

Renewable Energy Research and Innovation

The Impact of Climate Change on Decisions at End of Financed Life

Case Study at Rivière-au-Renard



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Disclaimer

- 1. I am not a climatologist
- 2. We work directly with climatologists at Ouranos



3. I will try to point out the information and interpretations that come from them, and those that are mine









The Project

Partners

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- Ouranos: climatologists
- Hydro Québec: utility perspective
- Nergica: wind energy and icing expertise



- Only RCP 8.5 (worst-case) scenario
- Only a single simulation: CRCM5 model, driven by CNRM-CM5

Case Study – Rivière-au-Renard





Temperature – Modeled Historical

Represents **climate**

(not events)

Average – Worst-Case Scenario (RCP 8.5)

Jan 20 Feb 15 Mar 10 Apr ς) Ο May Temperature (Jun 0 Jul --5 Aug Sep -10Oct Nov Dec -20 ~98^{î)} Simulated model data, not actual historical values (i.e. represents climate, not actual events) NERGICA Statistics (average and variance) are similar to the true historical values for this period (1981-2010)

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Temperature – Modeled Horizon 1

Average – Worst-Case Scenario (RCP 8.5)



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Temperature – Modeled Horizon 2

Average – Worst-Case Scenario (RCP 8.5)



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Temperature Averages

- Warming trend as we progress into the future (as predicted by climatologists global warming)
- Warmer temperatures mean lower density air, and lower power production. However, shouldn't be a very significant difference.



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Wind Speed Averages

- No significant trend in wind speed
- Consistent with what climatologists see in their models: there's no clear signal.





Operable Winds Averages

- Operable winds for our wind turbines: 3 m/s to 24 m/s.
- Similar to average wind speeds: no significant trend



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Instrumental Icing Duration Averages

• Icing season will likely be shorter in the future at our site



Monthly Duration (%)

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Icing Accumulation Maximum Averages

- Average of monthly maximum shows a less evident trend:
- For each month in which there is no reduction in the **duration** of ice (December to April), there is an **increase** in the maximum
- I interpret this as follows: while the icing season may become **shorter**, it may also become more **intense**.





Production

Averages

• Similar to wind speed heatmap: no clear trend



Wind Direction – Modeled Historical

Wind Rose – Worst-Case Scenario (RCP 8.5)





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Wind Direction – Modeled Horizon 1

Wind Rose – Worst-Case Scenario (RCP 8.5)





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Wind Direction – Modeled Horizon 2

Wind Rose – Worst-Case Scenario (RCP 8.5)





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Wind Direction

Averages

- Fortunately for us at our site: no significant changes in the wind rose are modeled
- May be very detrimental to a project at site assessment phase, if winds shifted direction over the course of the project.



Climate Averages at Rivière-au-Renard



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JN ☆ 学 团 ∩ Production

Impact on End of Financed Life

- Later fall and earlier spring means probably more production, since ice has more impact than temperature.
- But with potentially more extreme ice events, there is the possibility of reduced production in winter at our site.
- Other sites will likely have different conclusions



Lifetime Impact on End of Financed Life

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• Our wind farm is in a cold climate, so increased temperatures probably means fewer cold climate issues, without necessarily an increase in hot climate issues.

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- If winds are changing, then we can base decisions on digital twin models to see what loads will be like into the future.
- But it looks like we may have more intense icing events, so that will have an impact on loads on the components.

」 入 ☆ 舎 通 û Operations & Maintenance Impact on End of Financed Life



- Warmer temperatures and longer summers mean more months to complete maintenance activities. And technicians aren't exposed to such extreme cold temperatures.
- More intense icing season could mean more impact on our maintenance activities in winter.

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N ☆ ₽ I ∩ One Final Note

Preliminary results...

... from single simulation

→ More analyses under way
(other simulations, uncertainty)



N \Rightarrow **S** \Rightarrow **S**

Other project partners



Project funding partners



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Our main financial partners



