Southern Exposure: an overview of PV/Diesel in Korea, Malaysia and Australia

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Alaskan Center for Energy and Power

March 2015 Abstract

A summary of some efforts in the PV/Diesel/Battery area including solar forecasting. This is a meta talk which is intended to mostly lead to other material (nothing original is presented by the humble author).





Overview of PV/Diesel/Battery work in:

- 1. Korea
- 2. Australia
- 3. Malaysia
- 4. Sky Cameras and Solar Forecasting





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"Remember that every view, is based on where you are looking from" – Uncle Phil





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Projects larger than 26M\$:

- ► AGL Solar Project 166M\$
- Australian Solar Thermal Research Initiative 35M\$
- Australia-US Institute for Advanced Photovoltaics 33M\$
- Cooper Basin Enhanced Geothermal Systems Heat/Power 59M\$
- Kogan Creek Solar Boost project 34M\$
- ► Moree Solar Farm 101M\$
- ► NT SETuP Program 27M\$ (or 55M\$ total project)_



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- Single 1MW PV/Diesel/Battery system running diesel off (or 200% penetration in Alaskan) with an intended fuel saving of around 50%.
- ▶ Aiming to change both the organisation and the technology.





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- Sky Camera Forecasting (now casting)
- ► Demand Management using Saturn South kit (see Tim Warren).





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Main point to note is that: $35 \times \text{anything}$ is a lot, $35 \times 2\text{w}$ for commissioning means a few years work.



Contact: Andrew Gray

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- ► LEONICS (www.leonics.com)





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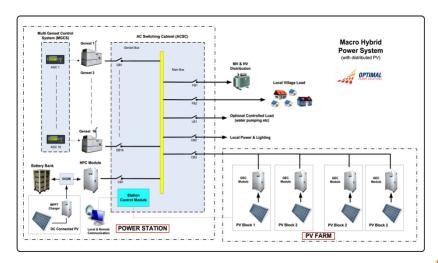
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- ► Optimal Power Solutions (www.optimal-power-solutions.com)
- ► LEONICS (www.leonics.com)
- Others...





Minigrid







KEPCO Gasado Island

- ▶ Population of 286, in southern South Korea.
- ► Load: 61..95..173 kW.
- ► Aim: 99% Renewable Energy, mixed PV, battery, diesel storage.
- ► Running since last year.





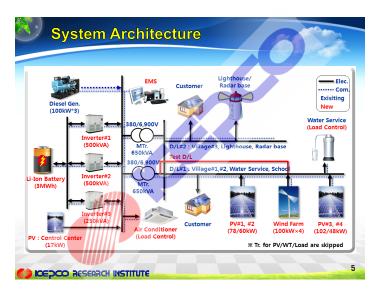
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- KEPCO Korean Electric Power Company (largest utility in S. Korea).
- Contact/Author: Wookyu Chae wkchae@kepco.co.kr who kindly provided the next few slides.
- 3. The complete presentation is available as well and is quite interesting.





Single Line Diagram







Equipment







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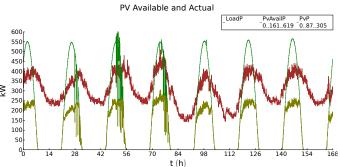
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- ► Researchers: UCSD, NUS, CSIRO, ANU,...
- ► And a few commercial suppliers: Fulcrum 3D, Pixel Sciences, Reuniwatt....





PV for 1 week

There are good days and bad days:

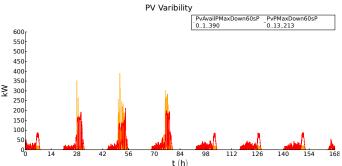






PV variation for 1 week

And a good days variation is less than spinning reserve:







- ► Assume 3 x 320kW generators with a minimum loading of 50% (160kW).
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SkyCam	Load kW	Gens	Gen kW	Pv kW	L/h	L/kWh
No	350	2	320	30	90	0.26
Yes	350	1	160	190	45	0.13
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SkyCam Procurement

Yet another model for procurement (for us at least: 1).

▶ 3 x Trial Systems at a target price of 15k\$.for 3..6 months.





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SkyCam Procurement

Yet another model for procurement (for us at least:1).

- ▶ 3 x Trial Systems at a target price of 15k\$.for 3..6 months.
- ▶ Everyone must provide a price for a:
 - ► Trial system for 12 months.
 - ▶ Rollout out of from 1..10 units over the next 2 years.
- ► The plan is for the trial results and methods to be made public (anyone interested).

"Amateur project managers talk about strategy, experts talk about procurement (or logistics)" – Unknown



¹Thanks to Tim Powe

Fulcrum 3D



CloudCAM

- fish-eye camera with 360/180deg sky coverage
- low cost cloud detection
- sampling rate >1s
 - typical sampling rate 5s
- system comes with integrated power supply, communications and weather sensors (pyranometer, temperature, pressure, humidity, rainfall...)



CloudCAM installed at Uterne Solar Power Station, NT

available now

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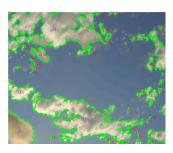




Fulcrum 3D



cloud identification



- each cloud is separately identified
 - individual cloud tracking and prediction
 - cloud growth / shrinkage
 - cloud disappearance & reemergence where multi-layered clouds exist
- individual cloud characterisation
 - determine its individual solar "blocking factor"
 - predict the magnitude of impact when it passes the sun

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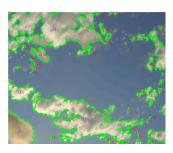




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Pixel Science









Who are we:

- Previously developed defence software for UAVs
- Now reformed a force for good in the world!



SolarTrack System 1st generation cloud event detection:

- Developed based on very low resolution, low frequency images, but performs very well
- Very low incidence of missed PV drop events, and 0 missed events over 87 days data at lower sensitivity level
- Simulated Diesel / Solar grid system demonstrates diesel savings between 71% and 89% of theoretical maximum



Now: SolarTrack System 2nd generation:

- Much improved imagery, better detection performance
- IP65 Production system hardware and live operation
- Relatively low cost for rapid return on investment





Australia Korea Solar Nowcasting Malaysia and Indonesia Lessons Learnt

Reuniwatt

Reuniwatt's solar power forecasting solution

A technology mix

To guarantee the **best accuracy** on every temporal horizon (from one minute to several days ahead) and on every spatial scale (from one production site to a whole region), Reuniwatt hybridizes and analyses different data



Cloud detection from ground images, shadow proiection



Satellite image treatment to measure cloud motions



wind forecasts on a alobal scale

Reuniwatt -





Reuniwatt

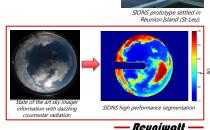
SIONS: Sky Imager for the Observation of cloudiNesS

Hardware presentation

- Images of the entire cloud cover thanks to a hemispherical mirror
- Data acquisition (transmission through GPRS, Wi-Fi, ...)
- Temperature and humidity sensors

An operational method

The patented algorithms detection enabled by the SIONS gives a thorough estimation of the cloud cover, including altitude and cloud optical thickness, on the entire cloud ceiling with a perfect non-dazzling circumsolar radiation.



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"Economics are the method; the object is to change the heart and soul" – Thatcher



