

Potential PV Penetration Study in the Western Cape

Work Package 1: PV Uptake Report

Workshop



CENTRE FOR RENEWABLE AND SUSTAINABLE ENERGY STUDIES

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Date: 19 February 2019

Place: Stellenbosch



RENEWABLE & SUSTAINABLE
ENERGY STUDIES



The Centre for Renewable and Sustainable Energy Studies was established in 2007 to facilitate and stimulate activities in renewable energy study and research at Stellenbosch University.

The Department of Science and Technology has been funding the Renewable and Sustainable Energy (RSE) Hub at Stellenbosch University since its establishment in August 2006. The aims of the RSE Hub are to develop human capital, deepen knowledge, and stimulate innovation and enterprise in the field of RSE. Currently the DST is still sponsoring the work of the Centre with an annual grant administered by the National Research Foundation.

Stellenbosch University was designated as the Specialisation Centre in Renewable Energy Technology as part of the Eskom Power Plant Engineering Institute (EPPEI). The research and teaching activities sponsored by Eskom focus on concentrating solar power (CSP) and wind energy and also includes the Eskom Chair in Concentrating Solar Power.

The Sasol Technology group sponsored the new facilities for the Centre for Renewable and Sustainable Energy Studies as well as the work and facilities of the Solar Thermal Energy Research Group at Stellenbosch University.



Content

- Introduction
- Literature Review
- Methodology
- Case Studies

Introduction

Deliverables

- **PV Uptake Report** – methodology to determine the potential uptake areas in the WC
- **Network Integration Report** – representative networks and the likely stability and design issues that could be experience with high PV in the WC
- **Emerging Technology Report** – emerging technology solutions that could remove the barriers for potential high PV in the WC

Introduction

PV Uptake Report - Objectives

- Review current status of rooftop PV in SA compared to countries that experienced high PV uptake in the past
- Present methodology of identifying potential uptake areas
- Identify potential PV uptake areas in the WC
- Identify the installable PV of selected case studies in the WC

Literature Review

International Experience

- Considered countries: China, Germany, Japan, Italy, United States and Australia
- Rooftop PV has been fueled by policies, financial incentives, metering arrangements and grid connection regulations
- The FIT and direct subsidy are used usually when specific renewable targets had to be met
- Self-consumption or net-metering scheme is used to encourage generation capacity dependent on captive load

Literature Review

Status of Rooftop PV in South Africa

- White papers, plans, policies, acts and regulations that are relevant to rooftop PV were reviewed
- It is evident that SA is committed to building the low-carbon economy and diversifying the energy sector by promoting RE
- Regulations and incentives have not been made to facilitate and encourage rooftop PV

Literature Review

Status of Rooftop PV in South Africa

- Rooftop PV market in SA relies on property owners with financial means and available rooftop space to install PV systems on their premises
- Sometimes without the knowledge of the distributors
- Only limited by the roof space available and personal financial constraints

Literature Review

Question

- If the rooftop PV installations continue, which areas are expected to have a high penetration of rooftop PV?

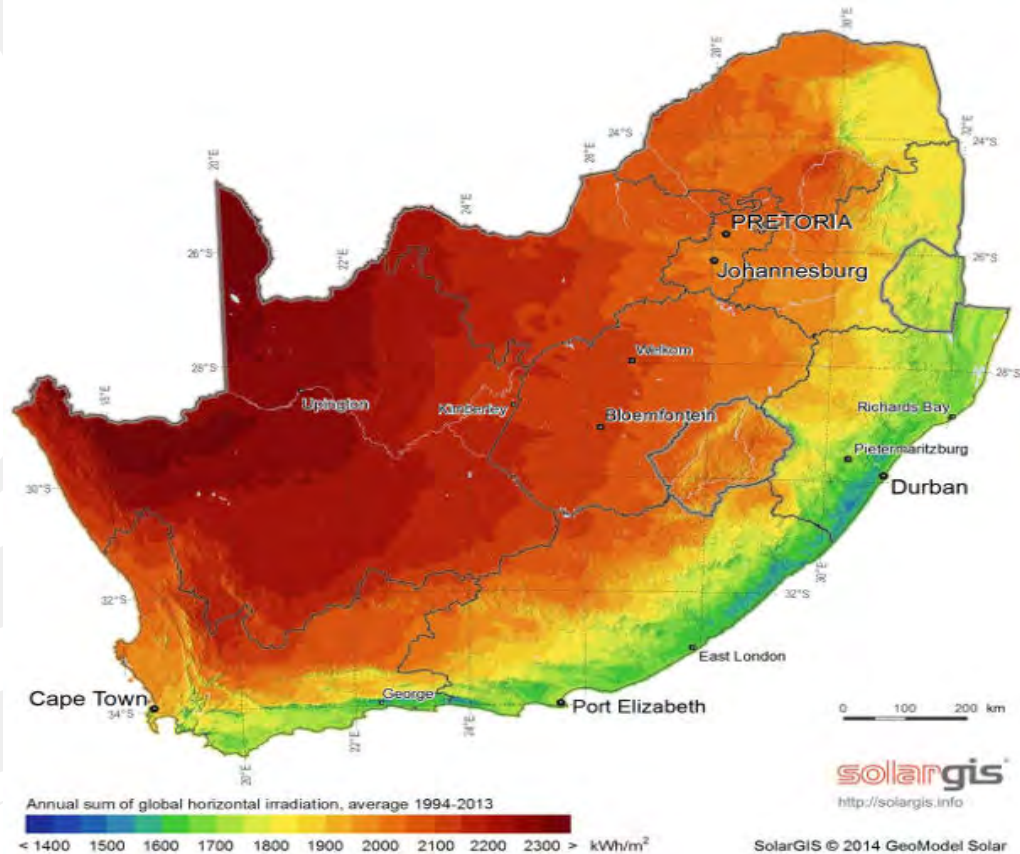
Methodology

Multi-Criteria Decision Analysis (MCDA)

- Set the goal/ define the problem
- Determine the criteria (factors/ constraints)
- Normalise the factors/ criterion
- Determine the weight of each factor
- Aggregate the criteria
- Validate the result

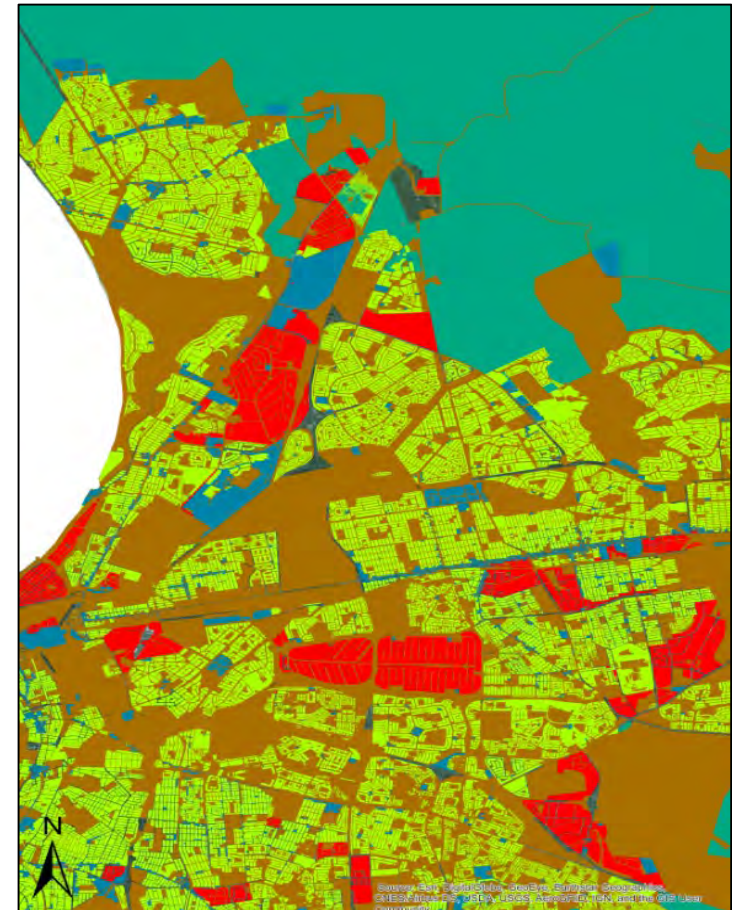
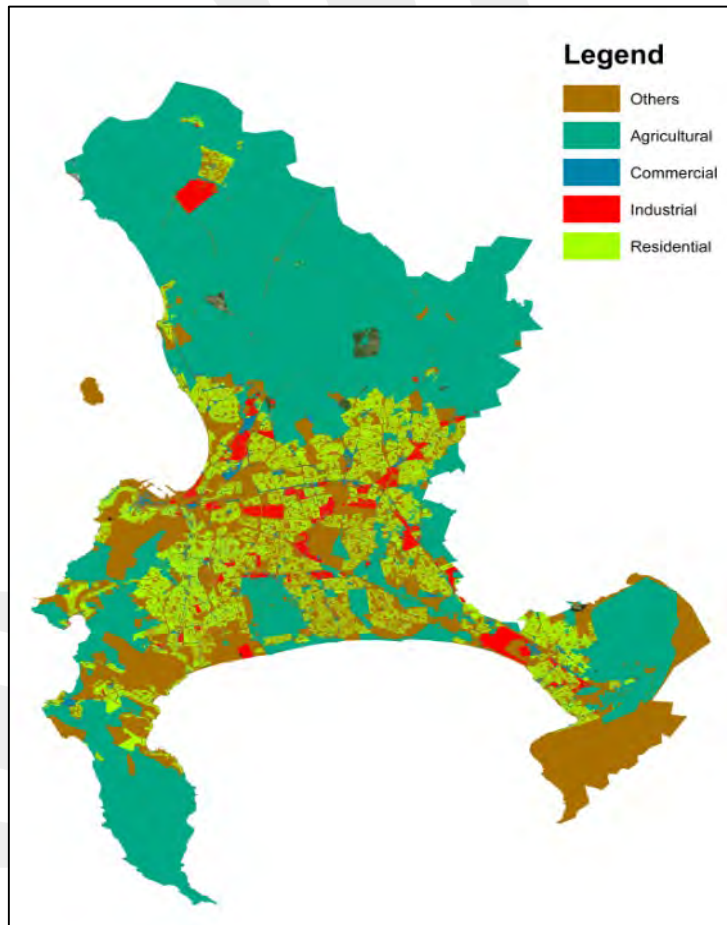
Methodology

Criteria 1: Available Solar Resources



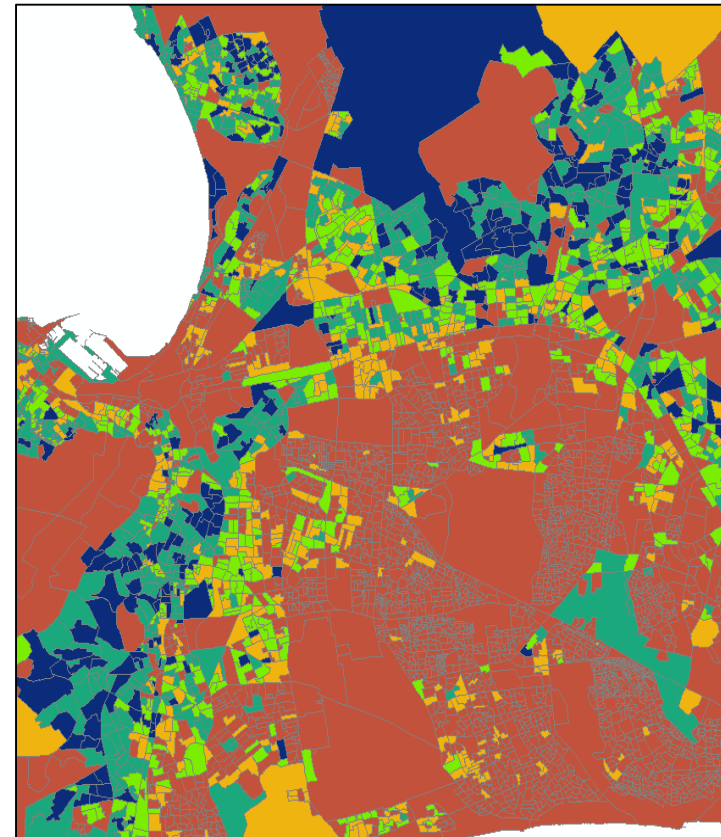
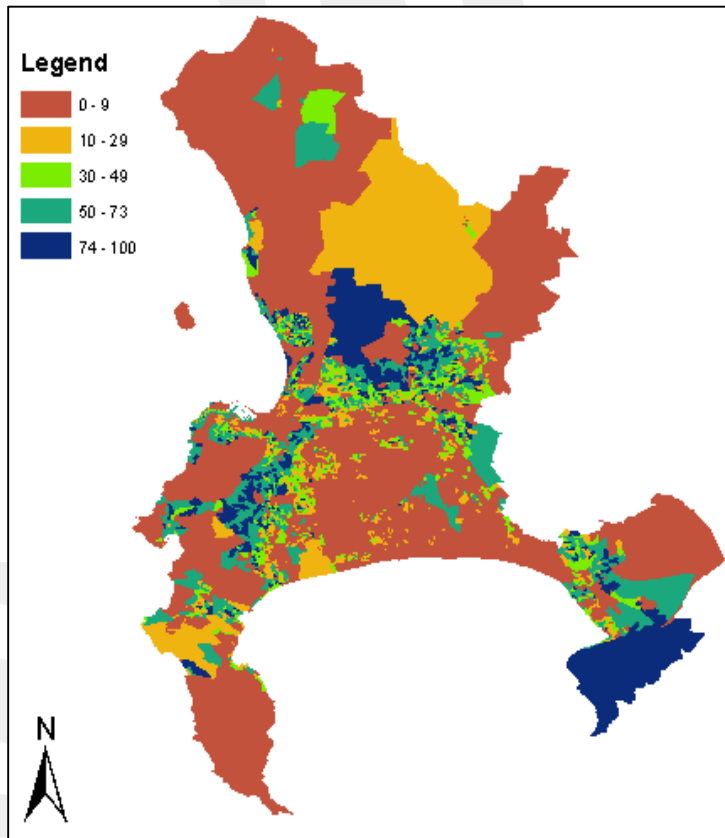
Methodology

Criteria 2: Land Use



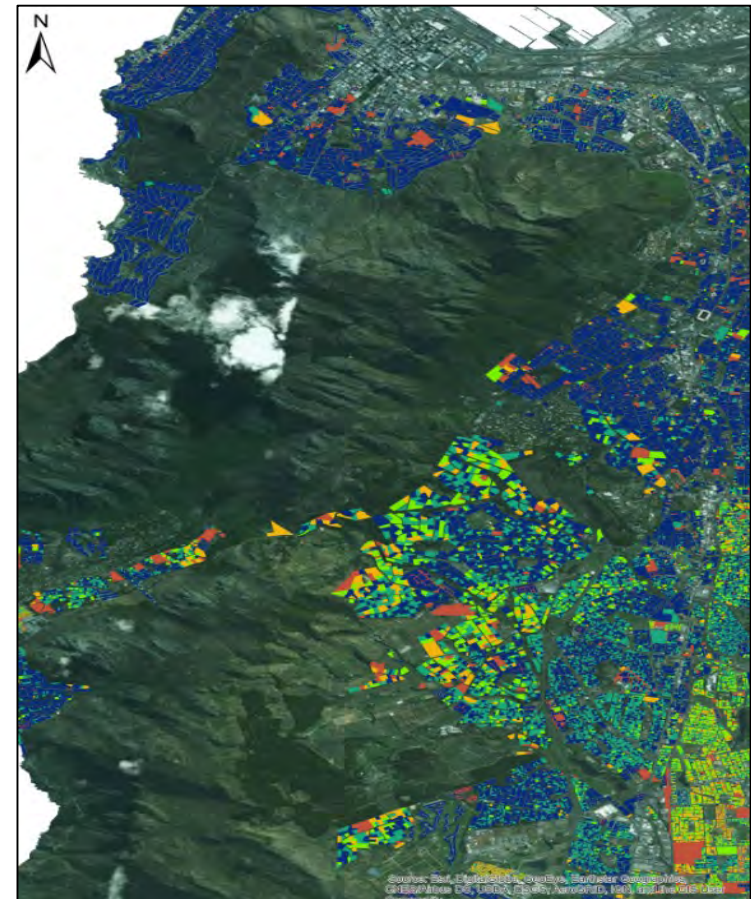
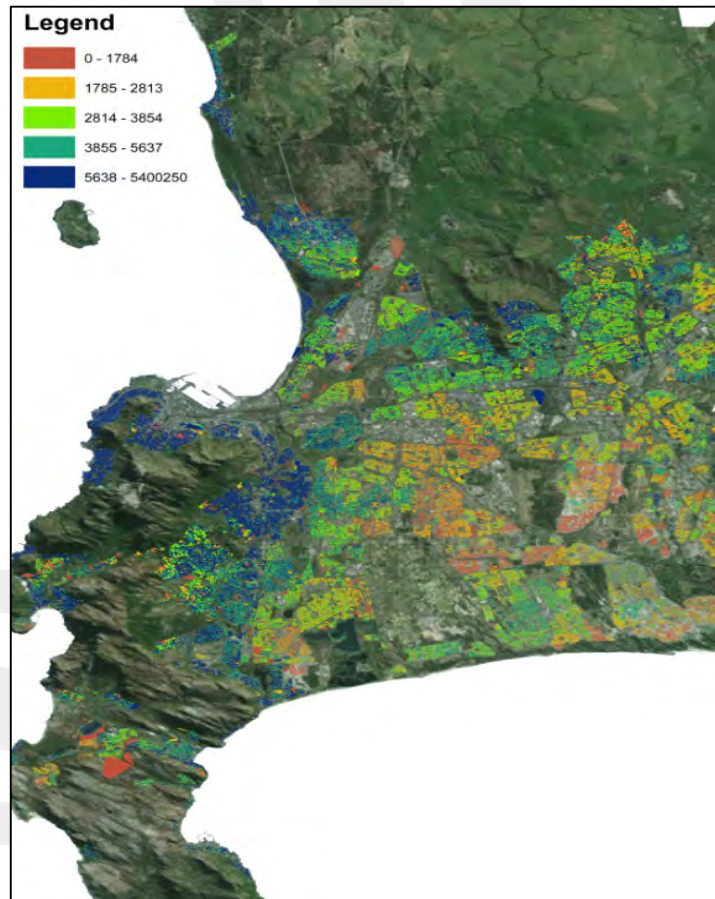
Methodology

Criteria 3: Living Standards Measure (LSM)



Methodology

Criteria 4: Value of Property Per Square Metre



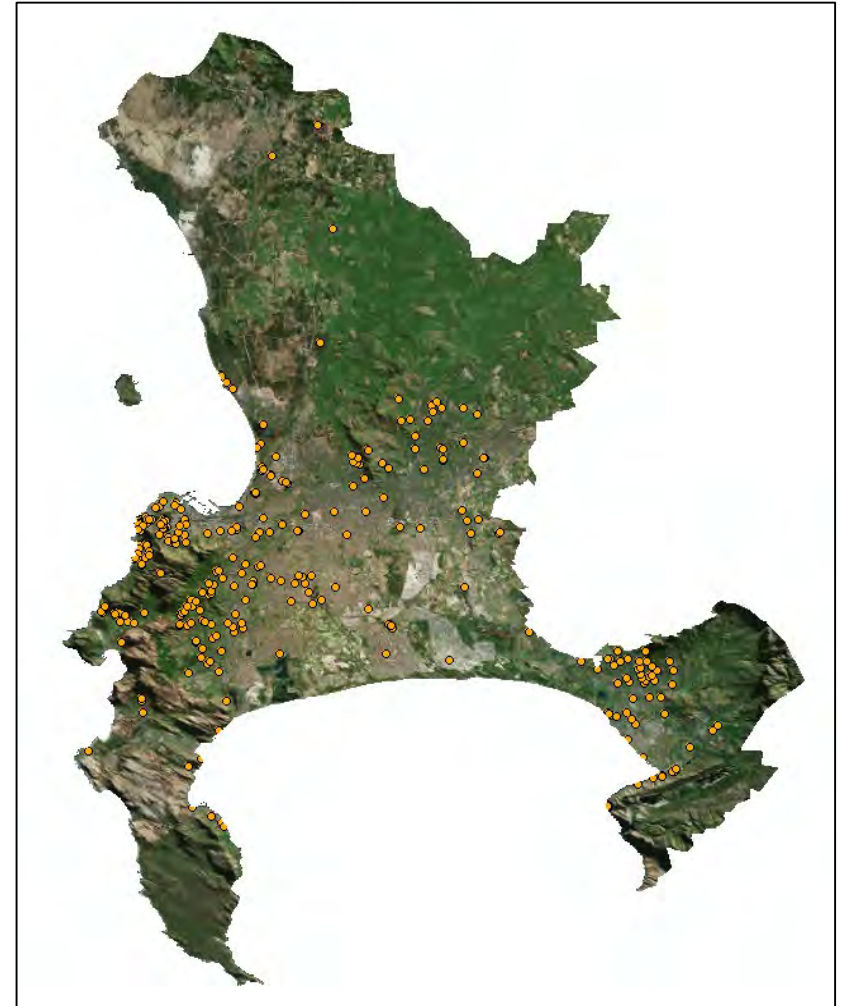
Methodology

Normalising, weighting and aggregating criteria

- Criteria are normalised to a common scale (1 to 10)
- Weighting involves determining the percentage weight of each criterion relative to its importance in determining the likely PV uptake areas
- Aggregating: *PV Uptake Score* = $\sum(\text{Criterion Score} \times \text{Assigned Weight})$

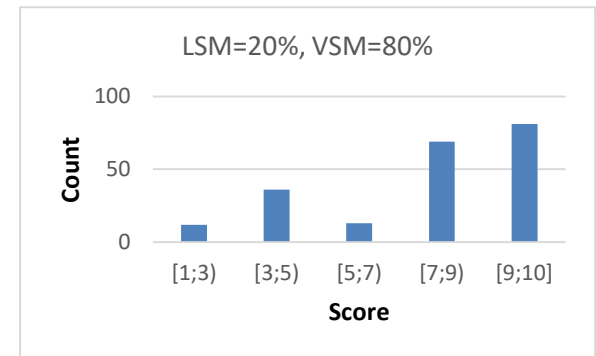
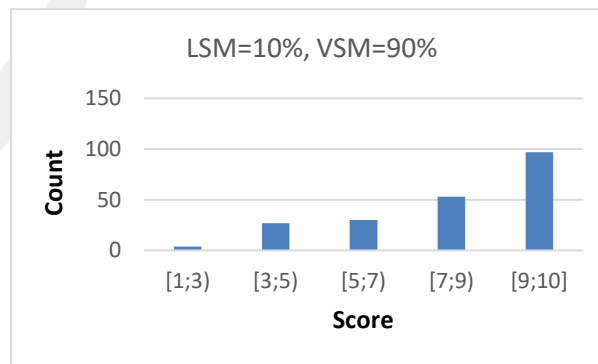
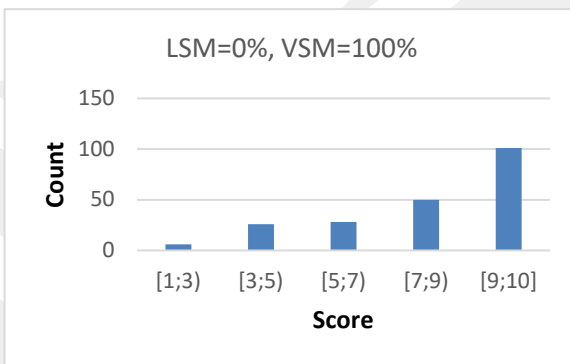
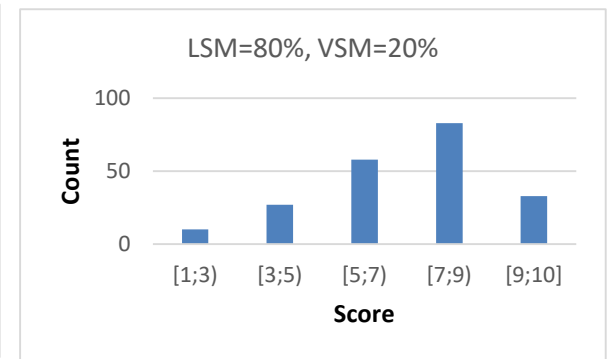
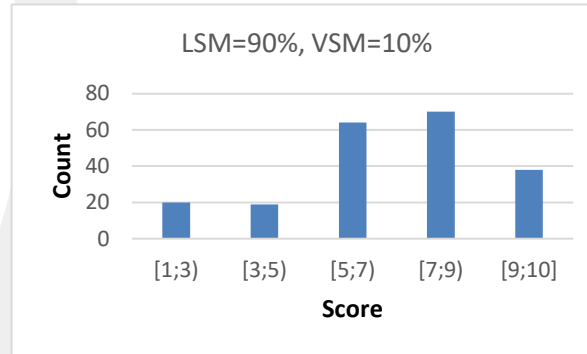
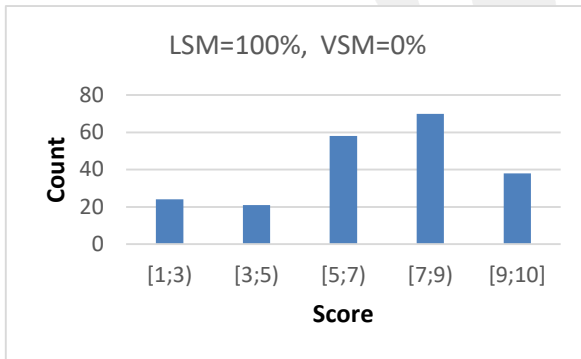
Methodology

- Results Validation
- Total installations: 340
- Residential installations: 211
- Assign PV uptake score to the existing PV installations
- Count PV installations located in high uptake areas (according to the proposed methodology)



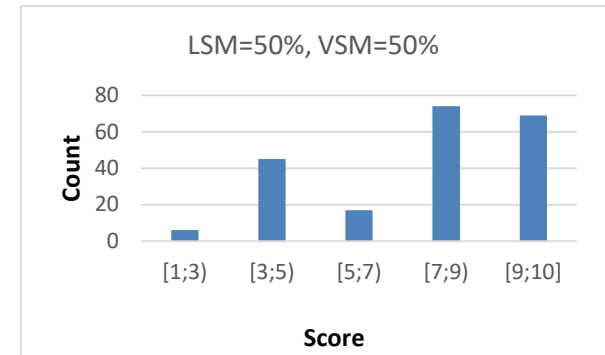
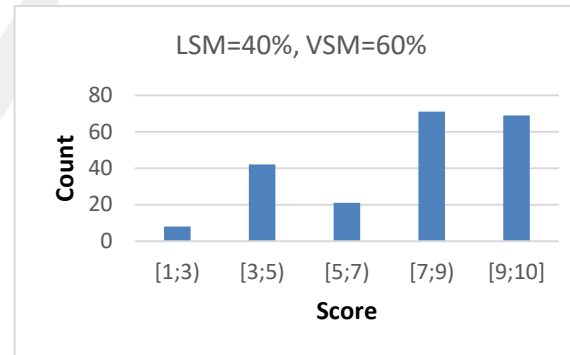
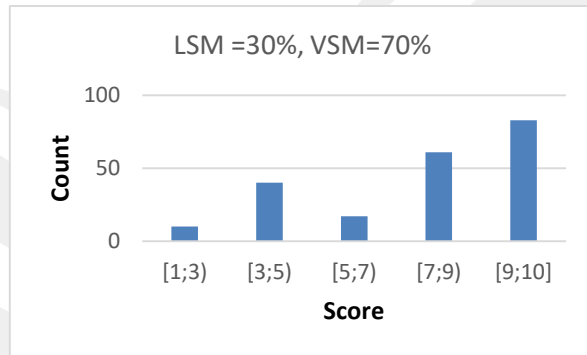
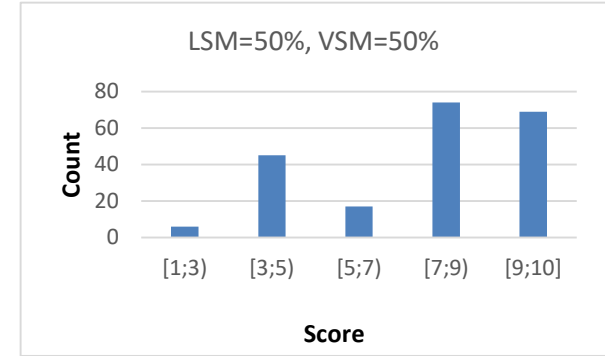
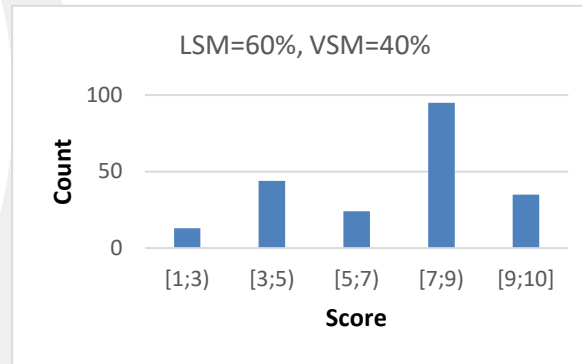
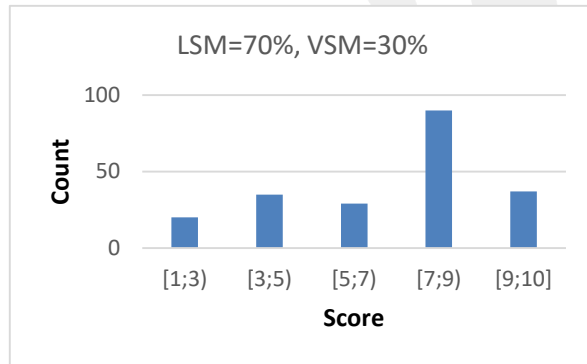
Methodology

Results Validation



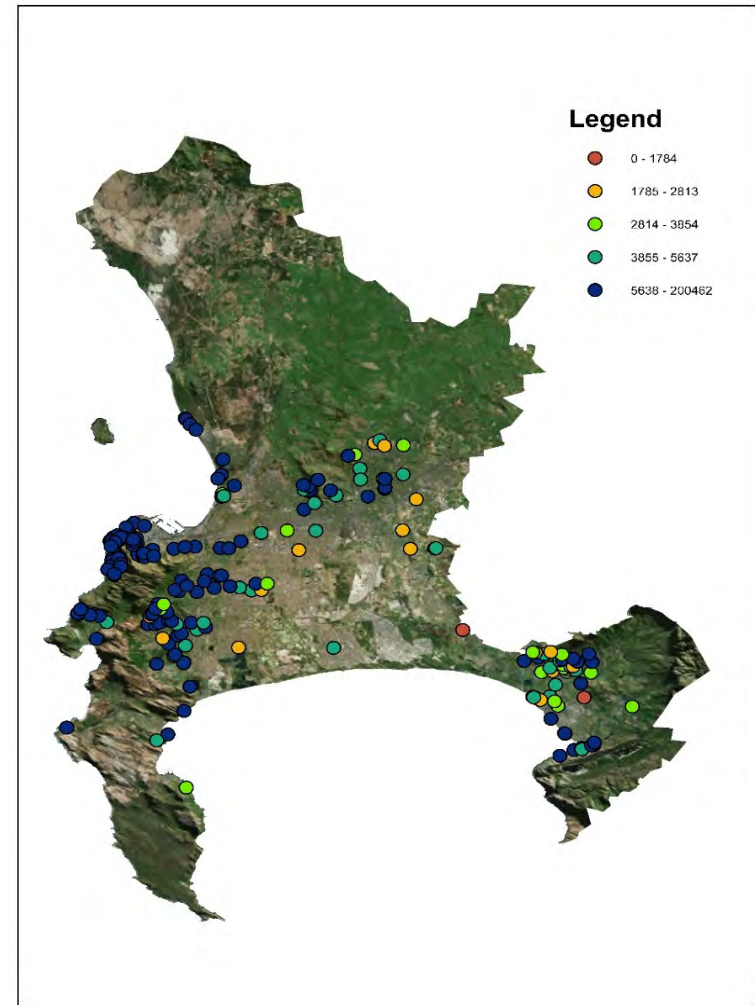
Methodology

Results Validation



Methodology

- Results Validation
- High correlation when the LSM data is not considered
- 150/211 or 71% of the sample PV installations falls within two upper classes



Case Studies

Questions

- Given the available roof space, how much rooftop PV can be installed in the WC?
- Will the NRS 097-2-3 criteria be violated before all roof space is covered in PV?
- Is there a significant difference in areas according to the electricity users (Industrial, commercial, residential)

Case Studies

Methodology

- Residential (Llandudno), Industrial (Montague Gardens) and Commercial (Century City)
- Google Earth, ArcGIS 10.5, PVplanner and Pvsyst
- Zero degrees tilt angle assumed for flat roofs
- Test PV array

Parameter	Value
PV modules	Yingli Solar 290 Wp (YL290CG2530F-1)
Inverter	Sunny Boy 3.68 kW (SB 3600 TL-21)
Number of PV modules	13
Number of inverters	1
Capacity	3.78 kW _p
Module area	25.35m ²



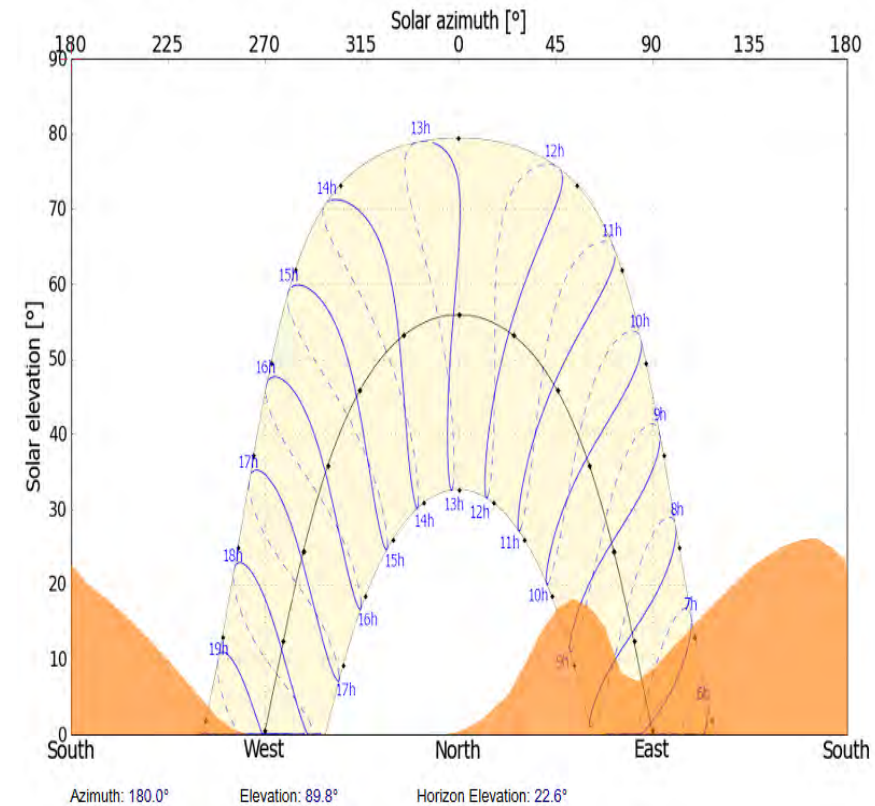
Case Studies

- Llandudno



Case Studies

- Llandudno



Case Studies

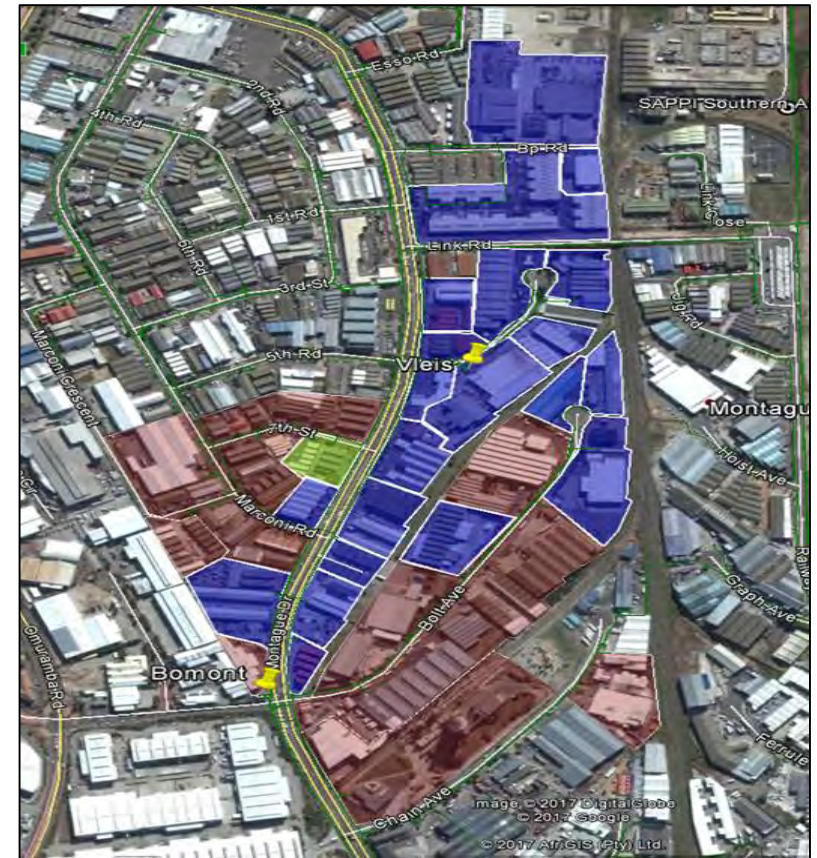
Llandudno

Direction	Area (m ²)	Percentage (%)	Installable capacity (kW _p)	Predicted energy production (MWh/year)
North	5 703.1	15	1012.5	1638.9
North East	2 433.1	6.4	432.0	660.7
North West	5 349.1	14.1	949.7	1490.6
East	2 386.9	6.3	423.8	575.6
West	5 039.6	13.3	894.7	1255.3
South West	3 931.6	10.4	698.0	838.1
Flat	13 090.6	34.5	2324.1	3396.1
Total	37 934	100	6734.8	9855.2

- Peak demand: **1.3 MVA**
- NRS 097-2-3 maximum capacity: **0.2 MWp**
- Installable rooftop PV: **6.7 MWp**
- Average annual generation potential: **9.9 GWh**

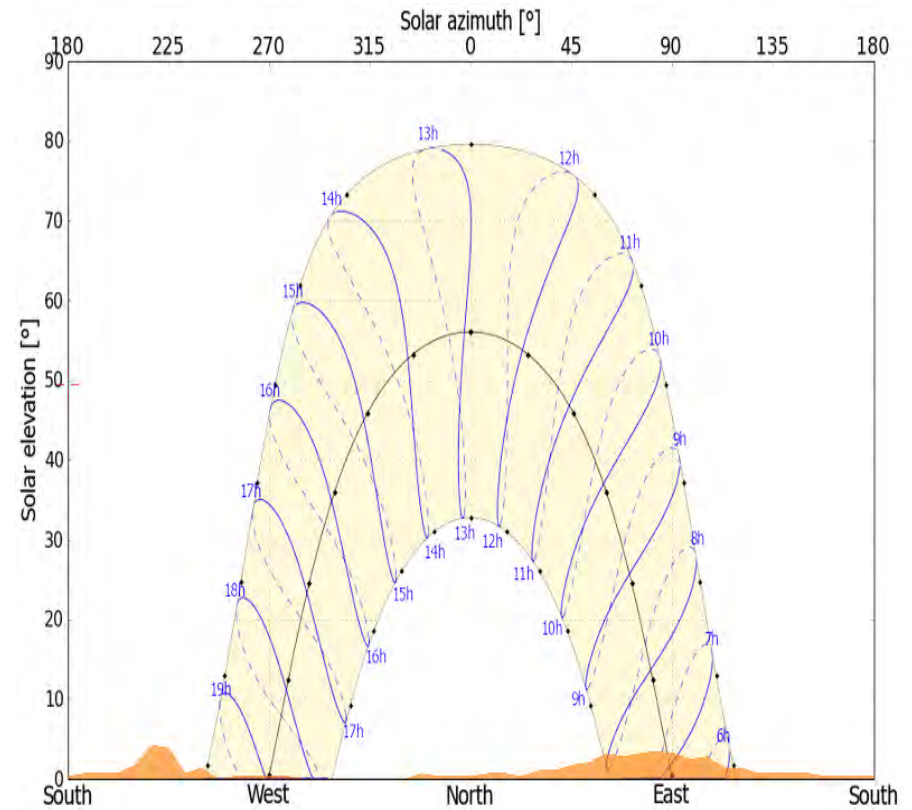
Case Studies

- Montague Gardens



Case Studies

- Montague Gardens



Case Studies

Montague Gardens

Direction	Area (m ²)	Percentage (%)	Installable capacity (kW)	Predicted energy production (MWh/year)
North	32467.8	23.1	4827.8	8343.3
North East	20322.7	14.5	3021.8	5017.9
North West	22469.2	16.0	3341.1	5506.7
East	15006.7	10.7	2231.4	3287.5
West	16986.7	12.1	2525.8	3684.2
Flat	33318.8	23.7	4954.3	7570.3
Total	140571.9	100.00	20902.35	33409.9

- Peak demand: **6.5 MVA**
- NRS 097-2-3 maximum capacity: **0.98 MWp**
- Installable rooftop PV: **20.9 MWp**
- Average annual generation potential: **33.4 GWh**

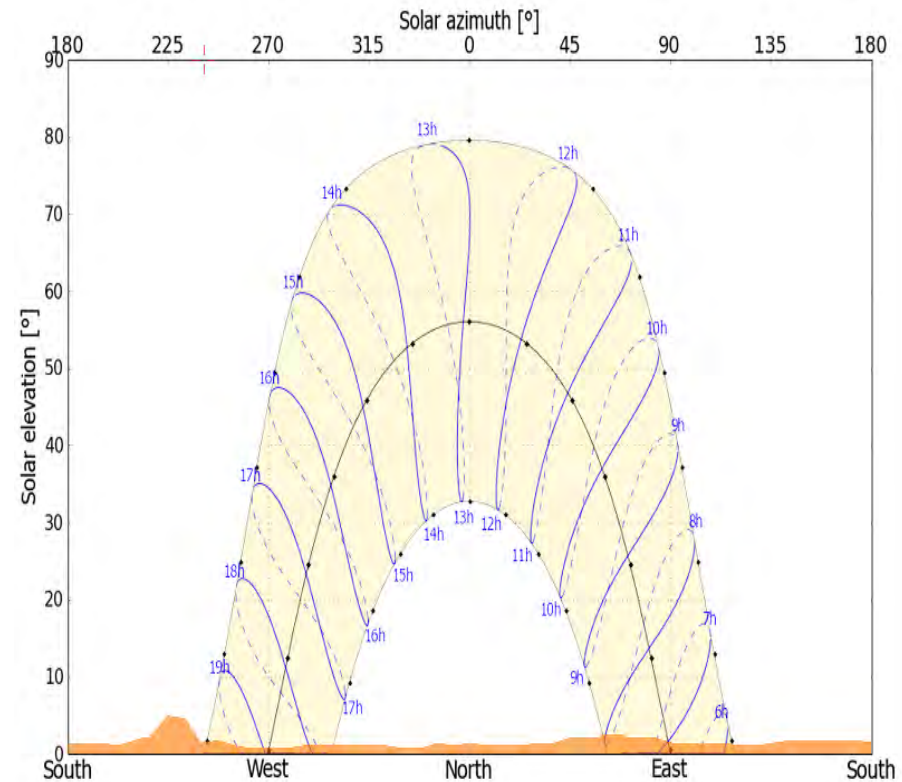
Case Studies

- Century City



Case Studies

- Century City



Case Studies

Century City

Direction	Area (m ²)	Percentage (%)	Installable capacity (kW _p)	Predicted energy production (MWh/year)
North	6354.9	12.5	944.9	1632.7
North East	8004.4	15.7	1190.2	1978.1
North West	11548.2	22.6	1717.2	2828.1
East	2814.1	5.5	418.4	6175.3
West	5476.0	10.7	814.3	1185.0
Flat	20814.5	30.3	3095.5	4730.0
South West	1353.4	2.7	201.2	2476.3
Total	56365.5	100.0	8382.6	13220.1

- Peak demand: **12.9 MVA**
- NRS 097-2-3 maximum capacity: **1.95 MWp**
- Installable rooftop PV capacity: **8.4 MWp**
- Average annual generation potential: **13.2 GWh**

Summary

Area	Peak demand (MVA)	NRS 097-2-3 maximum capacity (MW _p)	Installable rooftop PV capacity (kW _p)	Predicted energy production (MWh/year)
Llandudno	1.3	0.19	6.7	9.9
Montague Gardens	6.5	0.98	20.9	33.4
Century City	12.9	1.95	8.4	13.2

Thank you!

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