CCREEE
CARIBBEAN CENTRE FOR RENEWABLE ENERGY & ENERGY EFFICIENCY

AN INSTITUTION OF CARICOM

Solar PV Integration Training

Tuesday 11th May 2021

IRRP
INTEGRATED RESOURCE AND RESILIENCE PLANS

SUPPORTED BY

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DEUTSCHE ZUSAMMENARBEIT

IMPLEMENTED BY:
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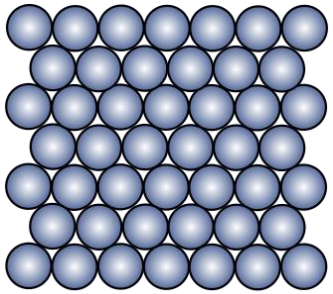
Solar Photovoltaic System Design – distributed generation and utility scale

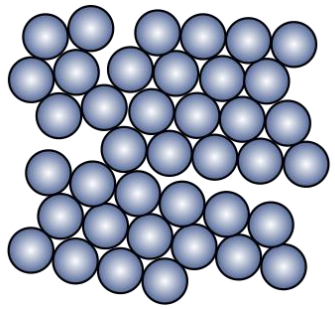
Your Speaker: Dr. Randy Koon Koon

Solar Photovoltaic System Design – distributed generation and utility scale

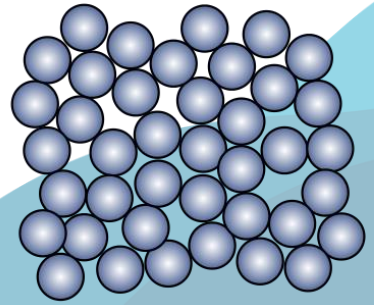
Cells which are composed of a single crystal are known as monocrystalline silicon (mono-Si)



The atoms of solar cells made from polycrystalline silicon (poly-Si), also called multi-crystalline silicon, have an irregular arrangement of crystallites.



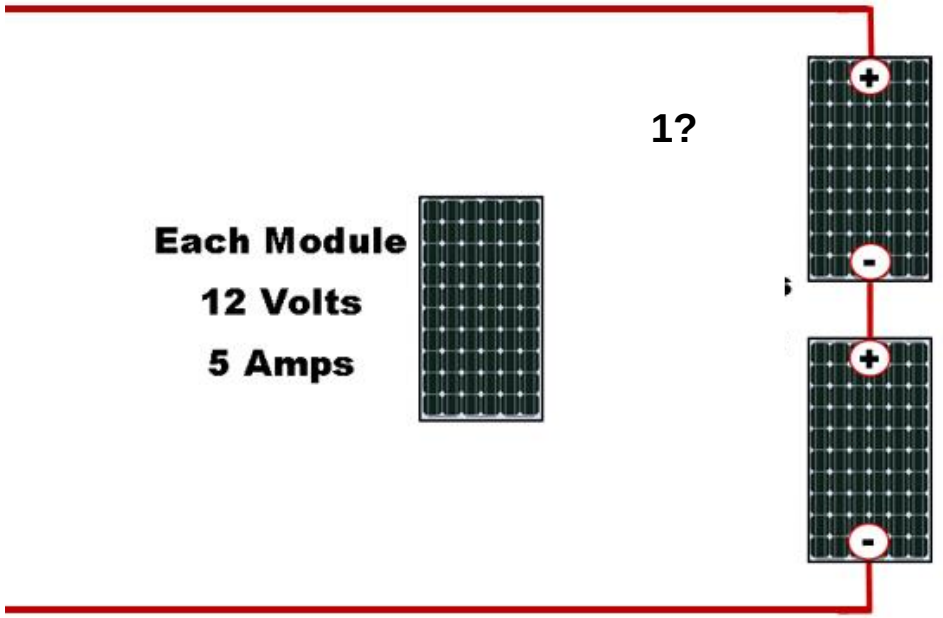
The atoms of solar cells made from amorphous silicon (a-Si), do not have a regular long-range arrangement of atoms in lattices.

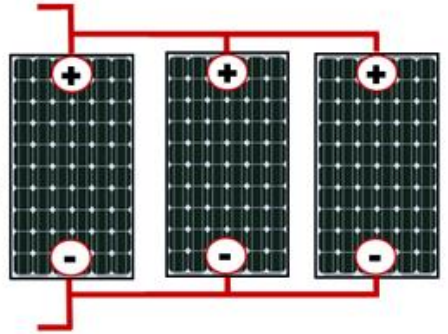


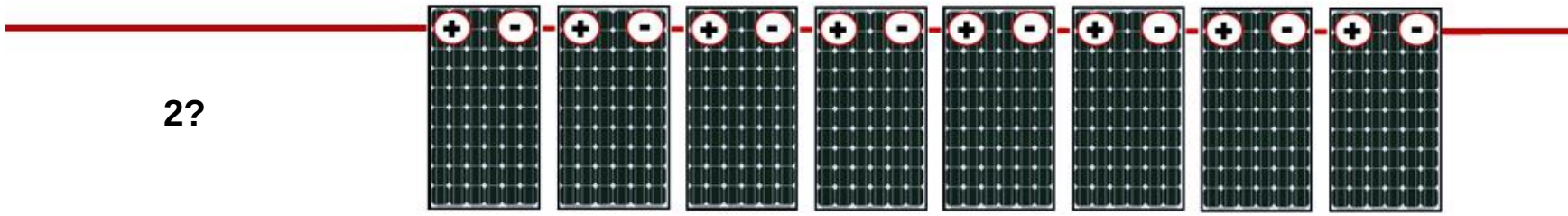
Solar Photovoltaic System Design – distributed generation and utility scale

Silicon PV cells have a n-type side exposed to sunlight and p-type side below it.

When solar radiation is incident on a cell, electron-hole pairs are generated due to the excitation from absorption of energy in photons.



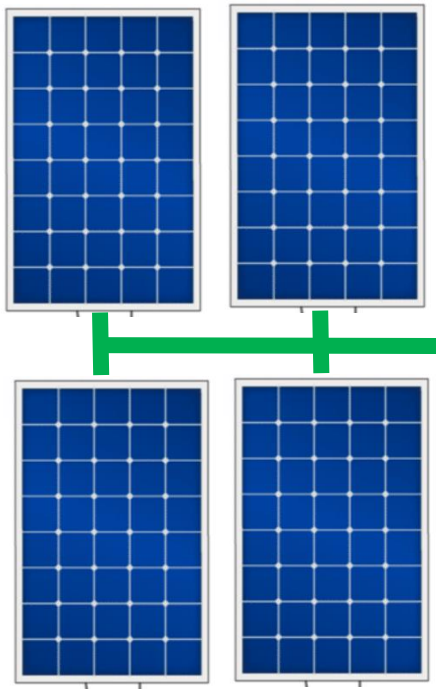




Solar Photovoltaic System Design – distributed generation and utility scale

Small-scale application

Fronius – Inverter / Charge controller

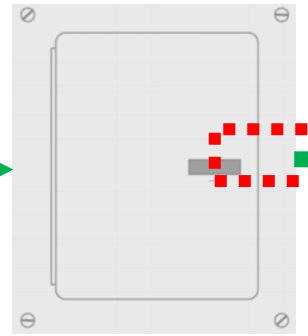


PV Modules

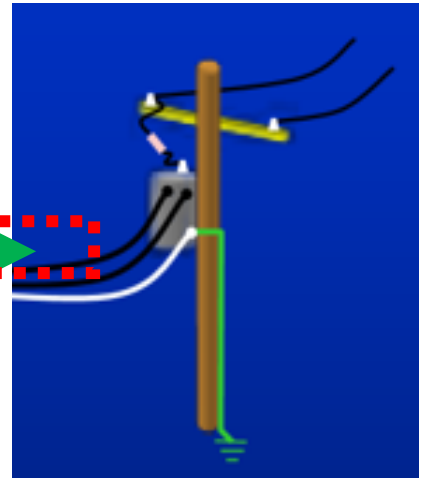
DC Disconnect

Combiner Box

AC Disconnect



Main Utility Panel



Utility Provider

Battery Bank

Let's think about the power conversions!
Are there any losses?
How can the system be improved?

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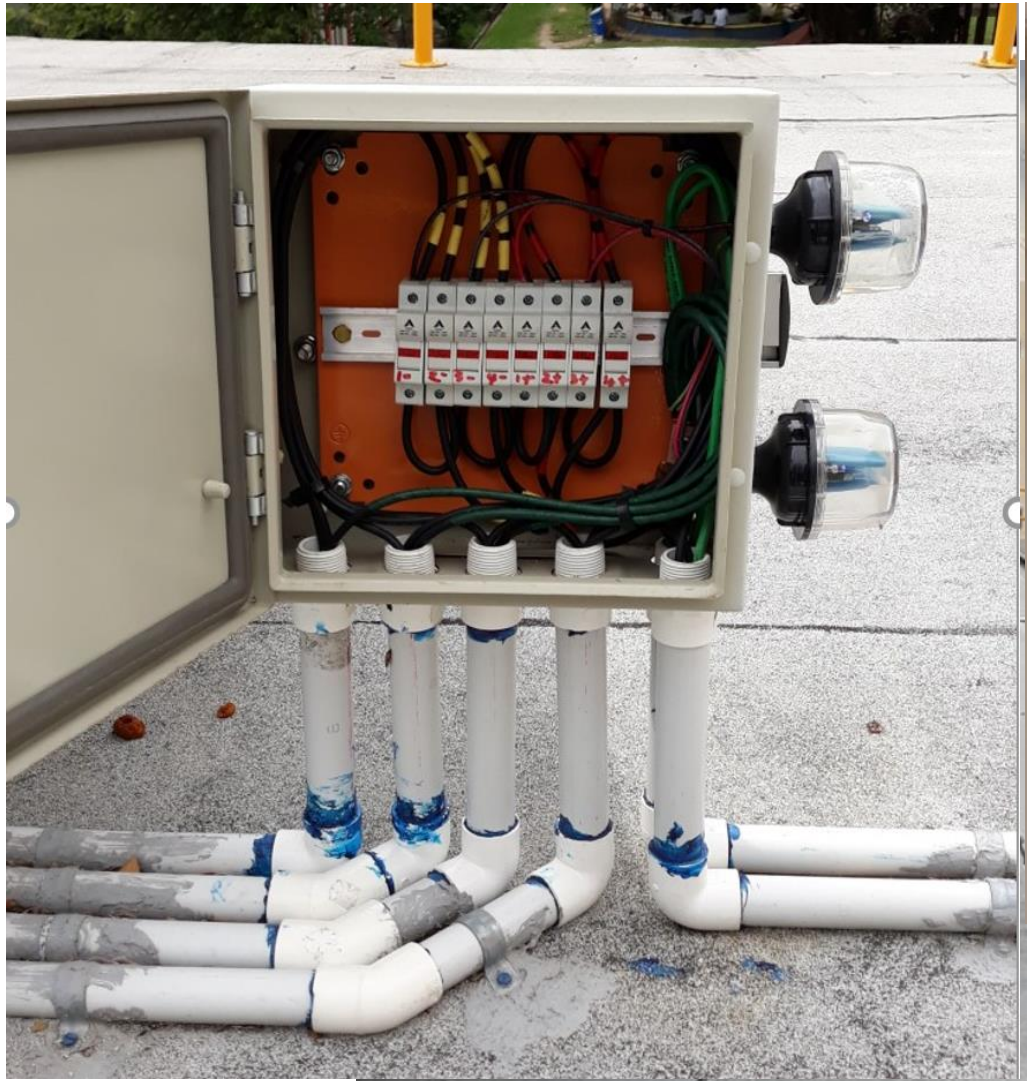
Let's use an example of a small-scale system - 20 kW PV grid-tied system – UWI Physics rooftop!



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Load Analysis Exercise

An inventory of all energy consuming devices must be tabulated. Power is tabulated (let's grab hold of our phone chargers) and the usage is estimated.

Load Description	Qty	Power Rating (W)	Operating Time (hrs./day)	Energy Consumption (Wh/day)
Refrigerator	2	160	8	2560
Bedroom lights	4	30	6	720
TV 36" LED Sony	2	110	4	880
PC Laptop Dell	3	40	8	960
Microwave	2	1200	0.5	1200
Phone Chargers	4	6	1	24
Wall lights	6	10	2	120

Total AC Power	**3180 W**
Total DC Power	**84 W**
Total AC Energy Consumption	**6,320 Wh/day**
Total DC Energy Consumption	**144 Wh/day**
Inverter Efficiency	**0.95 or 95%**
Average Daily DC Energy Consumption	

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Visualizing the problem! – The importance of energy audits.

PV Array

6,796.63 Wh/day

95% = 6,320 Wh/day

Therefore,

100% = (6320/95)*100

6,652.63 Wh/day

Battery Inverter

AC Load requirements

6,320 Wh/day

144 Wh/day

DC Load requirements

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Let's Expand the Approach with an example of a Utility Scale PV system

Content Solar Ltd. was launched in 201 – commercial operations of Jamaica's first utility-scale solar PV plant. Conten Solar, a 20 MW grid-connected solar plant

91,200 solar panels;
Covers 160 acres

Switchyard & Transformer:
33 kV to 138 kV

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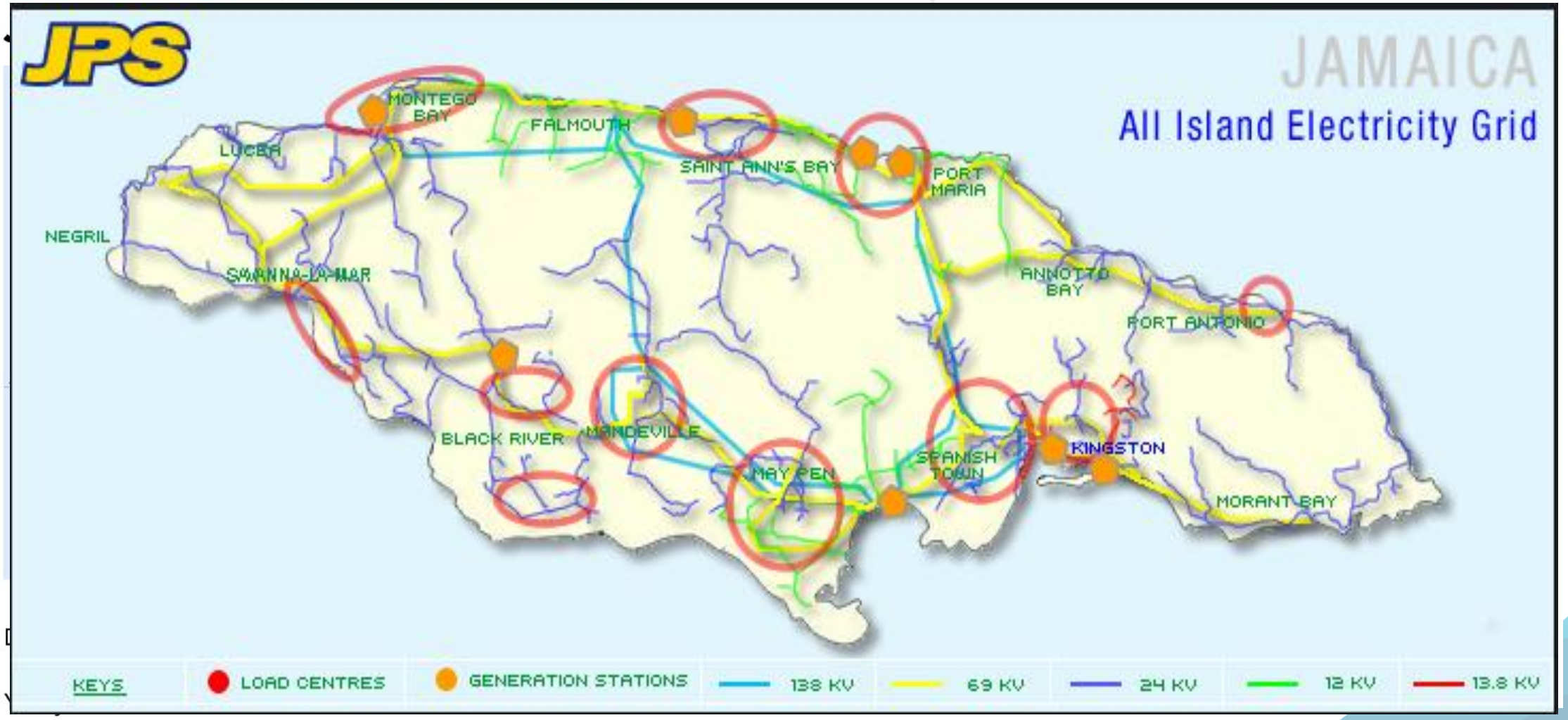
SOLAR RESOURCE MAP

GLOBAL HORIZONTAL IRRADIATION



Implications for the grid operator for Installation and Maintenance of solar PV system

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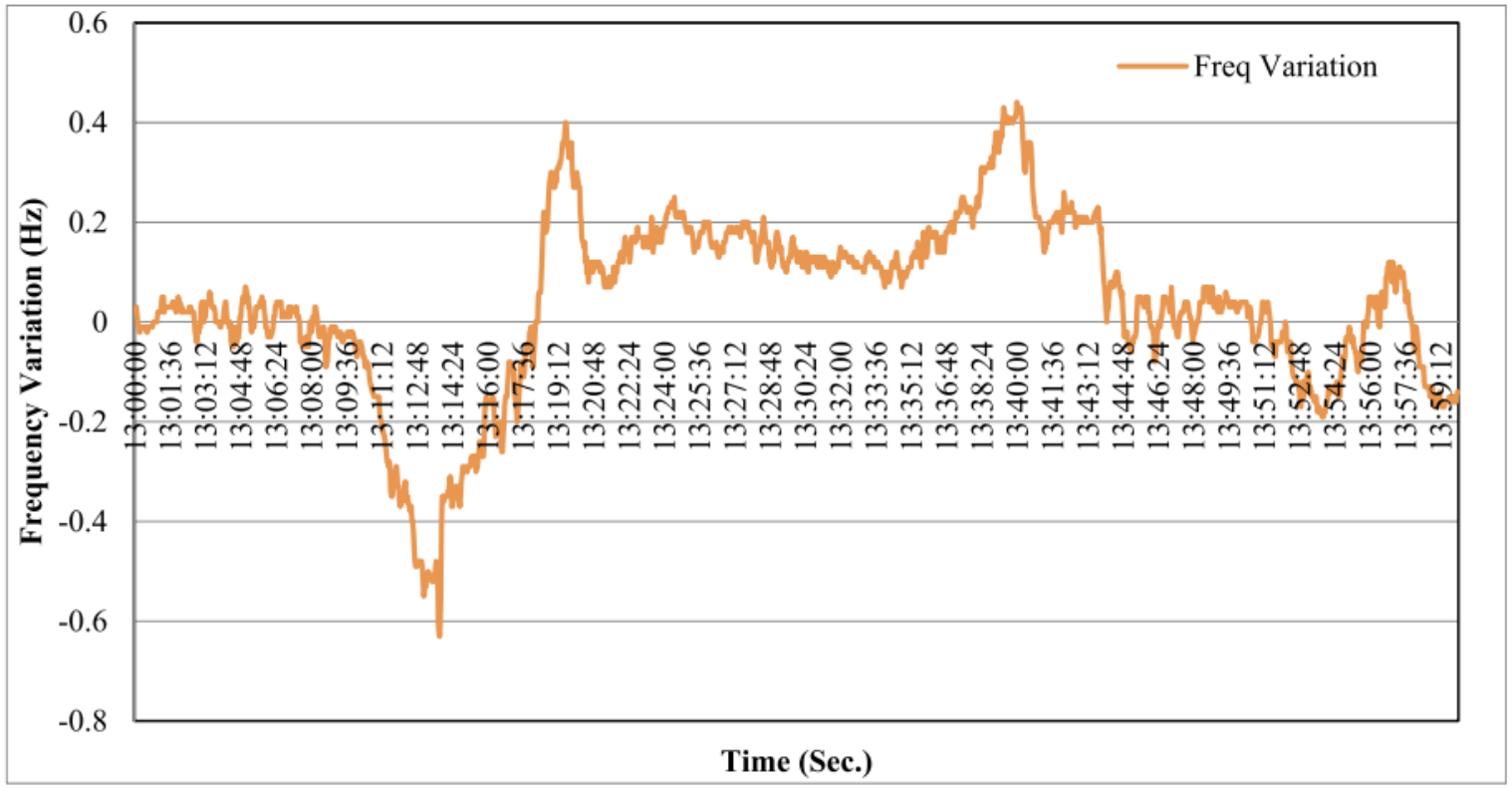

Through the further integration of solar power into the national electrical grid of Jamaica, JPS has experienced power quality and grid stability issues with the level of REs.

Such issues became evident in the area of frequency control which in some cases resulted in the system frequency falling outside of the steady-state operating limits.

Low operating frequencies occasionally resulted in the generators operating outside of their design-operating limits – leading to cumulative damage to the turbine blades and unintended under frequency load shedding.

Implications for the grid operator for Installation and Maintenance of solar PV system

Jamaica's Hybrid Energy Storage

Hybrid Energy Storage Solution – first of its kind in the Caribbean (US$ 21.3 million)

WHY?

Power readily available in the event that solar renewable systems suddenly lose power due to cloud cover, or other interruptions.

Project Specifics

The project involves constructing a 24.5 MW facility which will be a combination of low-speed flywheels and containerised lithium-ion batteries.

What else can aid the electrical grid?
Let's think about the impact of increasing small-scale PV installations across households.

THE END

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