Considerations about Solar Farms in Southern Alberta

MHURA
Medicine Hat Utilities Ratepayer Association

Presented to the Medicine Hat Utilities Ratepayer Association

By Michelle Stirling
Communications Manager
Friends of Science Society

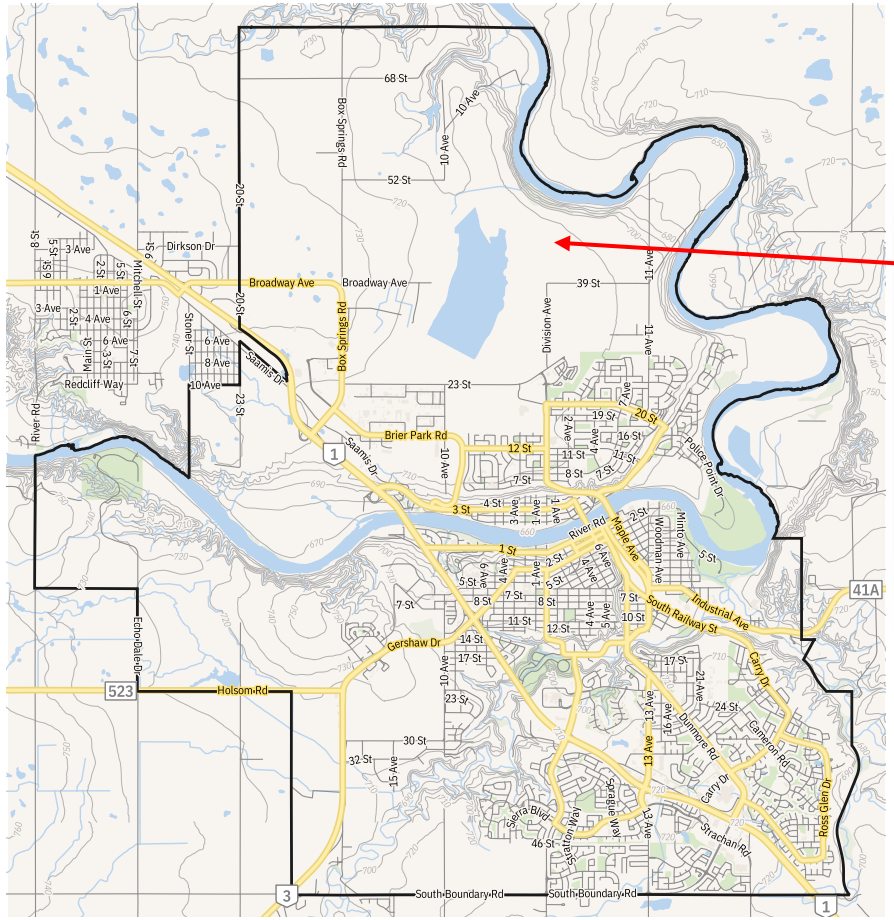
FRIENDS OF SCIENCE
Providing Insight into Climate Science

Medicine Hat Utilities Ratepayer Association has some questions about the proposed Saamis Solar Farm project

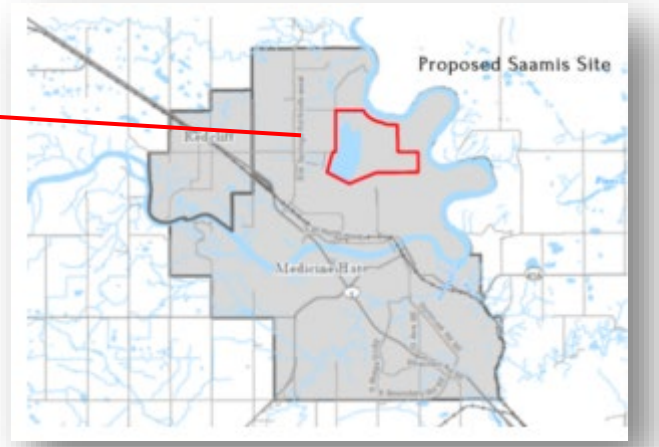
- QUESTIONS:
- Effect of renewables on overall electricity reliability?
- Do renewables affect selling price?
- Do these projects ever make money? If so, how long?
- Climate pattern changes - yes or no?
- Is it practical to retire traditional power sources?
- Any other issues of relevance

- MHURA BACKGROUND INFO:
- The original approval for the Saamis Solar Park (SSP) was for a 325 MW plant with New Grian 1056S Substation.
- The City is claiming that their only desire is to have the rights approved for DP Energy. They claim that their desire is to only develop 75MW initially with possible further development some time in the future.
- The other change would be to feed the power into the City's grid rather than the provincial grid.

Location of Saamis Solar Park is within Medicine Hat Municipal Boundaries



By awmcphee - Own work, CC0, https://commons.wikimedia.org/w/index.php?curid=81366028



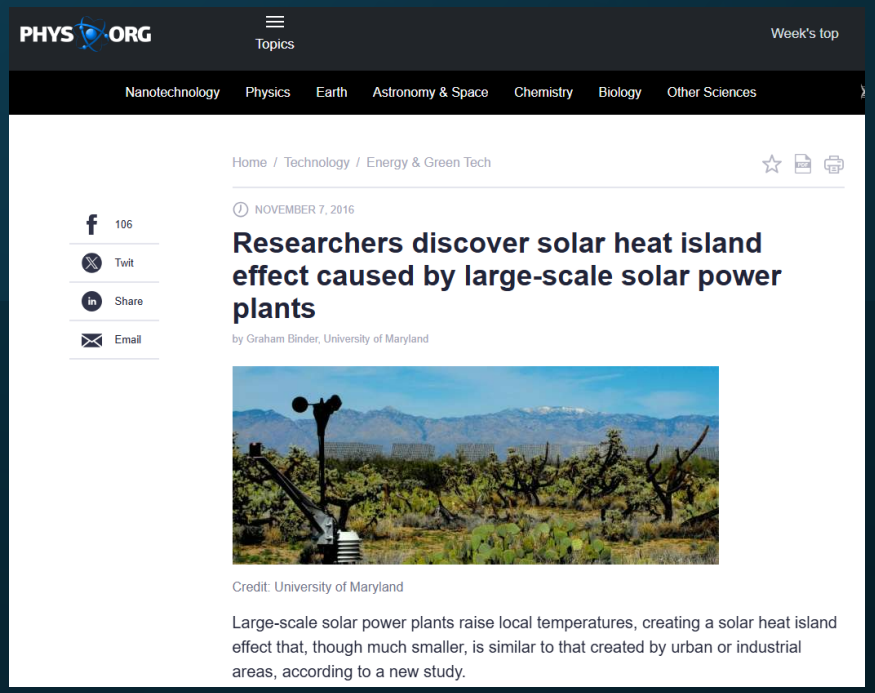
https://dpenergy.com/canada-saamis-solar-park-alberta/

Project Location

Saamis Solar Park Ltd. is currently planning a solar project on land in the north-eastern industrial sector of the city of Medicine Hat.

SAAMIS SOLAR PARK
A DP ENERGY PROJECT

Medicine Hat is Already in the Palliser Triangle



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106

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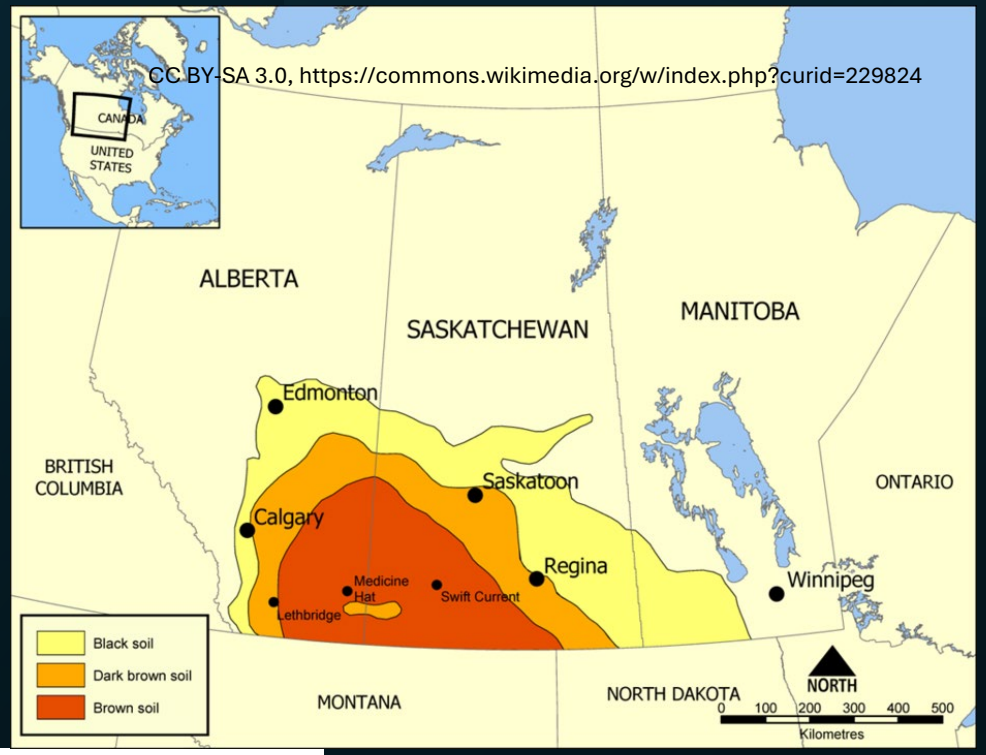
NOVEMBER 7, 2016

Researchers discover solar heat island effect caused by large-scale solar power plants

by Graham Binder, University of Maryland

Credit: University of Maryland

Large-scale solar power plants raise local temperatures, creating a solar heat island effect that, though much smaller, is similar to that created by urban or industrial areas, according to a new study.



For this study, the team defined the heat island effect as the difference in ambient air temperature around the solar power plant compared to that of the surrounding wild desert landscape. Findings demonstrated that temperatures around a solar power plant were 5.4-7.2 °F (3-4 °C) warmer than nearby wildlands.

https://phys.org/news/2016-11-solar-island-effect-large-scale-power.html#:~:text=Findings%20demonstrated%20that%20temperatures%20around,C)%20warmer%20than%20nearby%20wildlands

325 MW Size of Saamis Solar Park is Very Large vis a vis Alberta Solar Farms. Even the 75MW section is large.

Current Supply Demand Report

Legend

DCR - Dispatched (and Accepted) Contingency Reserve
TNG - Total Net Generation
MC - Maximum Capability

SUMMARY	
Alberta Total Net Generation	9753
Net Actual Interchange	158
Alberta Internal Load (AIL)	9595
Net-To-Grid Generation	7064
Contingency Reserve Required	419
Dispatched Contingency Reserve (DCR)	432
Dispatched Contingency Reserve -Gen	410
Dispatched Contingency Reserve -Other	22
FFR Armed Dispatch	0
FFR Offered Volume	367
Long Lead Time Volume	795

http://ets.aeso.ca/ets_web/ip/Market/Reports/CSDReportServlet

Indicates a net-to-grid asset. The value reported in the MC column represents the asset's gross MW value
Indicates that the asset includes energy storage

Last Update : Nov 04, 2024 04:43

All values listed are in MW

GENERATION			
GROUP	MC	TNG	DCR
GAS	13681	7182	122
HYDRO	894	103	181
ENERGY STORAGE	190	0	107
SOLAR	1812	0	0
WIND	5340	2171	0
OTHER	444	260	0
DUAL FUEL	0	0	0
COAL	0	0	0
TOTAL	22361	9716	410

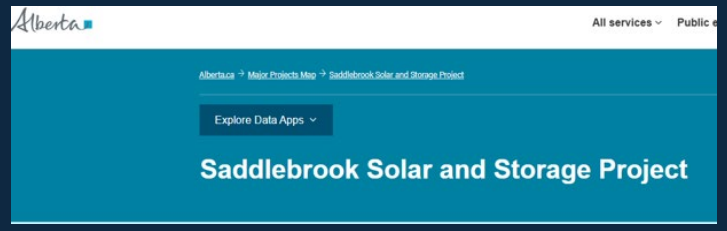
INTERCHANGE	
PATH	ACTUAL FLOW
British Columbia	202
Montana	-61
Saskatchewan	0
TOTAL	141

GENERATION			
GROUP	MC	TNG	DCR
GAS	13681	7178	122
HYDRO	894	104	181
ENERGY STORAGE	190	0	107
SOLAR	1812	0	0
WIND	5340	2168	0
OTHER	444	261	0
DUAL FUEL	0	0	0
COAL	0	0	0
TOTAL	22361	9711	410

SOLAR			
ASSET	MC	TNG	DCR
BRD1 Burdett (BRD1)	11	0	0
BUR1 Burdett (BUR1)	20	0	0
Barlow Solar (BLS1)	31	0	0
Big Sky Solar (ACD1)	140	0	0
Brooks Solar (BSC1)	15	0	0
Brooks Solar 1 (BRK1)	13	0	0
Brooks Solar 2 (BRK2)	14	0	0
COL1 Coaldale (COL1)^	23	0	0
Chappice Lake (CHP1)^	14	0	0
Claresholm 1 (CLR1)	58	0	0
Claresholm 2 (CLR2)	75	0	0
Clydesdale 1 (CLY1)	41	0	0
Clydesdale 2 (CLY2)	34	0	0
Conrad 1 (CRD1)	23	0	0
Conrad 2 (CRD2)	18	0	0
Deerfoot (DFT1)	41	0	0
East Strathmore Namaka (NMK1)	20	0	0
Empress Solar Park (EMP1)	39	0	0
Fox Coulee Solar (FCS1)	80	0	0
Hays (HYS1)	23	0	0
Hull (HUL1)	25	0	0
Innisfail (INF1)	22	0	0
Jenner (JER1)	23	0	0
Joffre Solar 1 (JFS1)	25	0	0
Joffre Solar 2 (JFS2)	22	0	0
Kneehill Solar (TRH1)	25	0	0
Lethbridge Solar (CLD1)	9	0	0
Michichi Creek (MCH1)^	14	0	0
Michichi Solar (MIC1)	25	0	0
Monarch (MON1)^	24	0	0
Saddlebrook Solar (SDL1)	81	0	0
Sollair Solar Energy Plant (SLR1)	75	0	0
Spring Coulee (SGC1)	30	0	0
Stavely (STV1)	17	0	0
Strathmore 1 (STR1)	18	0	0
Strathmore 2 (STR2)	23	0	0
Suffield (SUF1)	23	0	0
Travers (TVS1)	465	0	0
Vauxhall (VXH1)	23	0	0
Vulcan (VCN1)^	22	0	0
Westfield Yellow Lake (WEF1)	19	0	0
Wheatcrest (WCR1)	50	0	0
Youngstown Solar (YNG1)	6	0	0
kisikaw-pisim 1 (KKP1)*	7	0	0
kisikaw-pisim 2 (KKP2)*	7	0	0

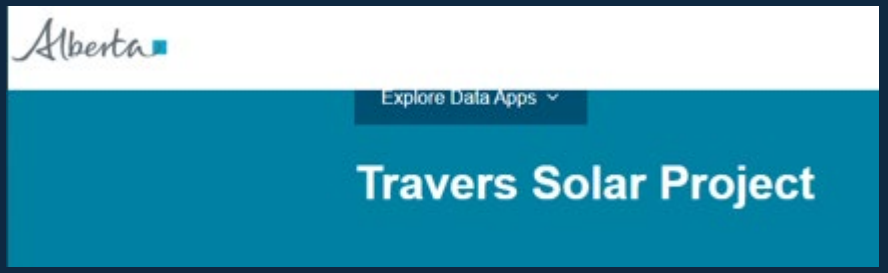
Three Existing Alberta Solar Farms and Costs

- Saddlebrook, near Aldersyde
- 81 MW
- $106 Million



- Sollair, near Airdrie
- 75 MW
- $150 Million

- Travers, south of Lomond
- 465 MW
- $700 million
- Largest solar project in North America



Who pays the $600 million?

MEDICINE HAT NEWS

City looks to buy Saamis Solar

BY COLLIN GALLANT ON AUGUST 28, 2024.

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@@CollinGallant

The City of Medicine Hat plans to buy a proposal for the largest urban solar array in Canada from a private developer that already has approval to build on 1,600 acres in northwest Medicine Hat.

The Saamis Solar Park is designed to produce 325 megawatts of power in peak conditions – slightly more than the city-owned gas-fired complex – and would partially cover a large former industrial site left over from fertilizer production.

The layout of the Saamis Solar Park as presented by DP Energy to the Alberta Utilities Commission. The City of Medicine Hat energy division announced Tuesday it will apply to purchase the approved solar project, which could cost $600 million to build.--Supplied photo

Private-sector developer DP Energy earned approval to build the estimated $600-million project from provincial regulators in July.

On Tuesday, the city's energy division announced it is seeking regulatory approval to purchase the project, stating it would add production capacity and position the city to meet net-zero timelines now being developed and debated by other levels of government.

https://medicinehatnews.com/news/local-news/2024/08/28/city-looks-to-buy-saamis-solar/#:~:text=Private%2Dsector%20developer%20DP%20Energy,from%20provincial%20regulators%20in%20July.

If it sounds too good to be true, ask more questions

MEDICINE HAT NEWS

- City of Medicine Hat analysis states that each 25-megawatt block of solar capacity could reduce provincial TIER levy payments by $1.5 million each year, raising to $2.4 million in 2027, when initial phases of a city-owned Saamis array could be in operation.
- Two years ago, energy officials and Mayor Linnsie Clark told the News that green energy would be strongly considered when the 110-year-old power company planned for its next expansion.
- That was in response to federal budgeting that could provide up to 15 per cent of construction costs, low-interest financing from the Canada Infrastructure Bank and a guaranteed “contract for difference” that would pay a carbon levy rebate even if the levy was cancelled by a new Conservative government.
- Clark did not return calls seeking comment Tuesday.

?

- **While the full construction estimate is $600 million, *the undisclosed sale price would be much less*.**
- Last April, council approved $7 million for an undisclosed “early clean energy opportunity” that this week Pancoast said related to the city meeting some conditions on its side of the sale.

https://medicinehatnews.com/news/local-news/2024/08/28/city-looks-to-buy-saamis-solar/#:~:text=Private%2Dsector%20developer%20DP%20Energy,from%20provincial%20regulators%20in%20July.

Going Green	An electricity surcharge set by the Chief Administrative Officer in order to balance the revenues and costs of the Electric Utility's programs that provide renewable or alternative energy.

Agenda

ENERGY, LAND AND ENVIRONMENT COMMITTEE MEETING
Thursday, September 05, 2024
4:00 PM
City Hall, Ted Grimm Conference Room
MS Teams: **Join the meeting now**

The *Municipal Government Act* (MGA) states all meetings are public unless the *Freedom of Information and Protection of Privacy Act* (FOIP) applies. See applicable references below.

Council Standing Committee meetings that are conducted through Microsoft Teams are recorded and kept temporarily for the use of Council and approved staff only. For more information regarding the storage and use of the recordings, please contact the FOIP Head at clerk@medicinehat.ca

- https://docs.medicinehat.ca/OnBaseAgendaOnline/Documents/ViewDocument/ENERGY%2C_LAND_AND_ENVIRONMENT_COMMITTEE_MEETING_5675_Agenda_Packet_9_5_2024_4_00_00_PM.pdf?meetingId=5675&documentType=AgendaPacket&itemId=0&publishId=0&isSection=false

Canadian Infrastructure Bank loan…contracts for difference…federal funding? It's all YOUR money.

Friends of Science @FriendsOScience

More than Axe the Tax — Nix Net Zero; these reports say why

1) What is climate policy costing us? "The total federal and provincial expenditures on climate measures over the period 2020 to 2030 as listed by the Carbon Policy Tracker are $476 billion or $11,900 per resident of Canada. **This equates to roughly $28,000 per household (i.e. an average of $2,800 per household per year).** This is just what has been announced to date; there remain five more fiscal years before 2030 during which governments may add more initiatives."

2) How about Contracts for Difference? (one example) In the referenced article above the CO2 emissions abatement is 185,000 tonnes (instead of the projected 9 million tonnes). As such the math is: (185,000 tonnes x $86.5 per Tonne + $200 million) / 185,000 tonnes = **$1,167.58 / tonne.** That's quite the carbon tax, eh?

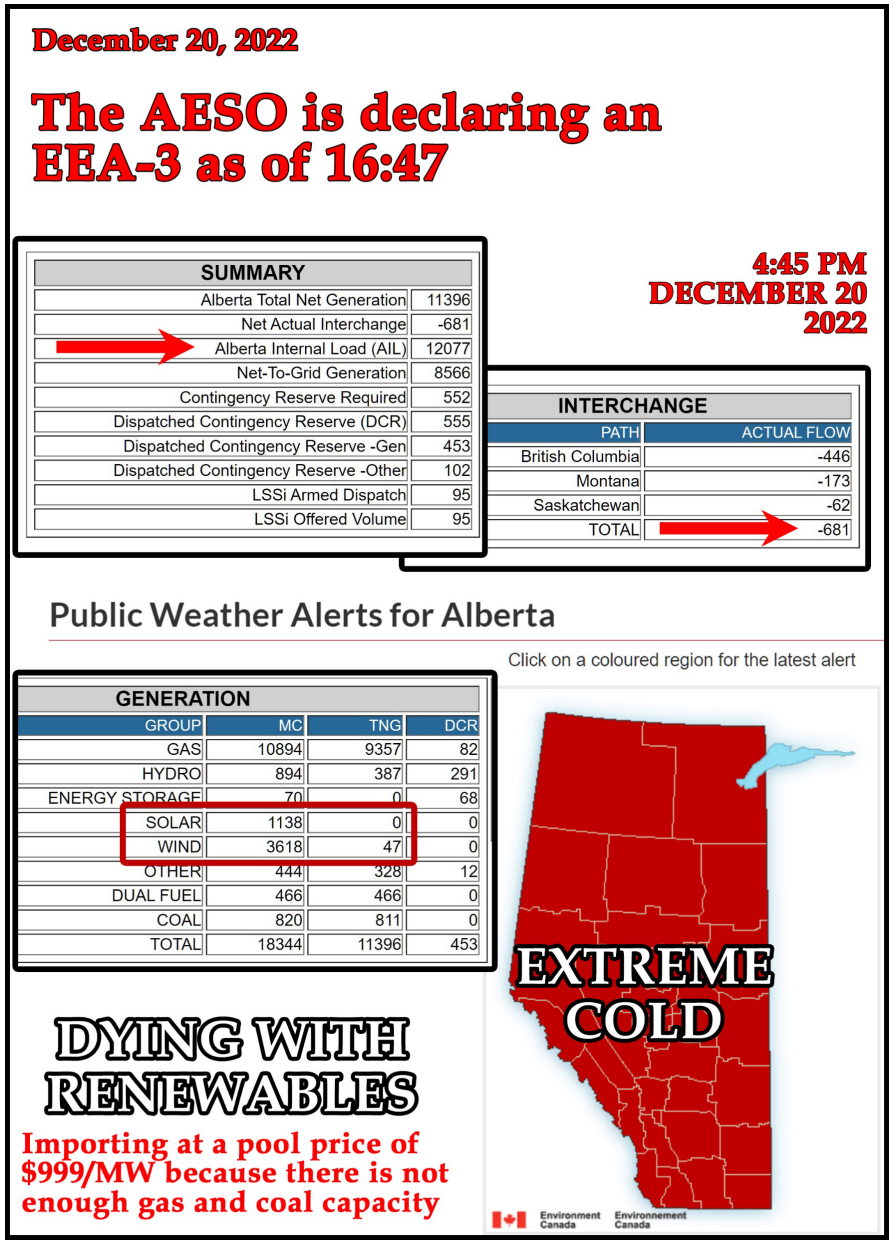
3) Reaching Net Zero? So, the Net Zero challenge ranges between $2 trillion and $5.2 trillion. That is an almost unimaginable amount of money. $2 trillion is $50,000 for every one of Canada's 40 million residents now, or $118,000 for every household. $5.2 trillion is $130,000 for every resident, or $306,000 for every household. **Averaged over 27 years, $2 trillion would cost every one of today's residents about $1,850 per year; averaged over 27 years, $5.2 trillion would cost every one of today's residents $4,815 per year.**

westernstandard.news/opinion/stirli…

11:39 AM · Jun 3, 2024 · **39.5K** Views

Effect of Renewables on Reliability.

Sudden loss of solar under clouds or at night or a drop in wind - you must have equivalent power at the ready to take over.
Sudden surges/drops can affect dispatchable plants and grid stability as well.



How will Medicine Hat pay for the Solar Farm?

City's stunted utility revenue likely to get worse

BY COLLIN GALLANT ON OCTOBER 31, 2024.

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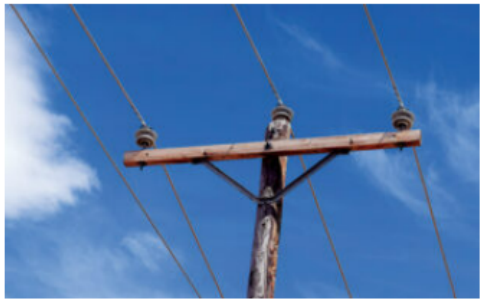
Medicine Hat's combined power and gas production units may struggle to stay in the black by 2026, as already hurting revenue could be dragged down further by higher carbon taxes and increasing cost to manage shrinking gas production, division officials told city council on Wednesday.



As power and gas prices continue to fall, the City of Medicine Hat could face a non-existent dividend by as early as 2026.--NEWS FILE PHOTO

They expect the power plant and much smaller gas business to remain cash positive, but with lower prices, sales and revenue alongside higher carbon costs and accounting measures for remaining well abandonment work.

That could provide just a $600,000 dividend to municipal coffers in two years, compared to more than $200 million over 2022 and 2023.

MEDICINE HAT NEWS

This year, financial officials estimate a $19-million profit on power will be set against a $6-million loss on gas, making the net dividend to city coffers about $12 million, or about $50 million less than expected.

Next year, the proposed budget predicts a $25.9-million profit on power and $19.9-million loss on gas, for a dividend of $6 million.

Then an $18.4-million power dividend in 2026 would be eaten up almost entirely by an expected $17.8-million loss in gas once net income is adjusted for well-liabilities.

"Those are forecasted at his point, and it's certainly not as rosy a picture as it has been in the previous couple of years," said Mayor Linnsie Clark. "Forecasts can change and we've heard about some of the uncertainties tonight, and in previous presentations.

"Energy is always a bit of a wave, and it's incumbent upon us as the owner of an energy company to prepare and mitigate those risks as best we can."

https://medicinehatnews.com/news/local-news/2024/10/31/citys-stunted-utility-revenue-likely-to-get-worse/

FIGURE 31: Monthly average on-peak solar capacity and generation

From the AESO 2023 Market Statistics Report (Province-wide)

https://www.aeso.ca/assets/Uploads/market-and-system-reporting/Annual-Market-Stats-2023_Final.pdf

Note that average generation (dark blue line) is well below installed capacity (yellow line).

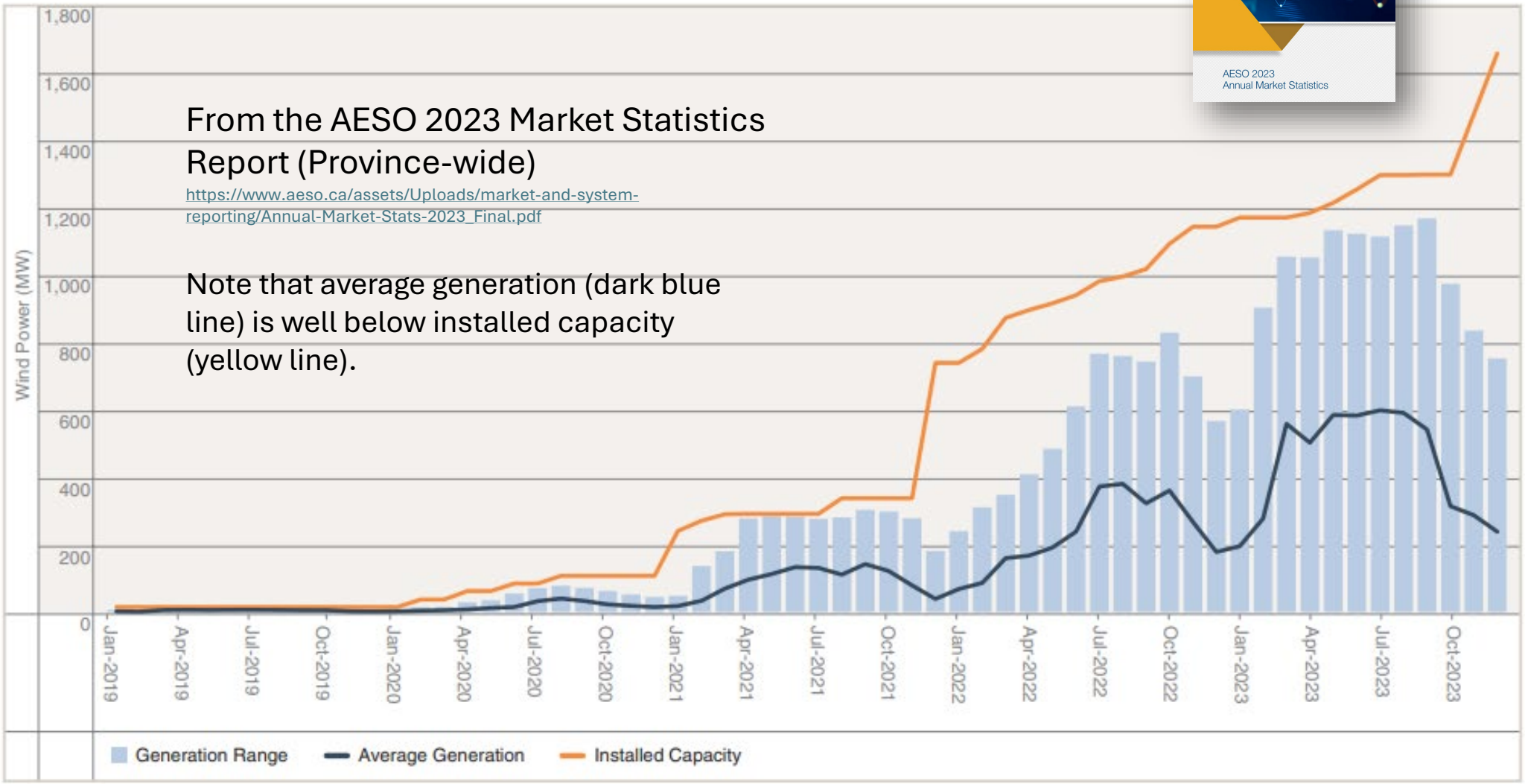
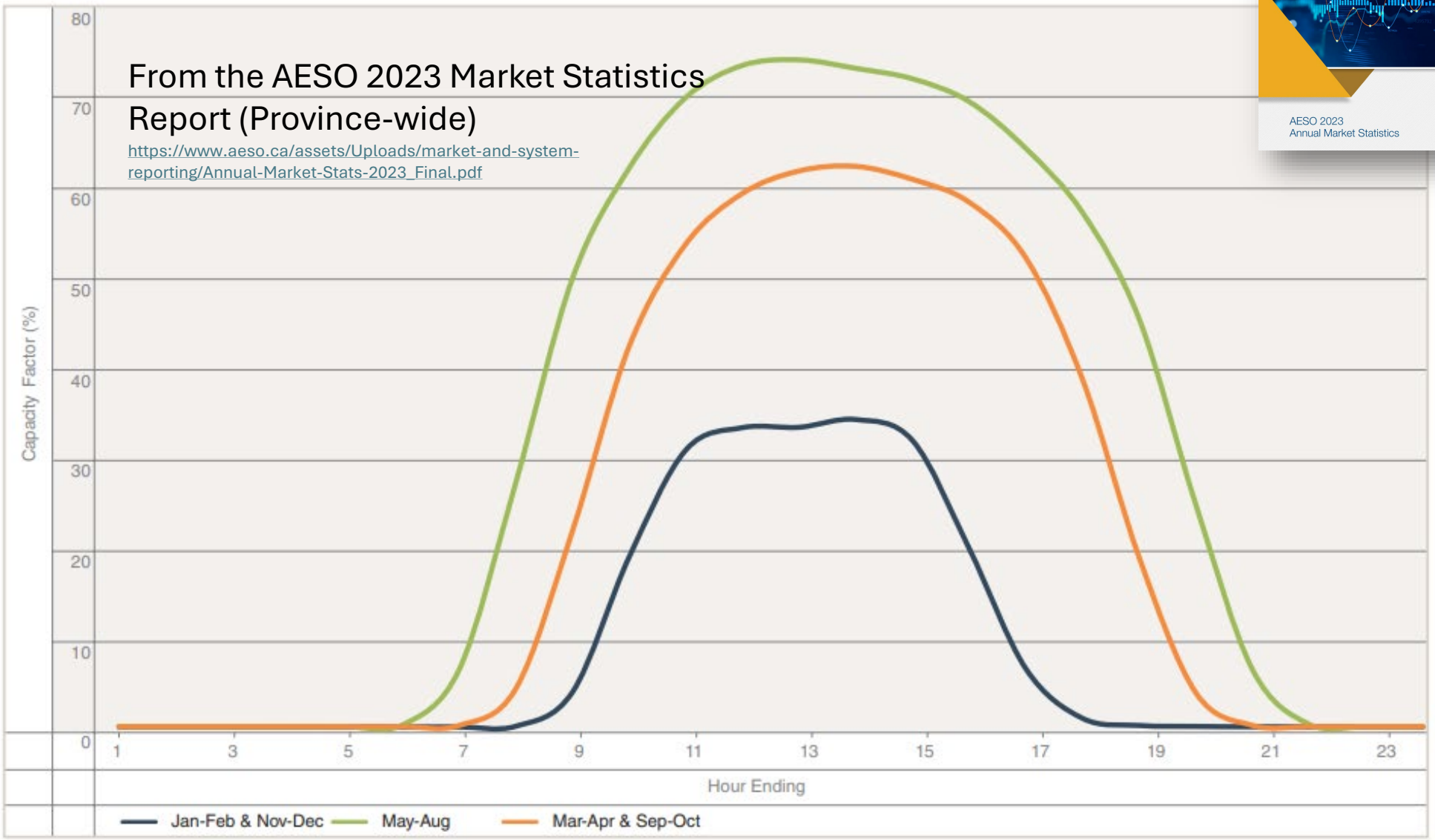


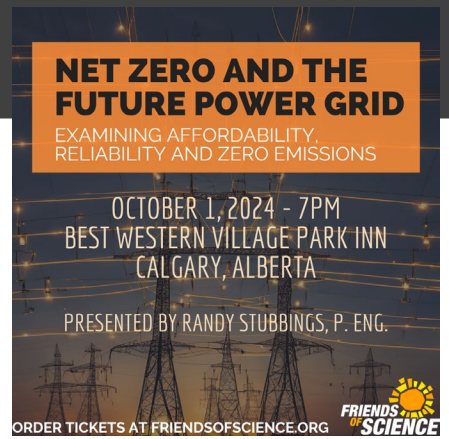
FIGURE 32: Seasonal average hourly output of solar fleet (2023)

From the AESO 2023 Market Statistics Report (Province-wide)

https://www.aeso.ca/assets/Uploads/market-and-system-reporting/Annual-Market-Stats-2023_Final.pdf

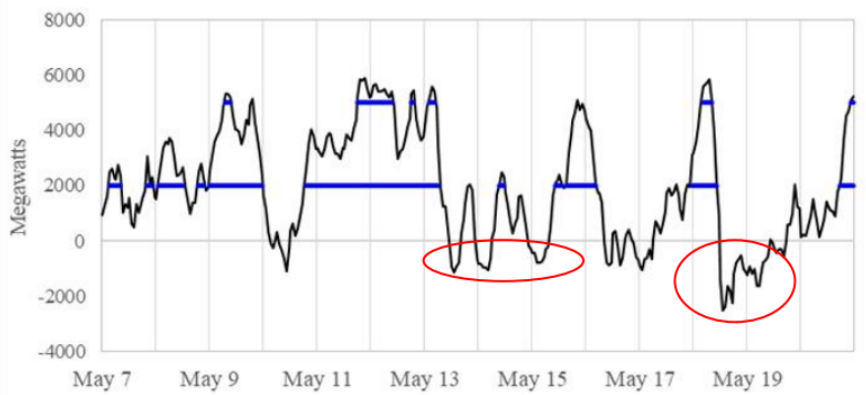


Do Renewables Affect Selling Price?



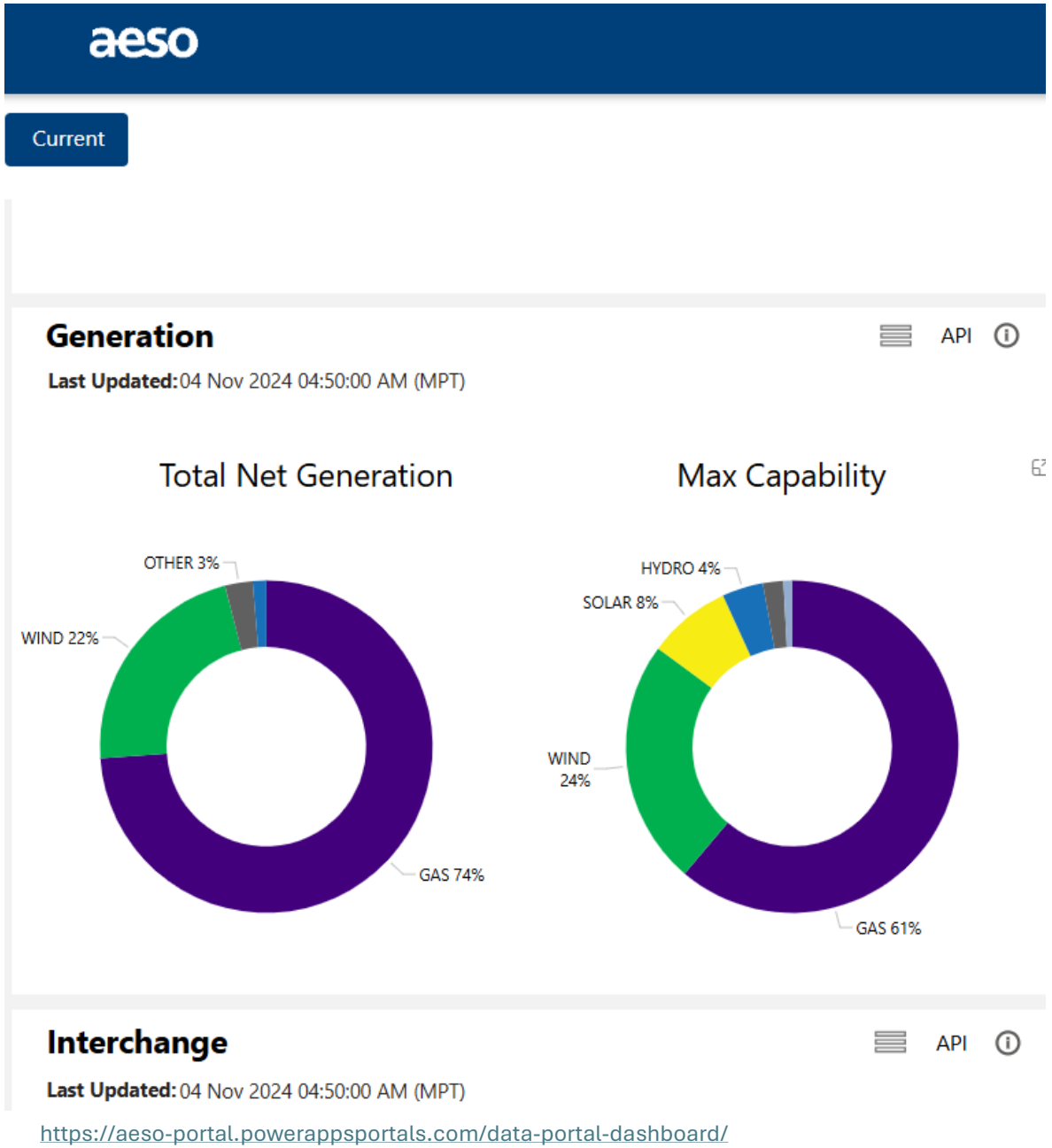
Effects of Nondispatchable Renewables

- As renewables increase further, both G2 and G5 are needed less
  - Energy sales are lower
  - Run cycles are shorter and less predictable
- The rate at which net demand changes is higher
- When net demand would be negative, some renewable generation must be curtailed



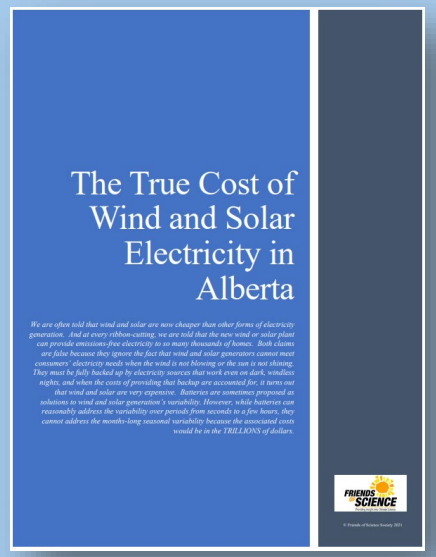
https://friendsofscience.org/library/events/net-zero-and-the-future-power-grid.html

Is it practical to retire traditional power sources? No.



https://aeso-portal.powerappsportals.com/data-portal-dashboard/

Baseload generation is required.



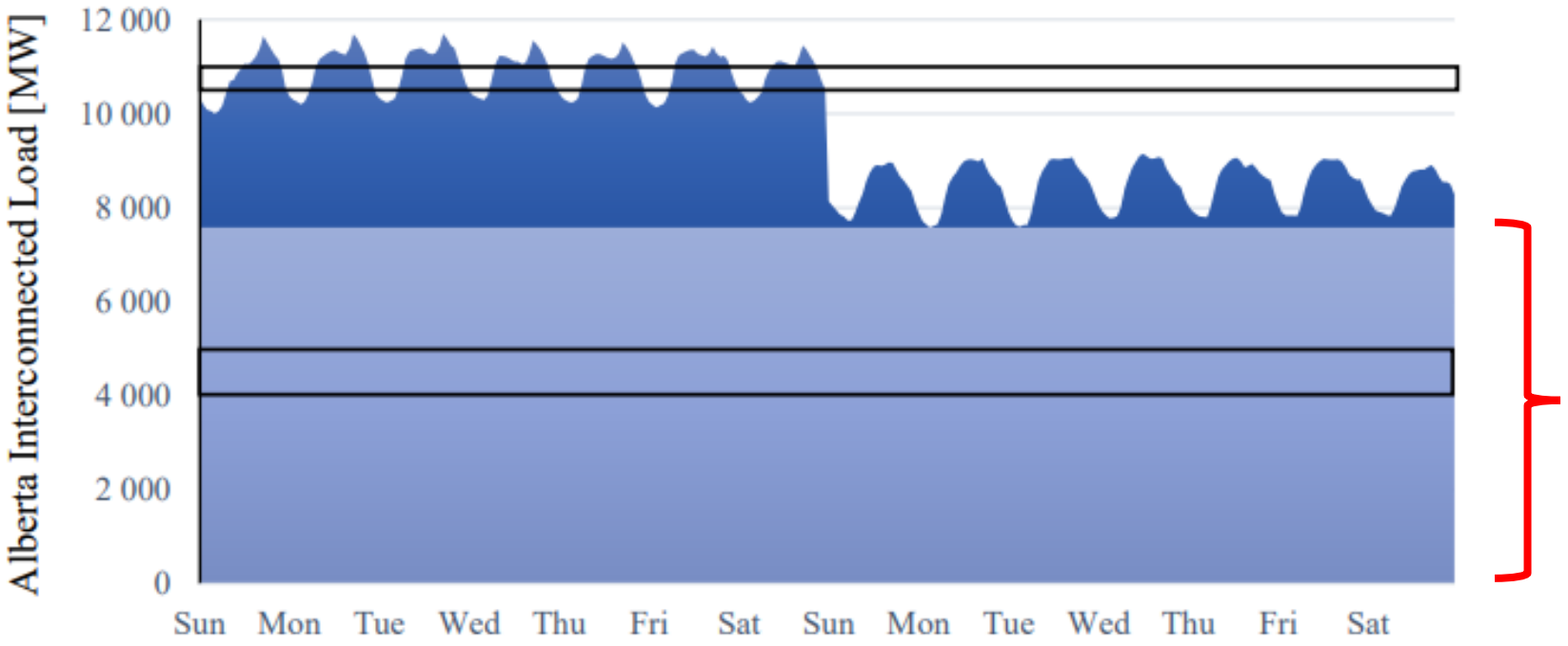
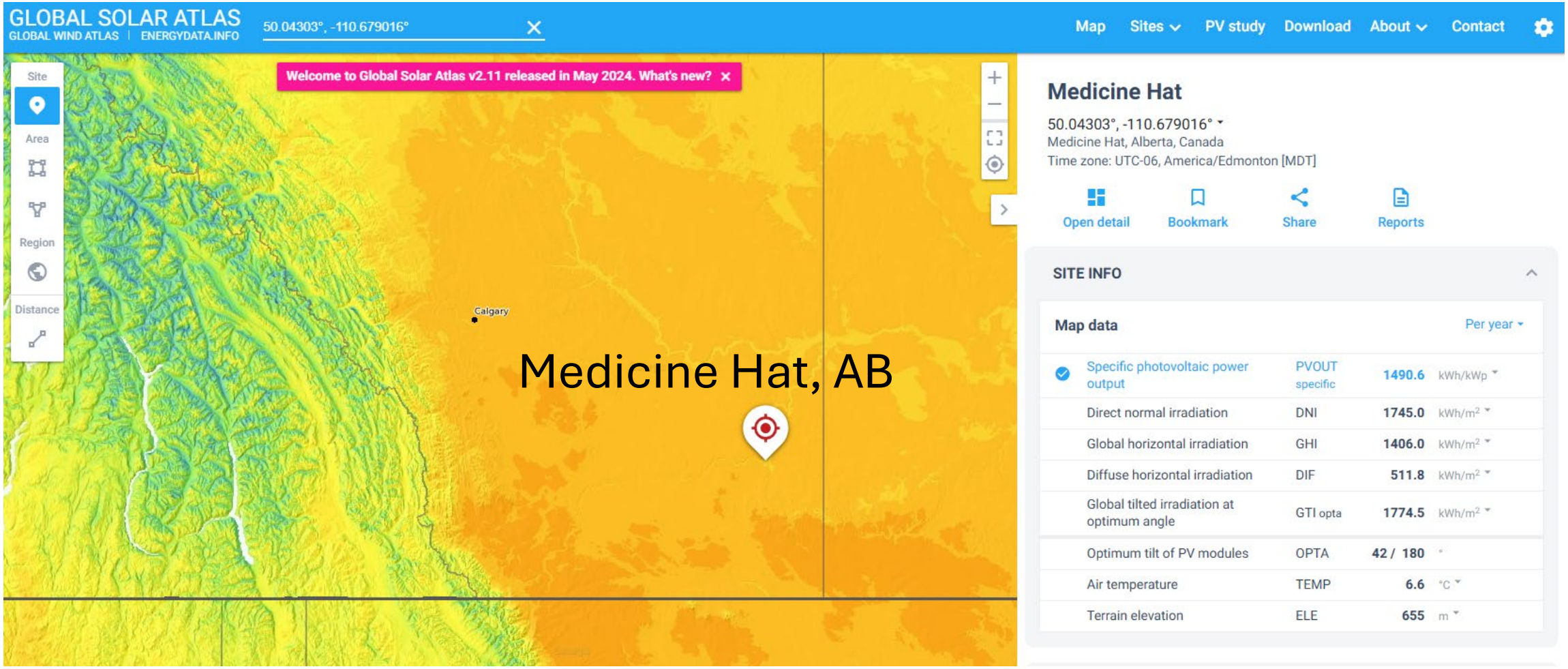


Figure B1: Alberta Interconnected Load for a winter week (left) and a summer week (right) in 2020. The annual base load is shown in lighter blue. The black rectangles will be discussed later.

Medicine Hat has some of the Best Solar Resources in Canada.
True.

https://globalsolaratlas.info/map?c=50.180416,-113.670044,7&s=50.04303,-110.679016&m=site


GLOBAL SOLAR ATLAS
GLOBAL WIND ATLAS | ENERGYDATA.INFO
50.04303°, -110.679016°
Map
Sites
PV study
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About
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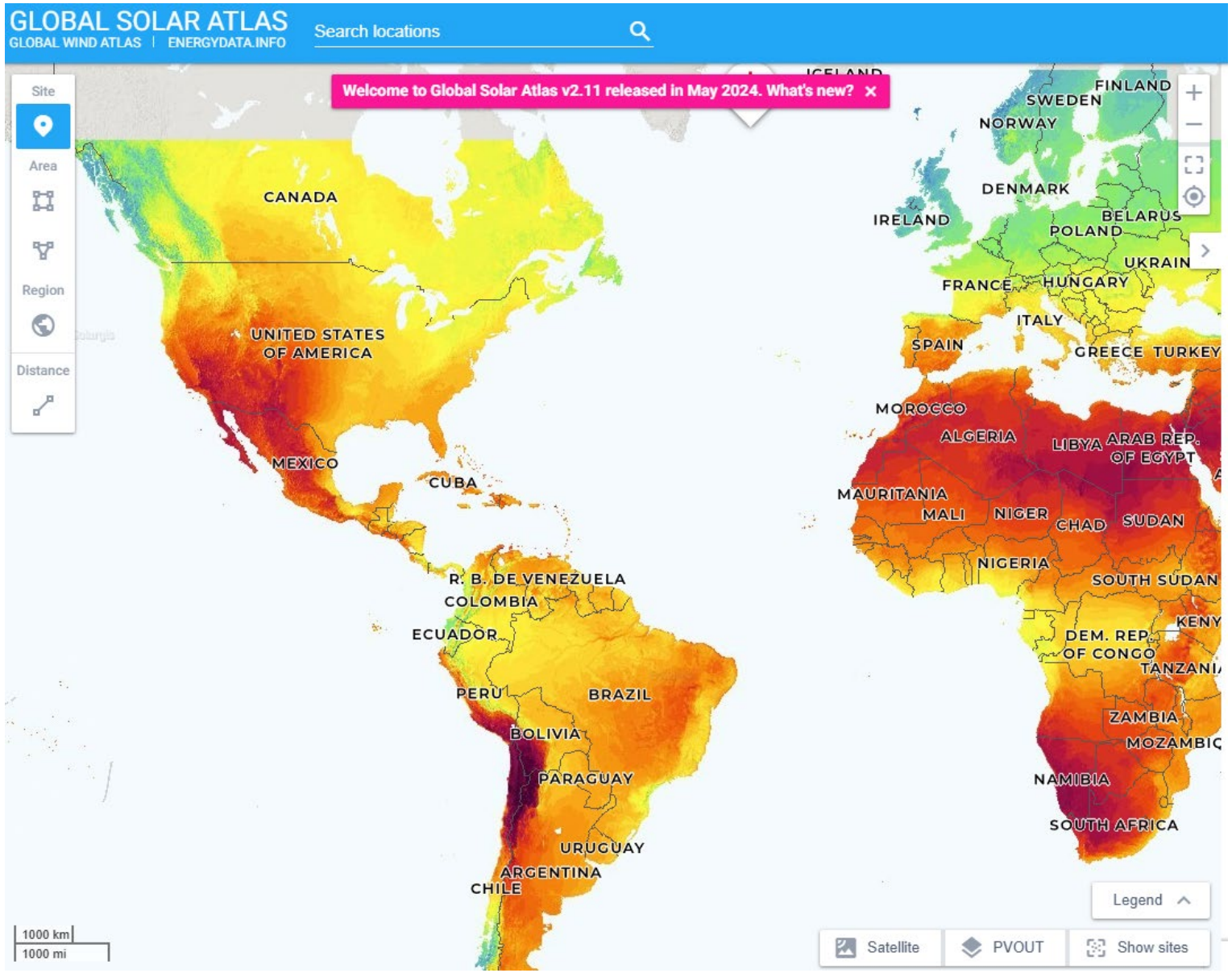
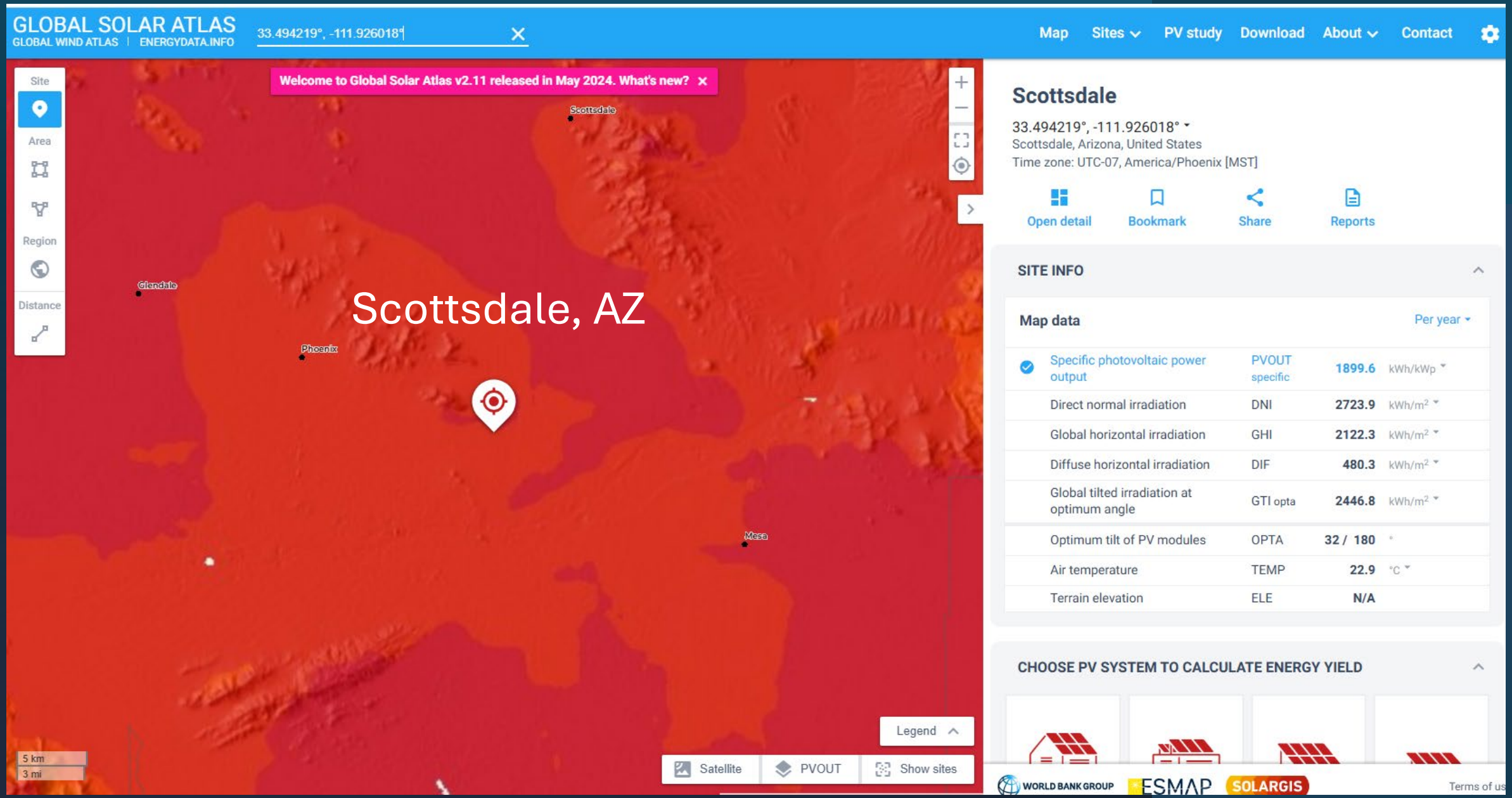
Welcome to Global Solar Atlas v2.11 released in May 2024. What's new?
Site
Area
Region
Distance
Calgary
Medicine Hat, AB
Medicine Hat
50.04303°, -110.679016°
Medicine Hat, Alberta, Canada
Time zone: UTC-06, America/Edmonton [MDT]
Open detail
Bookmark
Share
Reports
SITE INFO
Map data
Per year
Specific photovoltaic power output
PVOUT specific
1490.6
kWh/kWp
Direct normal irradiation
DNI
1745.0
kWh/m²
Global horizontal irradiation
GHI
1406.0
kWh/m²
Diffuse horizontal irradiation
DIF
511.8
kWh/m²
Global tilted irradiation at optimum angle
GTI opta
1774.5
kWh/m²
Optimum tilt of PV modules
OPTA
42 / 180
Air temperature
TEMP
6.6
°C
Terrain elevation
ELE
655
m

How does Canada's best compare to other places for solar?




GLOBAL SOLAR ATLAS
GLOBAL WIND ATLAS | ENERGYDATA.INFO
33.494219°, -111.926018°
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Welcome to Global Solar Atlas v2.11 released in May 2024. What's new?
Site
Area
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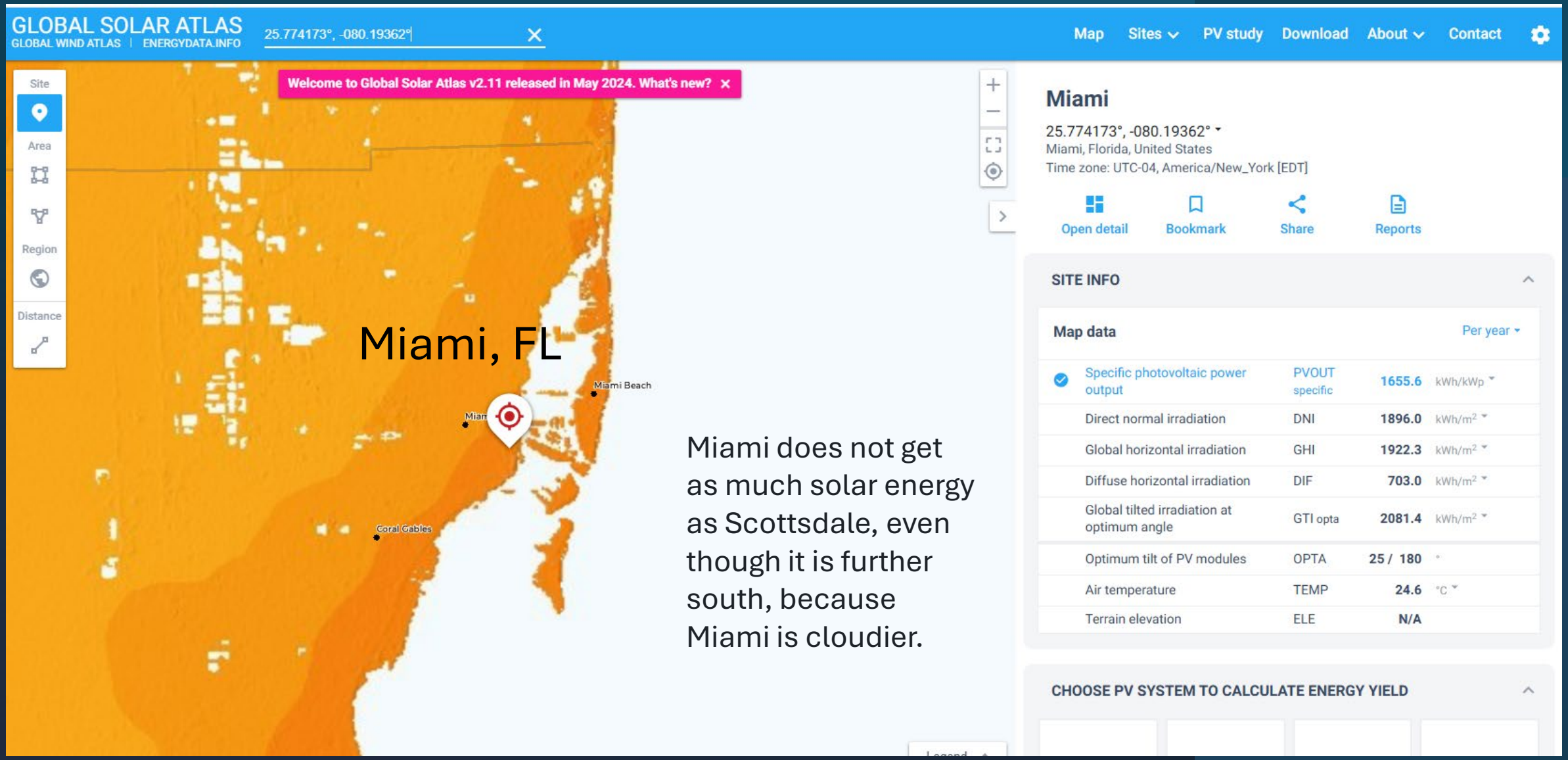
Scottsdale
Glendale
Phoenix
Mesa
Scottsdale, AZ
5 km
3 mi
Legend
Satellite
PVOUT
Show sites
Scottsdale
33.494219°, -111.926018°
Scottsdale, Arizona, United States
Time zone: UTC-07, America/Phoenix [MST]
Open detail
Bookmark
Share
Reports
SITE INFO
Map data
Per year
Specific photovoltaic power output
PVOUT specific
1899.6
kWh/kWp
Direct normal irradiation
DNI
2723.9
kWh/m²
Global horizontal irradiation
GHI
2122.3
kWh/m²
Diffuse horizontal irradiation
DIF
480.3
kWh/m²
Global tilted irradiation at optimum angle
GTI opta
2446.8
kWh/m²
Optimum tilt of PV modules
OPTA
32 / 180
°
Air temperature
TEMP
22.9
°C
Terrain elevation
ELE
N/A
CHOOSE PV SYSTEM TO CALCULATE ENERGY YIELD
WORLD BANK GROUP
ESMAP
SOLARGIS
Terms of us

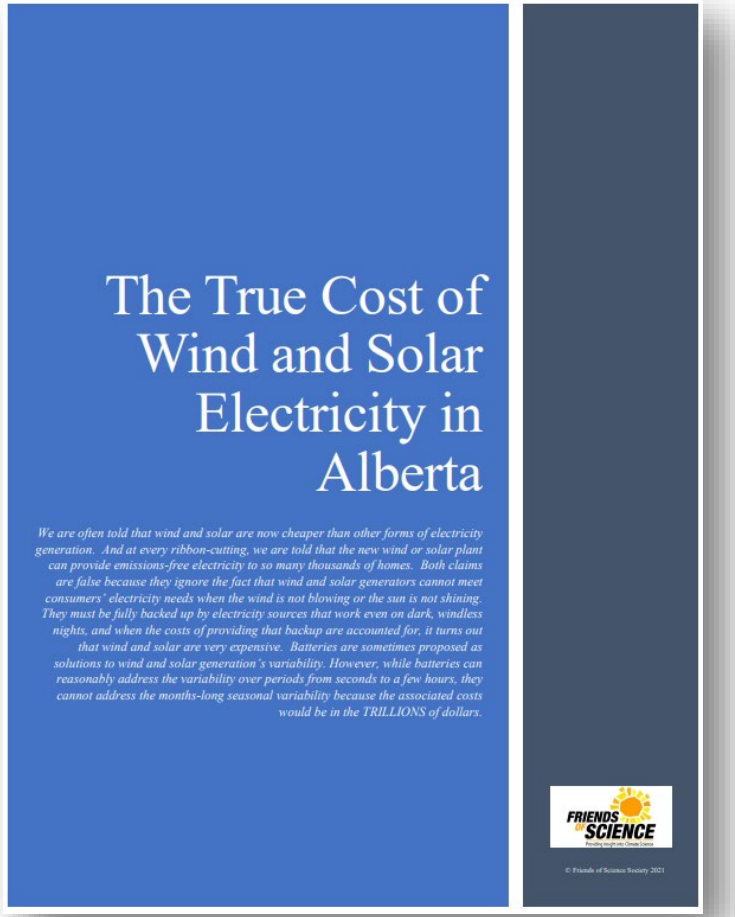


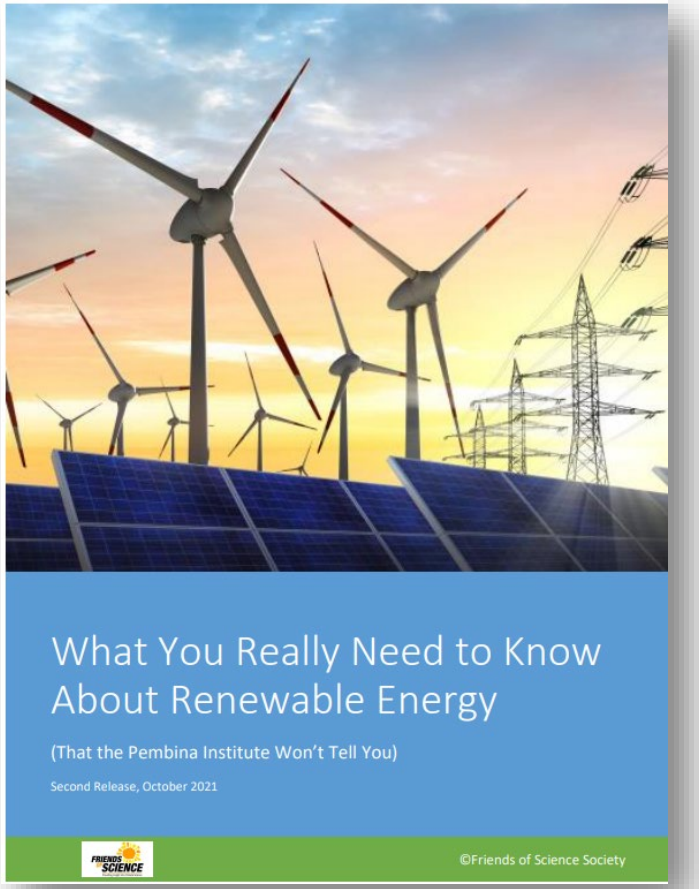
Miami does not get as much solar energy as Scottsdale, even though it is further south, because Miami is cloudier.

These 2021 reports compare Medicine Hat and Miami Solar

https://blog.friendsofscience.org/2021/04/25/the-true-cost-of-wind-and-solar-electricity-in-alberta/

https://blog.friendsofscience.org/wp-content/uploads/2021/10/Response-to-Pembinas-What-You-Need-to-Know-Parts-A-and-B-Oct-20-2021.pdf





Cheaper? Can Power ‘X’ number of Homes? Emissions-free?

True or False?

- We are often told that wind and solar are now cheaper than other forms of electricity generation.
- And at every ribbon-cutting, we are told that the new wind or solar plant can provide emissions-free electricity to so many thousands of homes.
- Both claims are false because they ignore the fact that wind and solar generators cannot meet consumers’ electricity needs when the wind is not blowing, or the sun is not shining.
- They must be fully backed up by electricity sources that work even on dark, windless nights, and when the costs of providing that backup are accounted for, it turns out that wind and solar are very expensive.
- Batteries are sometimes proposed as solutions to wind and solar generation’s variability.
- However, while batteries can reasonably address the variability over periods from seconds to a few hours, they cannot address the months-long seasonal variability because the associated costs would be in the TRILLIONS of dollars.

Miami

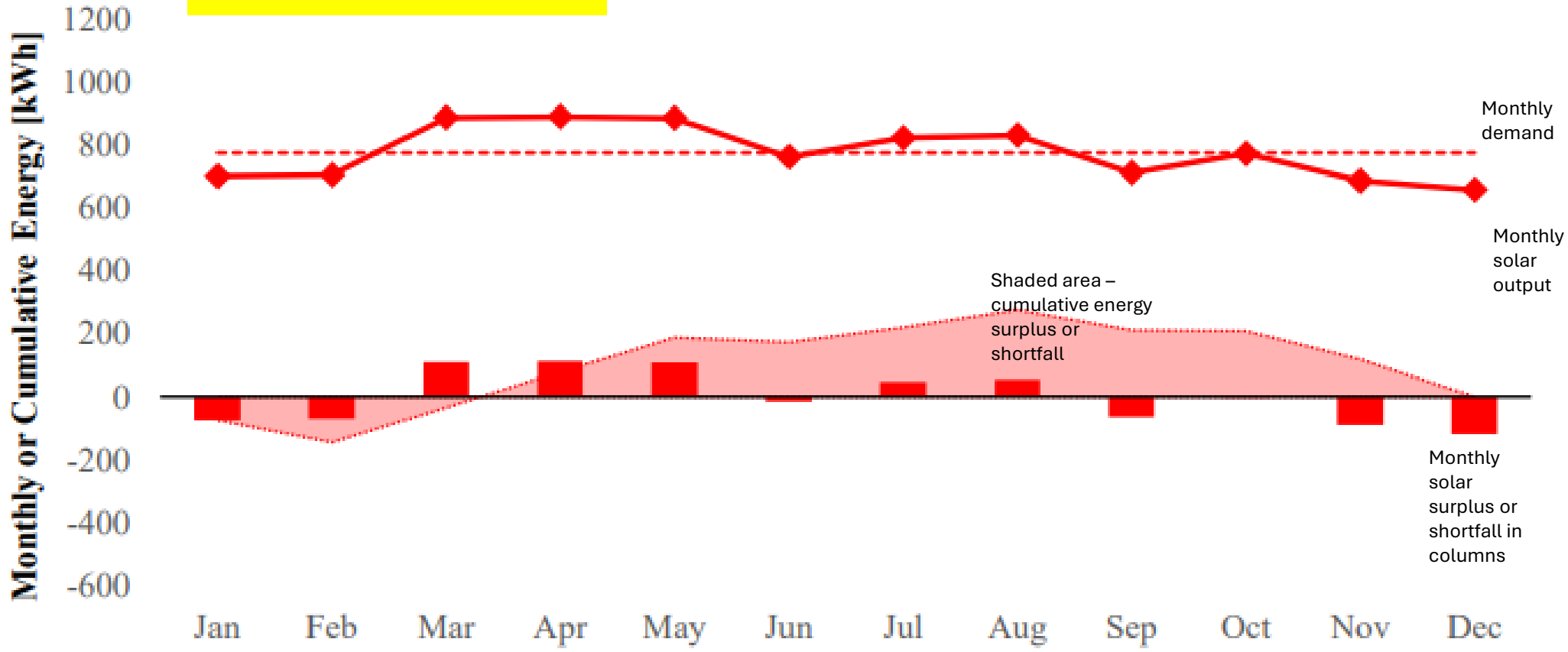


Figure A3: This chart shows: (i) monthly solar output as a solid line with markers; (ii) monthly electricity demand as a dashed line; (iii) monthly energy surplus (+) or shortfall (−) as columns; and (iv) the cumulative energy surplus or shortfall at the end of each month as a shaded area. The chart is for the Miami electricity consumer.

Medicine Hat

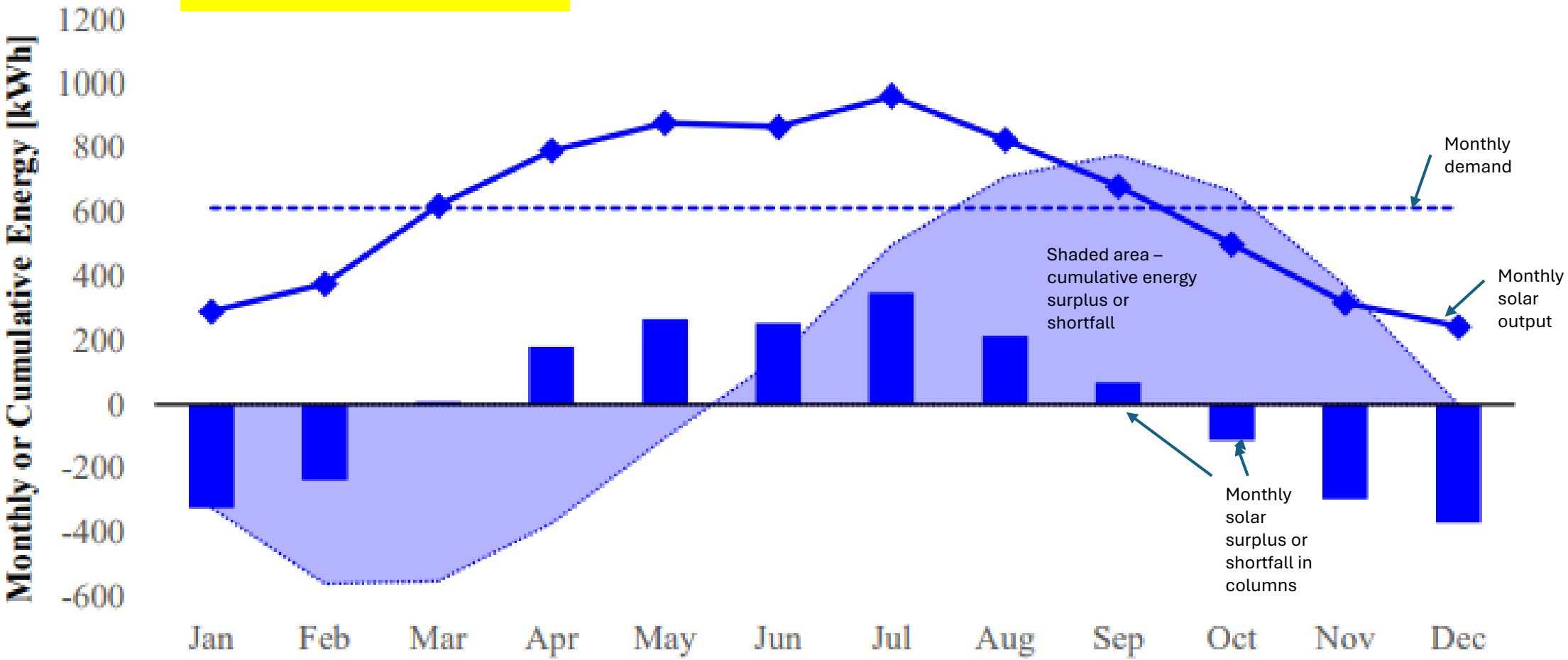


Figure A4: This chart is the same as Figure A3, except that it's for the Medicine Hat customer.

Seasonal Variations Create Problems

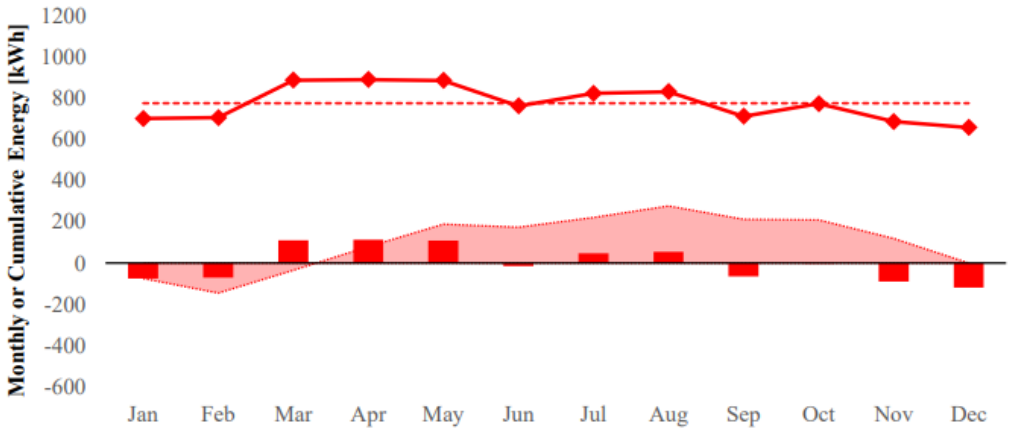


Figure A3: This chart shows: (i) monthly solar output as a solid line with markers; (ii) monthly electricity demand as a dashed line; (iii) monthly energy surplus (+) or shortfall (−) as columns; and (iv) the cumulative energy surplus or shortfall at the end of each month as a shaded area. The chart is for the Miami electricity consumer.

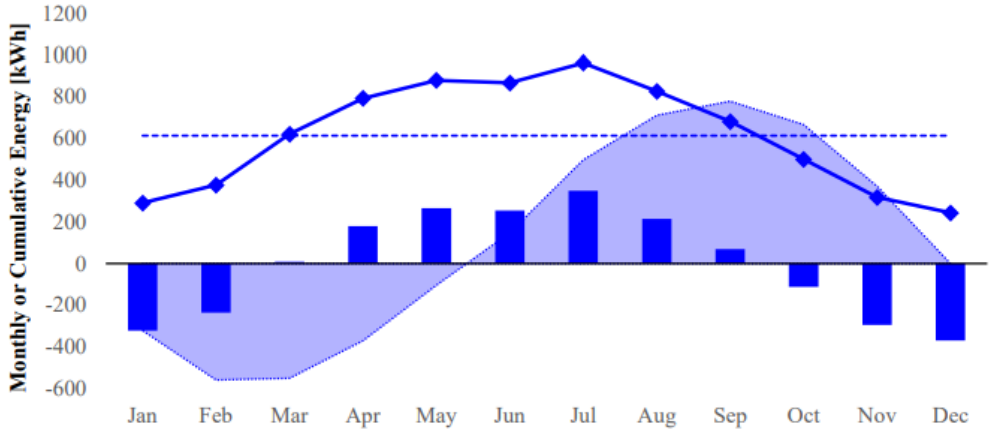


Figure A4: This chart is the same as Figure A3, except that it's for the Medicine Hat customer.

These differences between Miami and Medicine Hat are inescapable consequences of the greater seasonal variation of solar energy at higher latitudes, and they clearly show why simply comparing annual energy production between solar arrays in different parts of the world is meaningless.

Future Medicine Hat

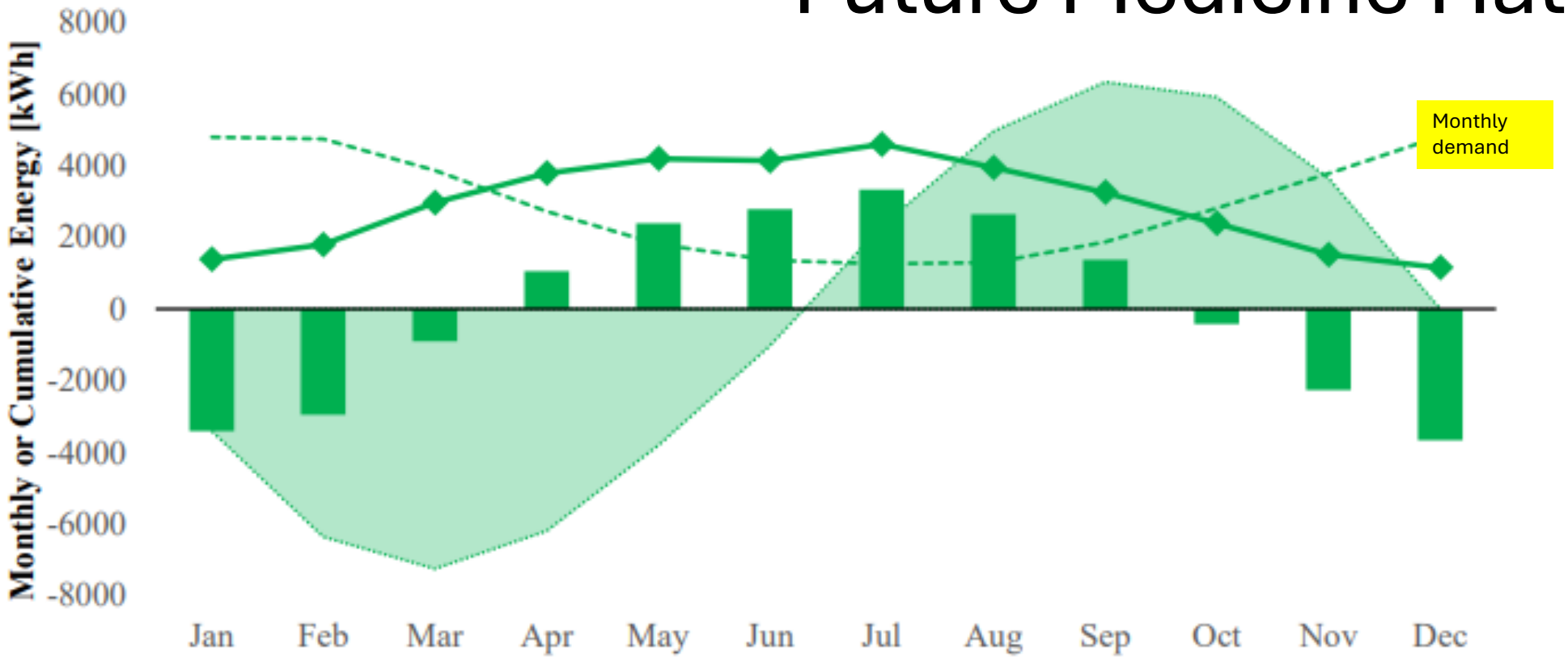


Figure A5: This chart is the same as Figures A3 and A4 except that it's for "future Medicine Hat," where the residential use of fossil fuels is assumed to have been eliminated. The anti-correlation between solar generation and electricity demand is obvious. Caution must be used when comparing this chart to Figures A3 and A4: the vertical scale here is much different than on the other two charts.

Future Medicine Hat

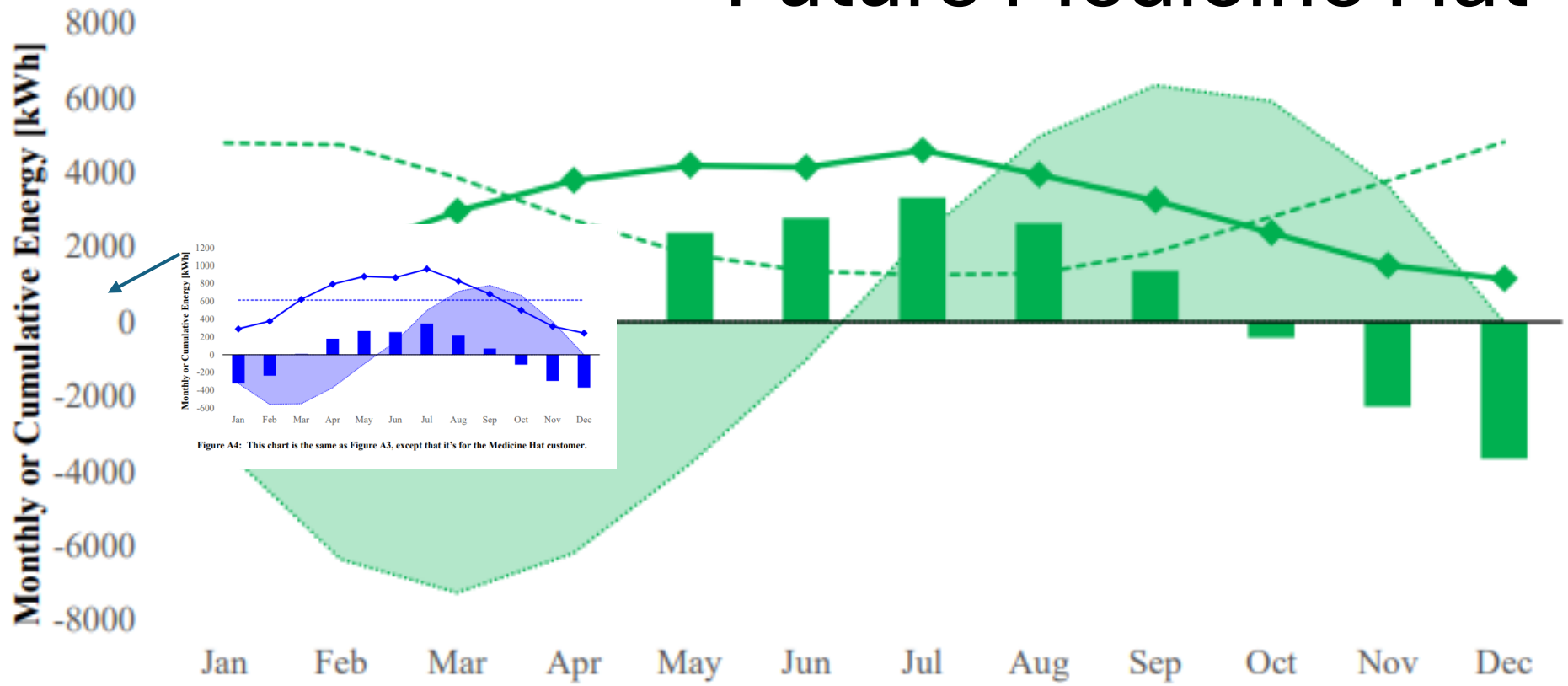
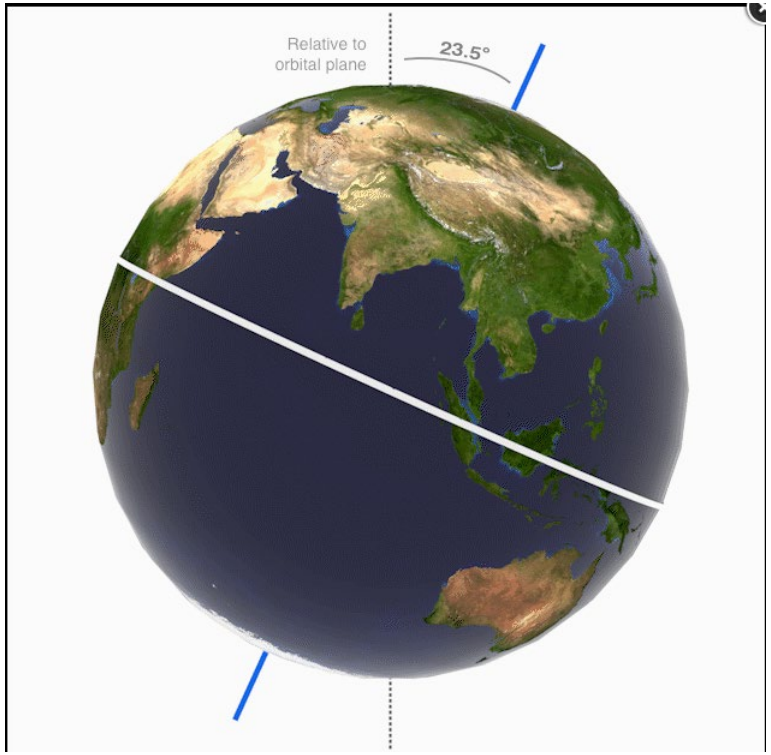


Figure A4: This chart is the same as Figure A3, except that it's for the Medicine Hat customer.

Figure A5: This chart is the same as Figures A3 and A4 except that it's for "future Medicine Hat," where the residential use of fossil fuels is assumed to have been eliminated. The anti-correlation between solar generation and electricity demand is obvious. Caution must be used when comparing this chart to Figures A3 and A4: the vertical scale here is much different than on the other two charts.

Battery Storage for High Latitudes?

- As we move further away from the equator, solar energy's seasonal variation gets larger and electricity demand tends to shift from summer-peaking to winter-peaking.
- In Alberta **the winter peaks will become vastly larger if consumers are forced to convert from natural gas heating to electric heating.** *[Note: Heat pumps are more efficient than gas furnaces, but at extremely cold temperatures they shut down and electric backup is needed.]*
- The changes to supply and demand that occur as we move to higher latitudes increase the amount of storage needed to turn solar generators into reliable energy sources.
- **In Alberta, the needed storage is not just that required to get through a few cloudy days, but rather that required to get through the October-to-March solar energy shortfall. This amount of battery storage is not economically feasible for Alberta families**.



https://sealevel.jpl.nasa.gov/ocean-observation/understanding-climate/the-earth/#:~:text=Because%20the%20Earth%20is%20a,at%20noon%20on%20the%20equator.

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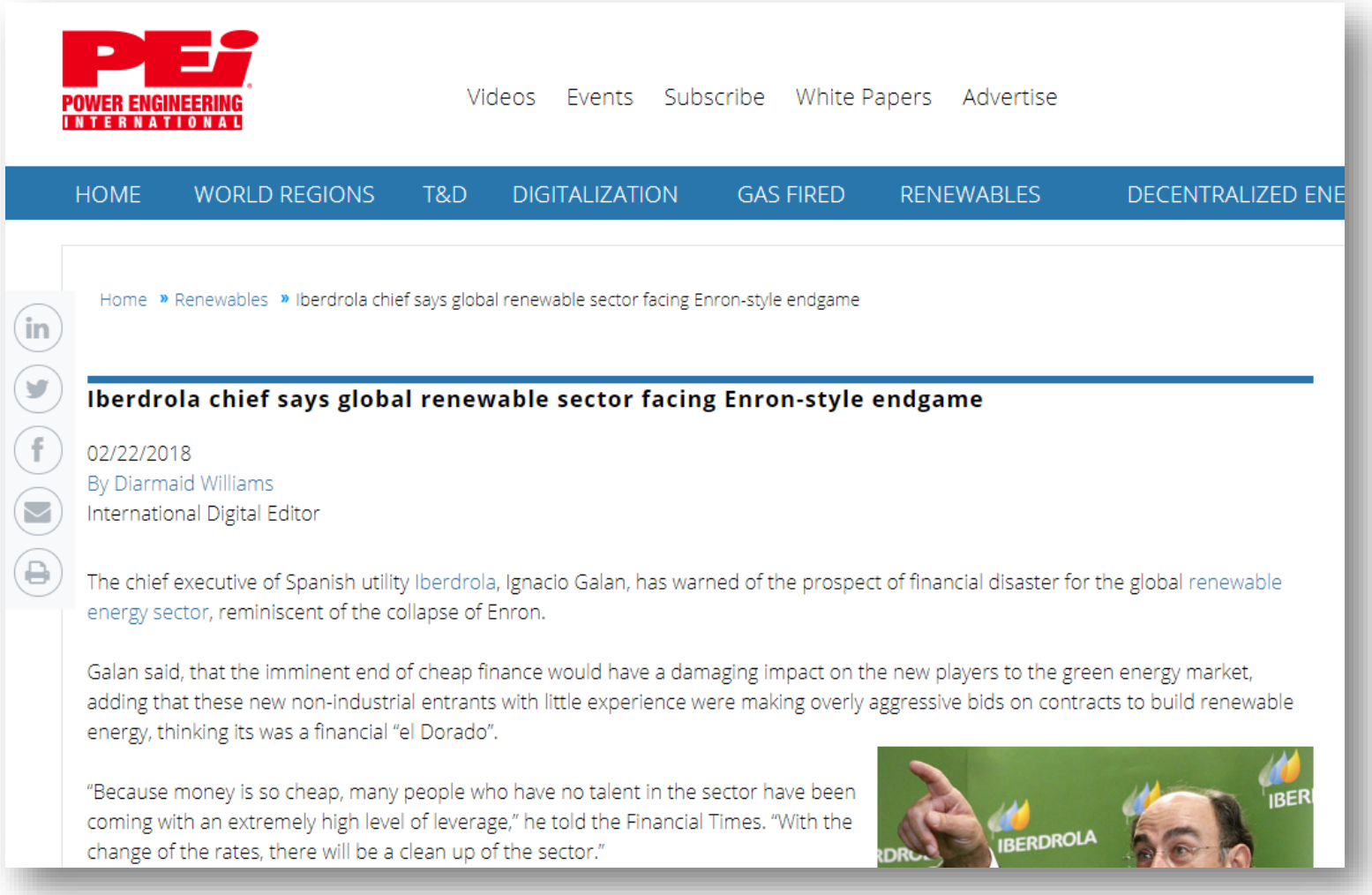
Do these projects ever make money. If so, how long?

- These projects often make lots money for the developer. Sometimes for carbon market traders.
- Sometimes the subsidies and trade-offs against the burden of carbon tax appears to make them profitable – but subsidies come from YOUR pocket, too.
- AESO is looking at lowering the price floor from $0/MWh to NEGATIVE $100/MWh. Negative prices would arise when it's very sunny and/or windy and there's lots of solar and/or wind generation.
- What happens when it hails? How long a life does a solar farm have?
- Will you have to PAY someone to take power during over supply, like Ontario?
- Costs of decommissioning/recycling?

Are you an unwitting part of a rescue mission for renewables?



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Home » Renewables » Iberdrola chief says global renewable sector facing Enron-style endgame

Iberdrola chief says global renewable sector facing Enron-style endgame

02/22/2018
By Diarmaid Williams
International Digital Editor

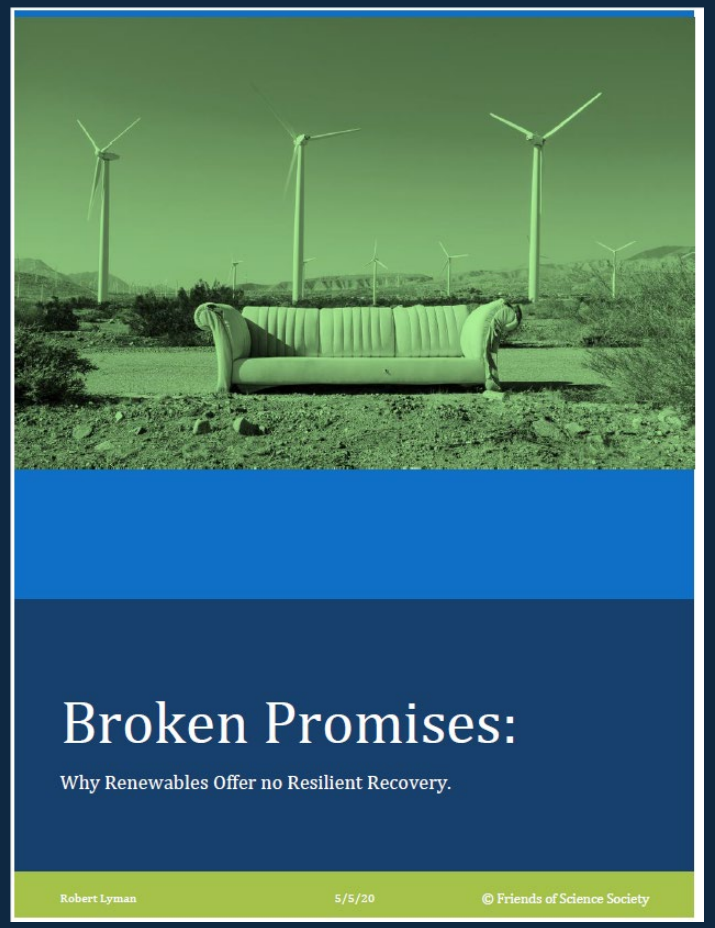
The chief executive of Spanish utility Iberdrola, Ignacio Galan, has warned of the prospect of financial disaster for the global renewable energy sector, reminiscent of the collapse of Enron.

Galan said, that the imminent end of cheap finance would have a damaging impact on the new players to the green energy market, adding that these new non-industrial entrants with little experience were making overly aggressive bids on contracts to build renewable energy, thinking its was a financial "el Dorado".

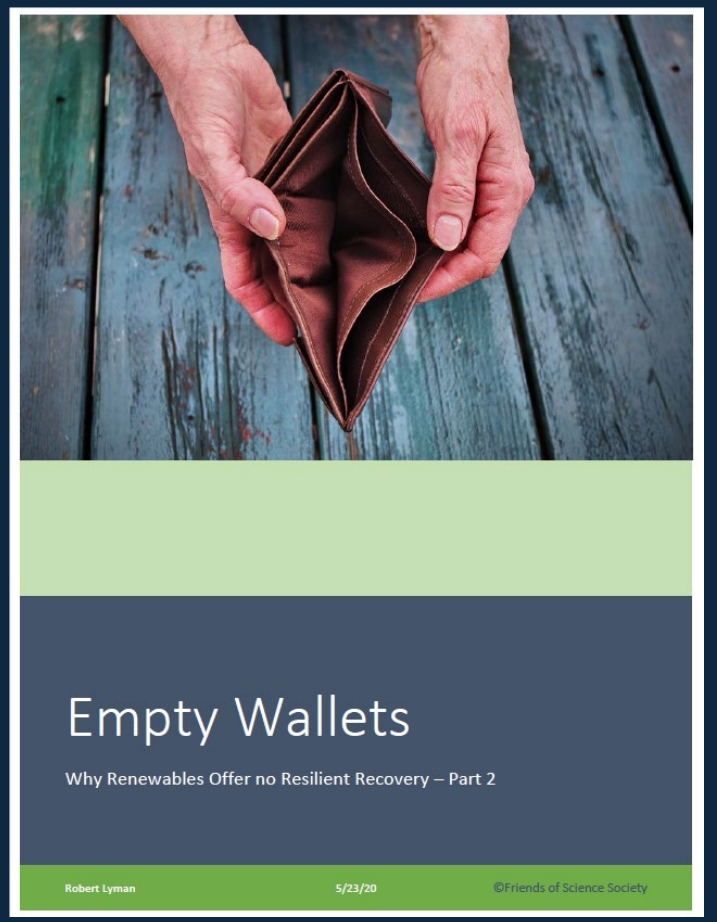
"Because money is so cheap, many people who have no talent in the sector have been coming with an extremely high level of leverage," he told the Financial Times. "With the change of the rates, there will be a clean up of the sector."

https://www.powerengineeringint.com/renewables/iberdrola-chief-says-global-renewable-sector-facing-enron-style-endgame/

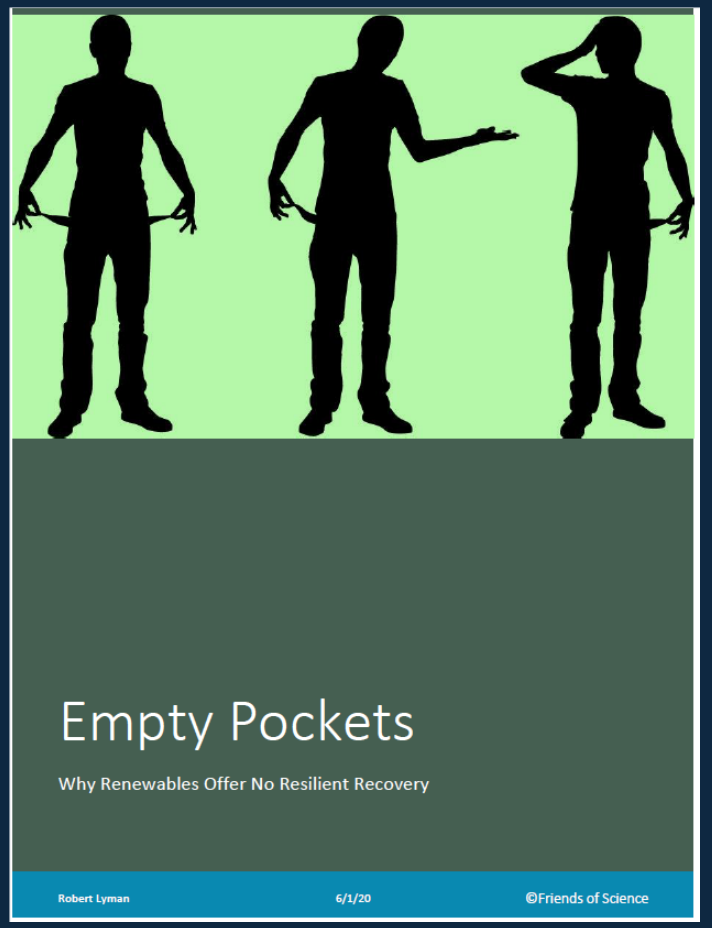
Why Renewables Offer no Resilient Recovery



https://blog.friendsofscience.org/2020/05/05/broken-promises-why-renewables-offer-no-resilient-recovery-part-1/



https://blog.friendsofscience.org/2020/05/24/empty-wallets-why-renewables-offer-no-resilient-recovery-part-2/



https://blog.friendsofscience.org/2020/06/01/empty-pockets-why-renewables-offer-no-resilient-recovery/

Climate pattern changes, yes or no?

Facts vs Fortune Telling

Alberta's Climate Future Report Review

Friends of Science Society

2020-05-24

https://friendsofscience.org/assets/documents/Alberta%20Climate%20Future%20rebuttal.pdf

Gas	World Warming	Canadian Contribution	Alberta Contribution
	C/Century	C/Century	C/Century
CO_2	0.85	0.016	0.0052
CH_4	0.085	0.0016	0.00052
N_2O	0.064	0.0012	0.0037
Total	**1.0**	**0.019**	**0.006**

six thousandths

-The world warming column is from: C. de Lange, J. Ferguson, W. Happer & W. A. van Wijngaarden, **2022**, "Nitrous Oxide & Climate", *Atmos. & Oceanic Phys.* arXiv: 2211.15780.

-Canada produced 1.9% of CO_2 according to https://www.worldometers.info/co2-emissions/

-According to Environment and Natural Resources Dept. of Government of Canada in 2019 Alberta generated about 37% of Canada's carbon dioxide equivalent output.

-For simplicity, we assume same emission fraction for CH_4 and N_2O as for CO_2

In closing: Medicine Hat's situation, like many cities, is complicated.

- Squeezed by Net Zero diktats
- Squeezed by carbon tax on gas powered electricity
- Offered grants and 'free money' for renewables
- Facing losses due to market conditions/orphaned wells
- Appealing opportunity to deal with a brownfield site

- **Will the proposed solution make things worse? Create more problems?**
- Grid instability?
- Requirement to pay the grid to take excess power?
- Regional heat dome, warming/drying – esp for the large project?
- Creation of micro-climate which may affect local weather extremes (hail, convective heat, soil drying)? Snakes may not be the only environmental consideration.
- Long-term cost-benefit?
- Cost of decommissioning/recycling? Who does that burden fall to?

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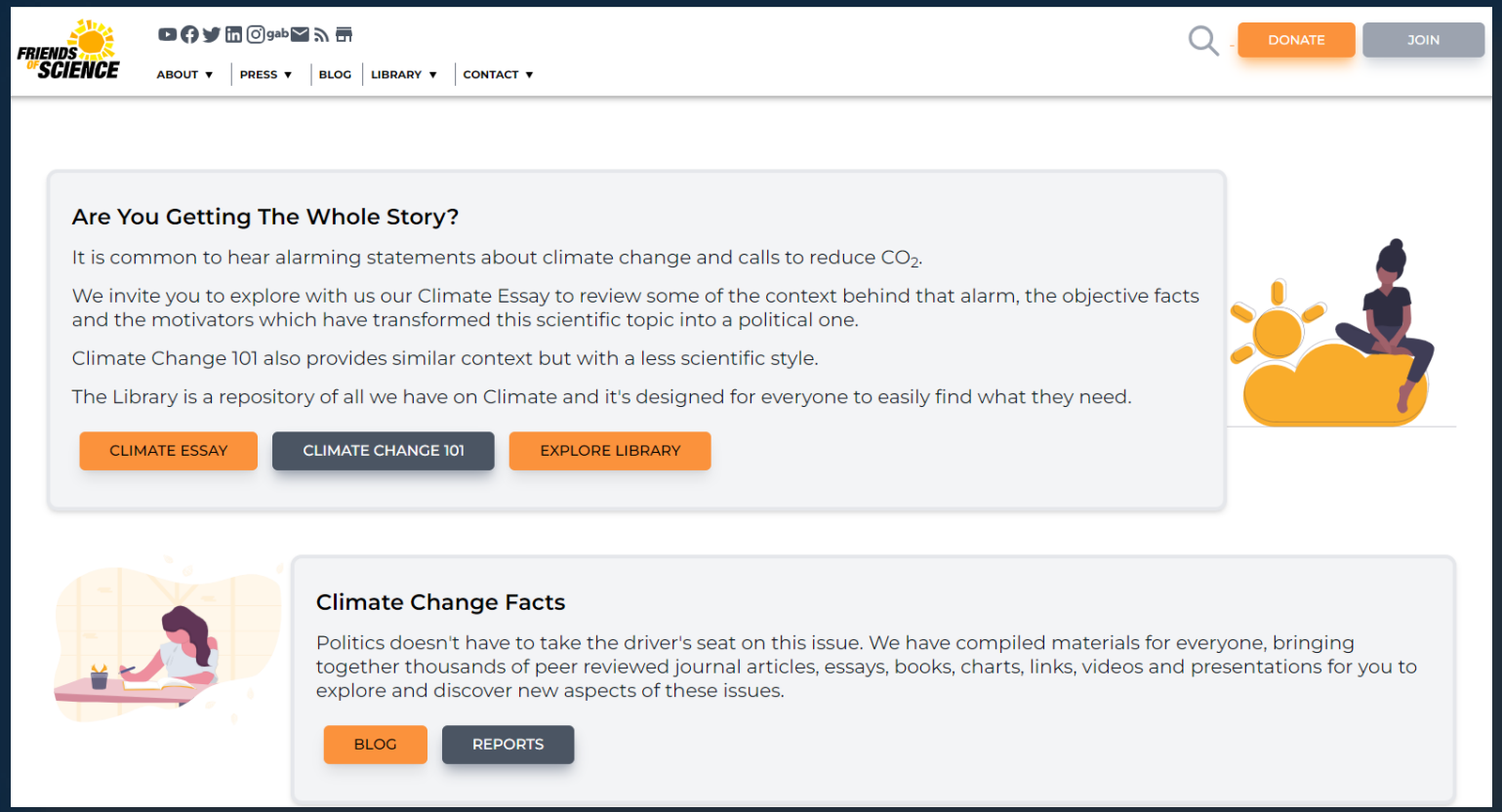

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