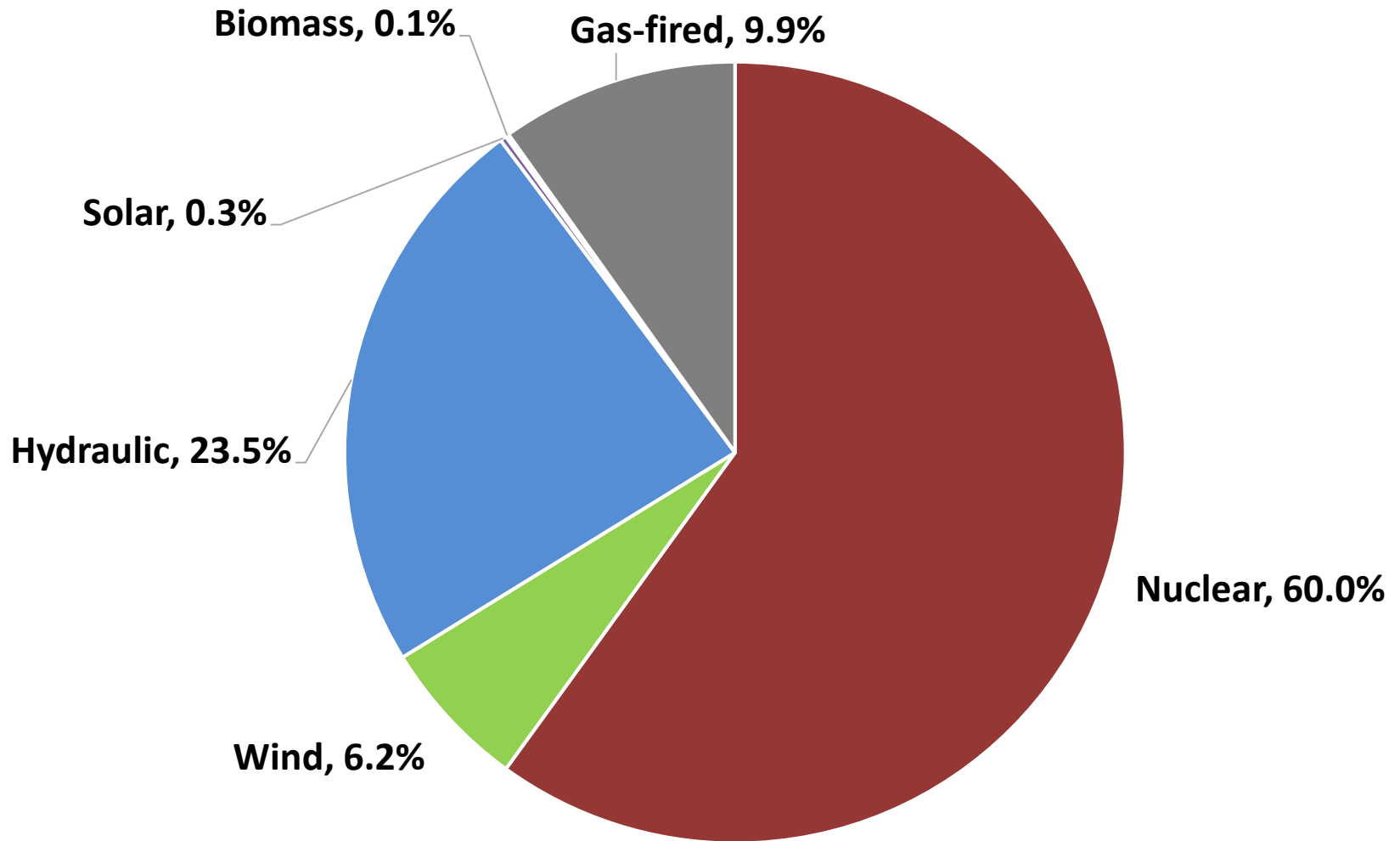


# Ontario's Opportunity





# Electricity Sources in Ontario in 2016



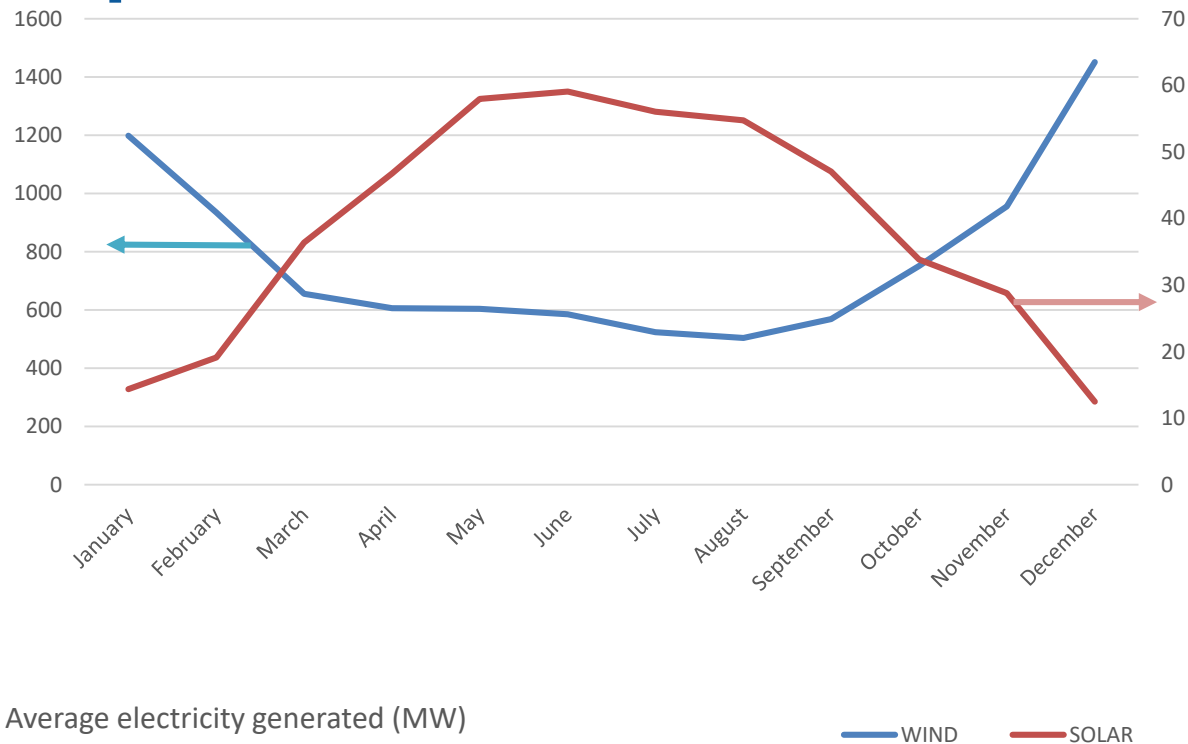
# Eight Bruce CANDU Reactors = 6.3 GW



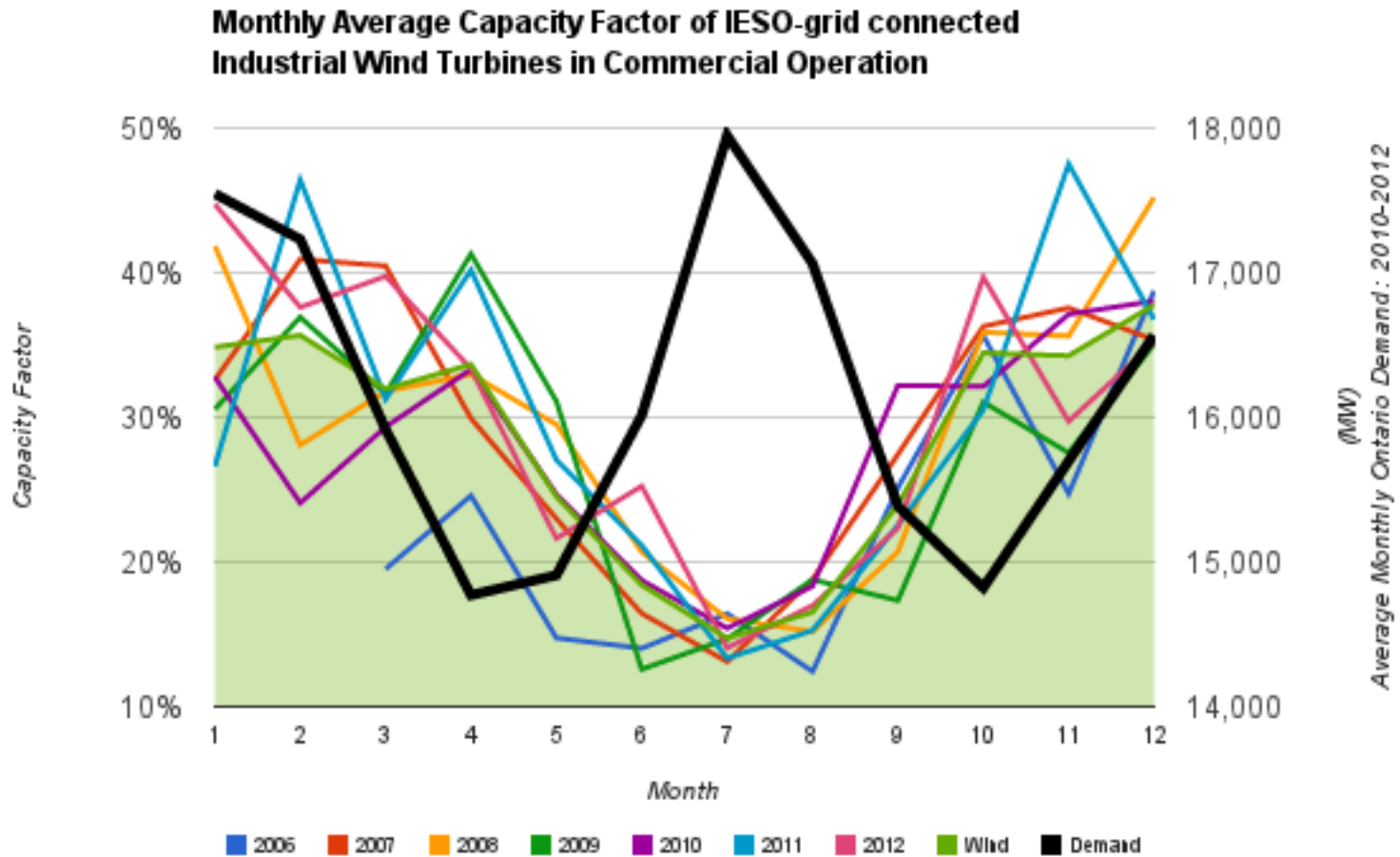
# Four Darlington CANDUs = 3.5 GW



# Wind and Solar are Seasonally Variable as well as Fickle; Wind = 4.8 GW but capacity factor in 20-30% range compared to 80s% for CANDUs



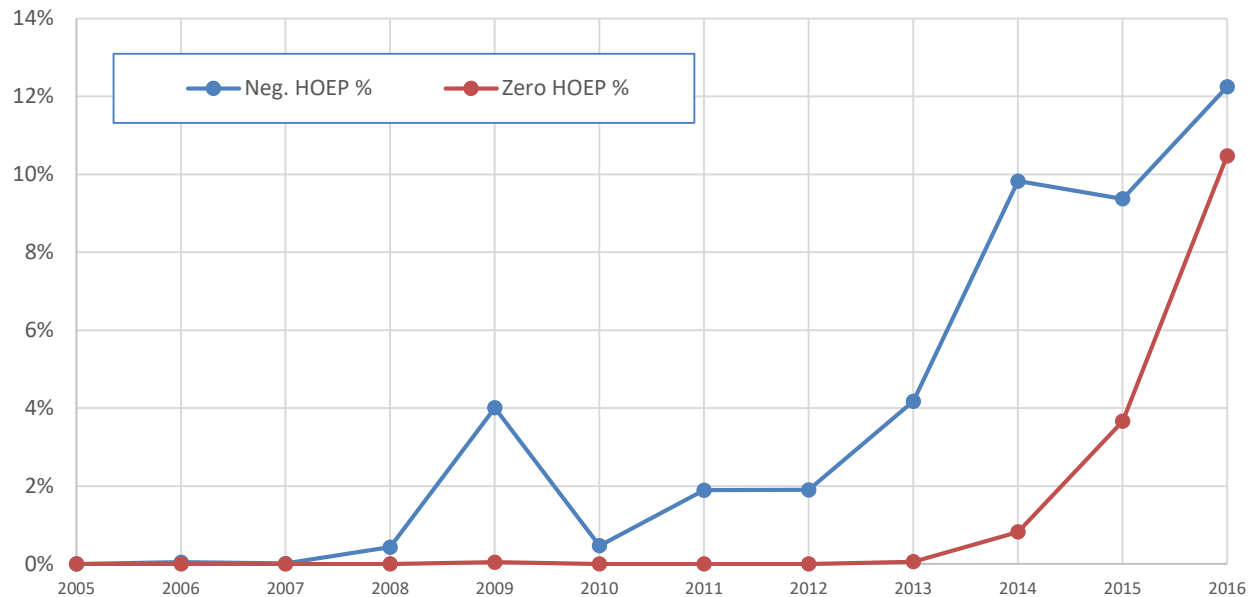
# Wind is ill-synchronized





# And Nuclear does not like load-following ...

## ... leading to this



# A Green Ontario Future

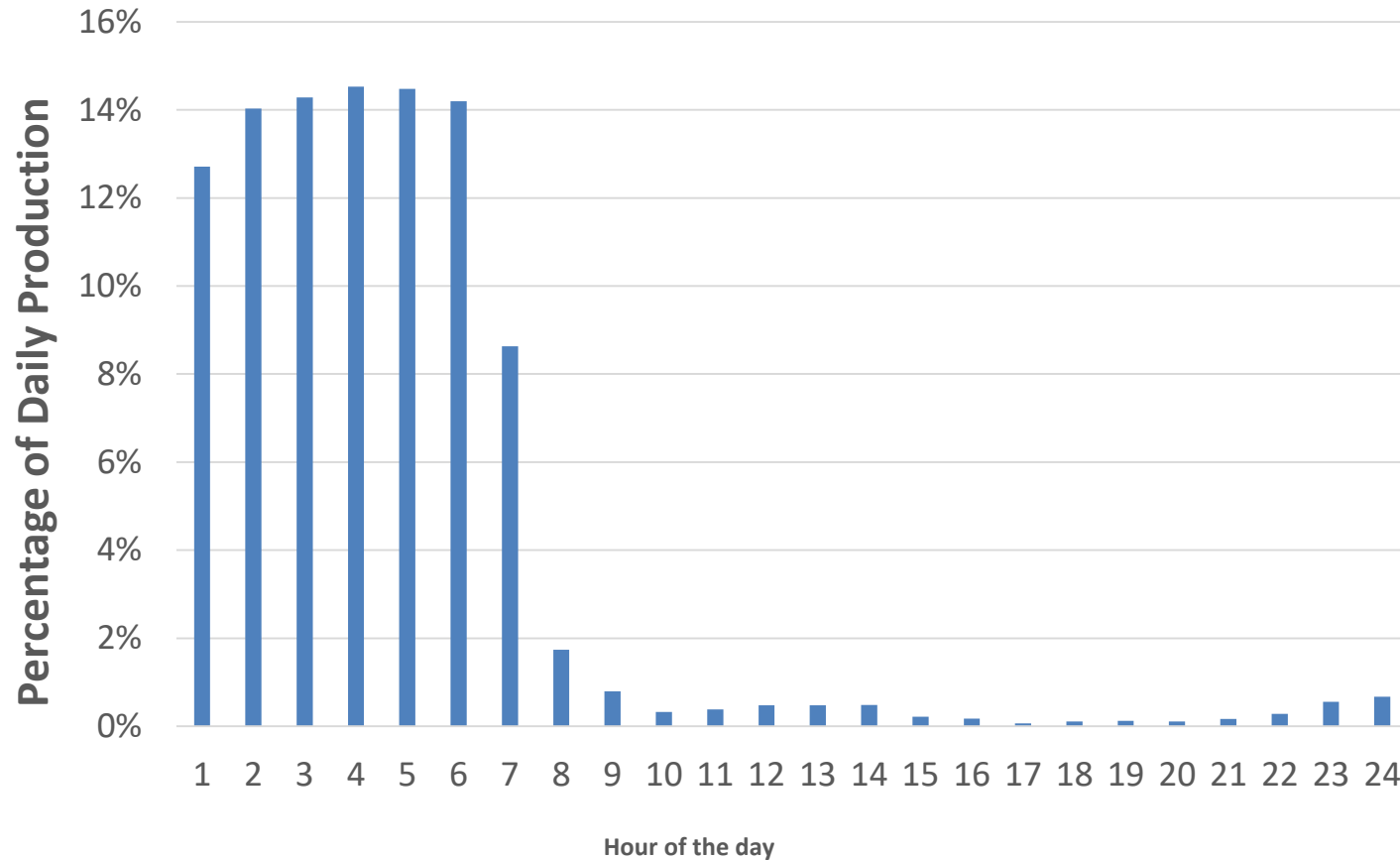


# Wind, Solar and Nuclear need a Large Flywheel: Hydrogen

- But electricity → hydrogen → electricity is 30% efficient
  - electricity must be very “green”
  - as Ontario’s is – fully 90% “green”
  - Make hydrogen when grid has excess power
- Need to maintain greenness
  - Thoughts of covering the peaks with CH<sub>4</sub>-fired units would be badly misplaced
- Hydrogen can fuel more than hydrail
  - Other heavy-duty applications: heavy-duty trucks, ships
- Cavern storage can allow seasonal smoothing



# Off-Peak Surplus Electricity for GO Hydrail: when



# Batteries are an Alternative

- We can and should utilize both batteries and hydrogen/fuel cells
  - Batteries work best for lighter use applications
    - Lifetime is an issue
    - ... best helped by drawing on a fraction of capacity ... and occasional use
    - Batteries are still heavy
  - Hydrogen & fuel cells
    - Easily fueled in captive situations like GO hydrail
  - Battery, fuel cell and electrolyser technologies are all improving very rapidly
  - In contrast, track electrification is expensive mature technology and exacerbates grid supply/demand mismatch



# A Green Transportation Future for Ontario is Imperative

