The financial impact of residential rooftop PV on local governments in South Africa

A case study into Stellenbosch Municipality

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Discussion: what should be the role of municipalities

Municipality's Concern

- South African municipalities serve historically as electricity distributors and many rely on electricity revenue.

- Around 30 percent of total revenue comes from electricity sales. In some cases it can go up to 70% percent of the total income (Tusan & MacDonald 2014).The surplus is partly used to cross finance departments that run on losses. Rooftop PV forms a potential threat on this income from electricity sales as people's purchases diminish from municipality. Electricity is for many (larger) municipalities seen as the cash cow or the golden egg.

  - This does not count for every municipality, there are also many (mainly small and rural) municipalities that are in debt and owe Eskom money

Research question

- What will be the **impact** on Stellenbosch Municipality's **electricity revenue** if households in high-user suburbs are occupying the maximum capacity for EG according to NRS standard to feedback electricity produced by residential **rooftop PV** to the grid?

Methodology

- Single case study
- Mixed method but quantative analyses is dominant
- - secondary data from Stellenbosch Municipality is being used
- An extreme case scenario has been used to project a possible future impact.

Research Process & Tools

- **Identification high user suburbs**
- Potential investment areas for rooftop PV

- **Electricity Grid Map**
- Analyses of maximum grid capacity in kW for channeling EG back to electricity grid based on NRS 097-2-series

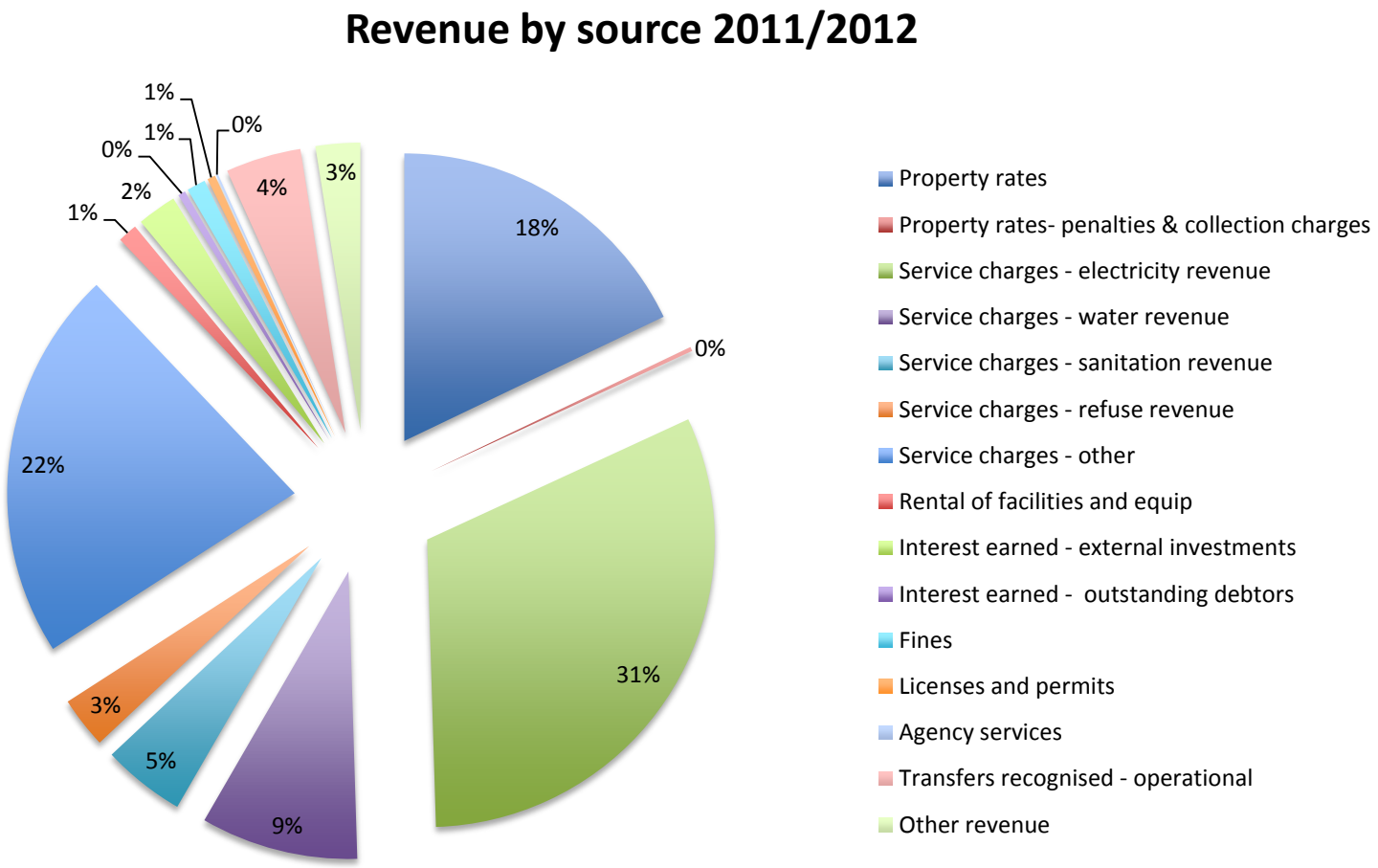
- **Record solar PV system**
- Hourly solar PV generation Profile for a municipal financial year 2013/2014

- **Municipality's electricity profile**
- Zimele technology: hourly electricity output Stellenbsch Main and Cloetesville substation

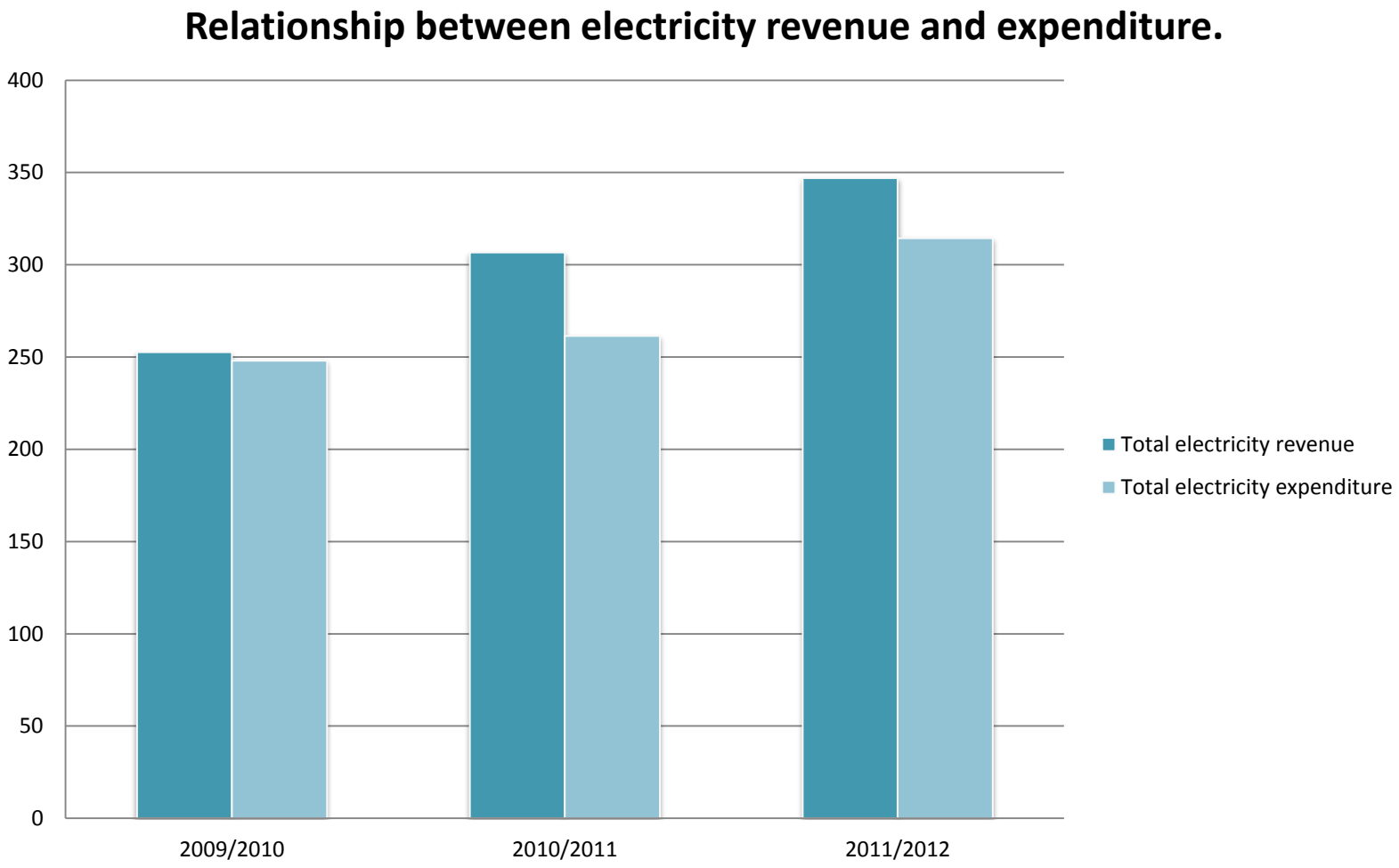
Contextualising research

- Provides context
- Assesses municipality’s argument

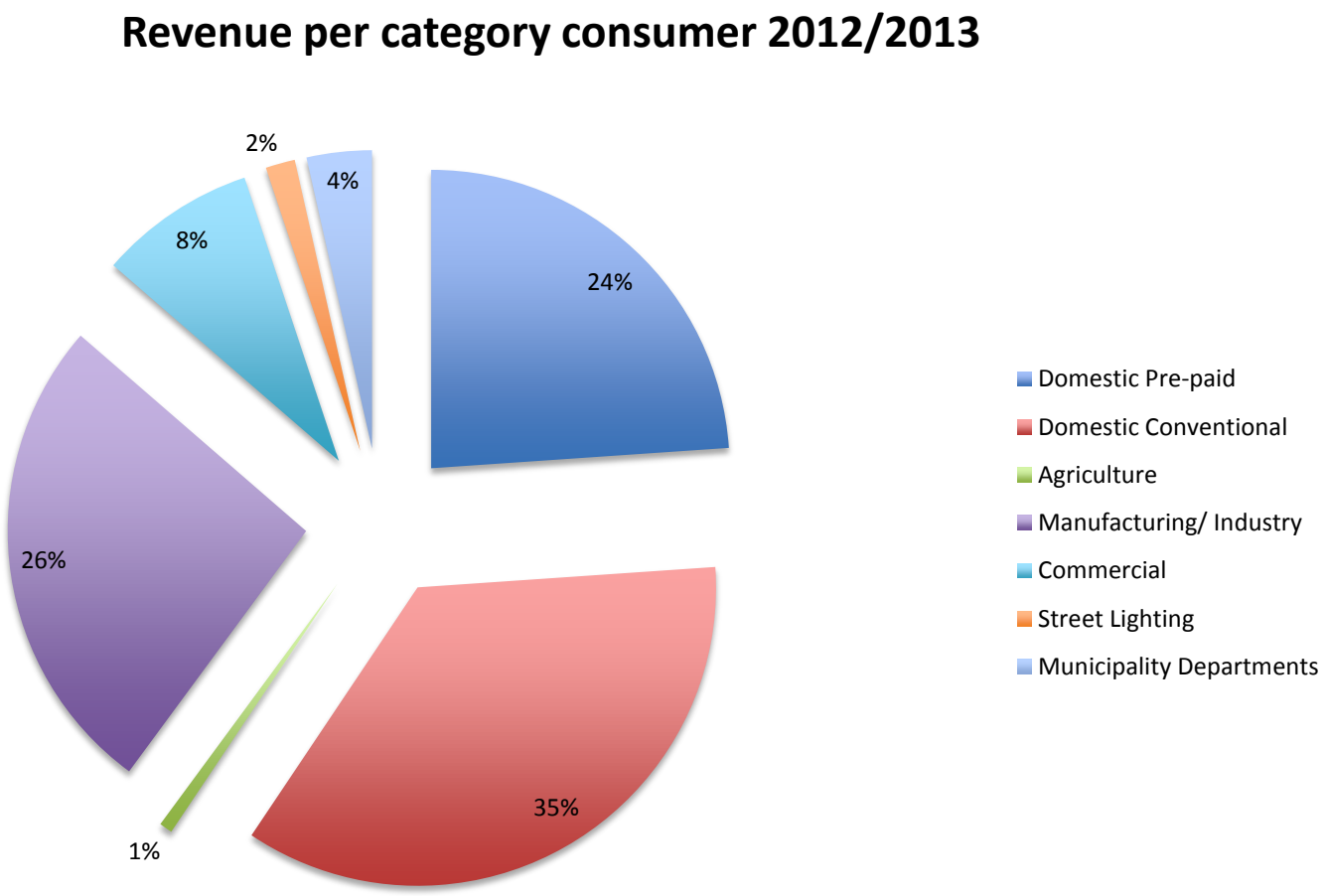
Assessment of Municipality's argument



Assessment of Municipality's argument



Why focus on residential sector?



Why focus on residential sector?

- 60% of the electricity revenue comes from the residential sector in Stellenbosch
- Residential sector responsible for most fluctuations in load profile
- Add the most during peak hours
  - During peak hours electricity is more costly for municipality: municipality pays in certain circumstances (Winter) more to Eskom per unit than citizens pay per unit to the municipality

Identified High User Suburbs

Average electricity usage per suburb

- Highest user suburbs
- Uniepark 1130 (Pre-paid) 1105 (credit)
- Dalsig 960 (Pre-paid) 1050 (credit)

- With exceptional high users of over 10.000kWh a month

- Lowest user suburbs
- Kayamandi 156 (pre-paid) 420 (credit)
- Cloetesville 570 (Credit)

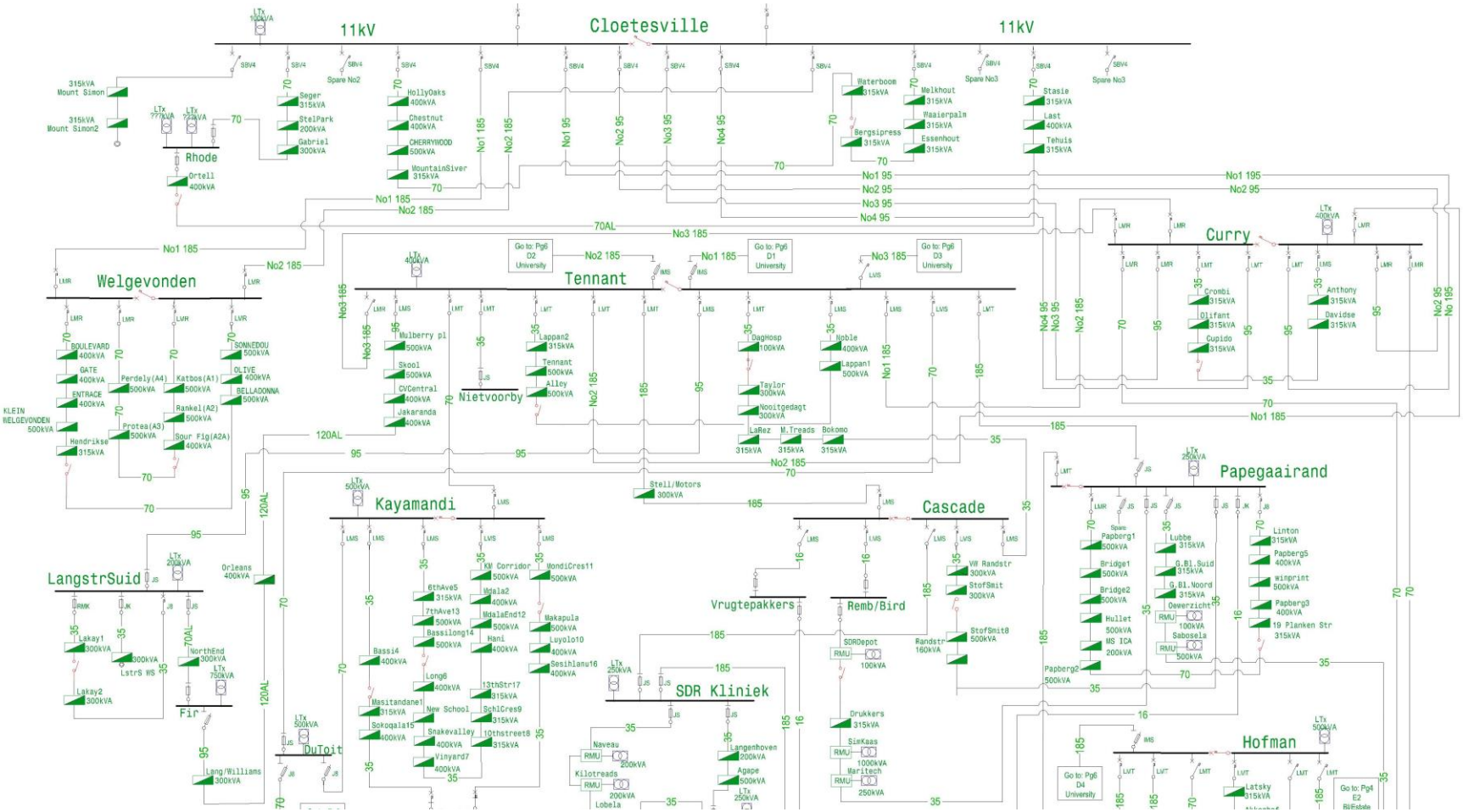
Analysis 1) Grid capacity for Embedded Generation

- **How much consumer-generated electricity can go onto the grid according to South African standards?**

- NRS 097-2-series

- Two steps taken:
- 1) From MV/LV Transformer
- 2) From MV feeder level

Analysis of grid capacity for receiving EG according to NRS 097-2-series



Conclusion Welgevonden

Conclusion			
Step 2 Max. Transformer	kVA	kVA (125% NMD)	kW PF=0,95
Total	5815,0	**1453,8**	**1381,1**
Step 3 Max. MV Feeder	kVA	kVA (115% NMD)	kW PF=0,95
	7656,0	**1148,4**	**1091,0**
Difference between totals	1841,0	**-305,4**	**-290,1**

Overall max Transformer

Substation	Area	Transformer kVA	kVA (25% NMD)	kW PF = 0,95
Jan Marais	Uniepark & Karindal	3925,0	981,3	932,2
Markotter	Dalsig & Brandwacht	4665,0	930,0	883,5
Golf Club	Paradyskloof & Die Boord	11415,0	2853,8	2711,1
Cloetesville	Welgevonden	5815,0	1453,8	1381,1
Main	Onder Papegaaiberg	4945,0	1236,3	1174,4
Total		30765,0	7455,0	7082,3

Overall max MV Feeder

Substation	Area	MV Feeder kVA	kVA (15% NMD)	kW PF=0,95
Jan Marais	Uniepark & Karindal	6578,0	986,7	937,4
Markotter	Dalsig & Brandwacht	11484,0	1722,6	1636,5
Golf Club	Paradyskloof & Die Boord	20328,0	3049,2	2896,7
Cloetesville	Welgevonden	7656,0	1148,4	1091,0
Main	Onder Papegaaiberg	8052,0	1207,8	1147,4
Total		54098,0	8114,7	7709,0

Sub-conclusion

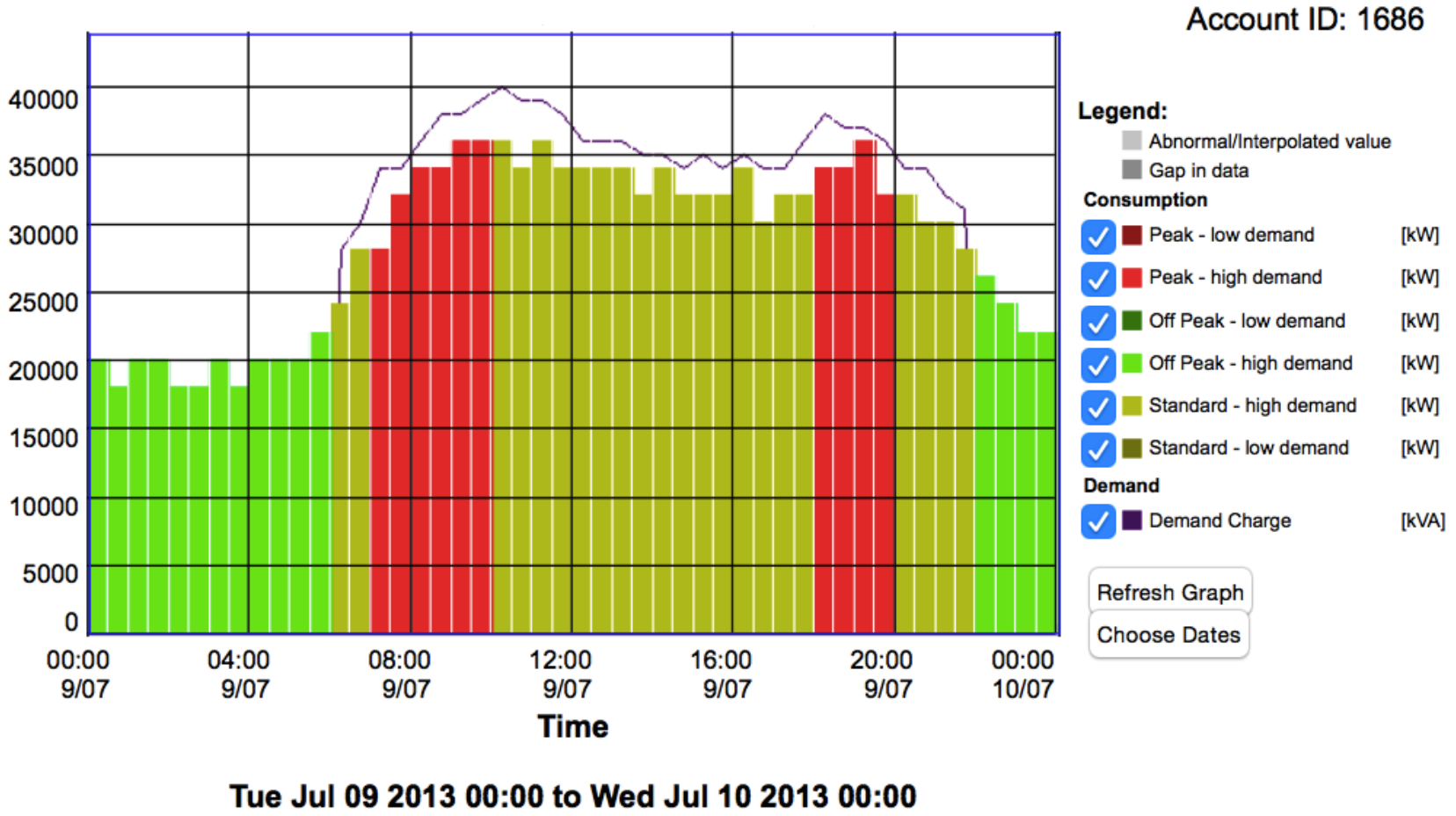
- Maximum EG that can be put back onto the grid is between 7 and 7,7 MW for the identified high user suburbs

- Safest approach is to take the lowest value as point of departure for further measurement

Analysis 2) Impact on load profile

- Impact in kW on electricity output profile of municipality for the identified high-user suburbs

Electricity load output profile Stellenbosch

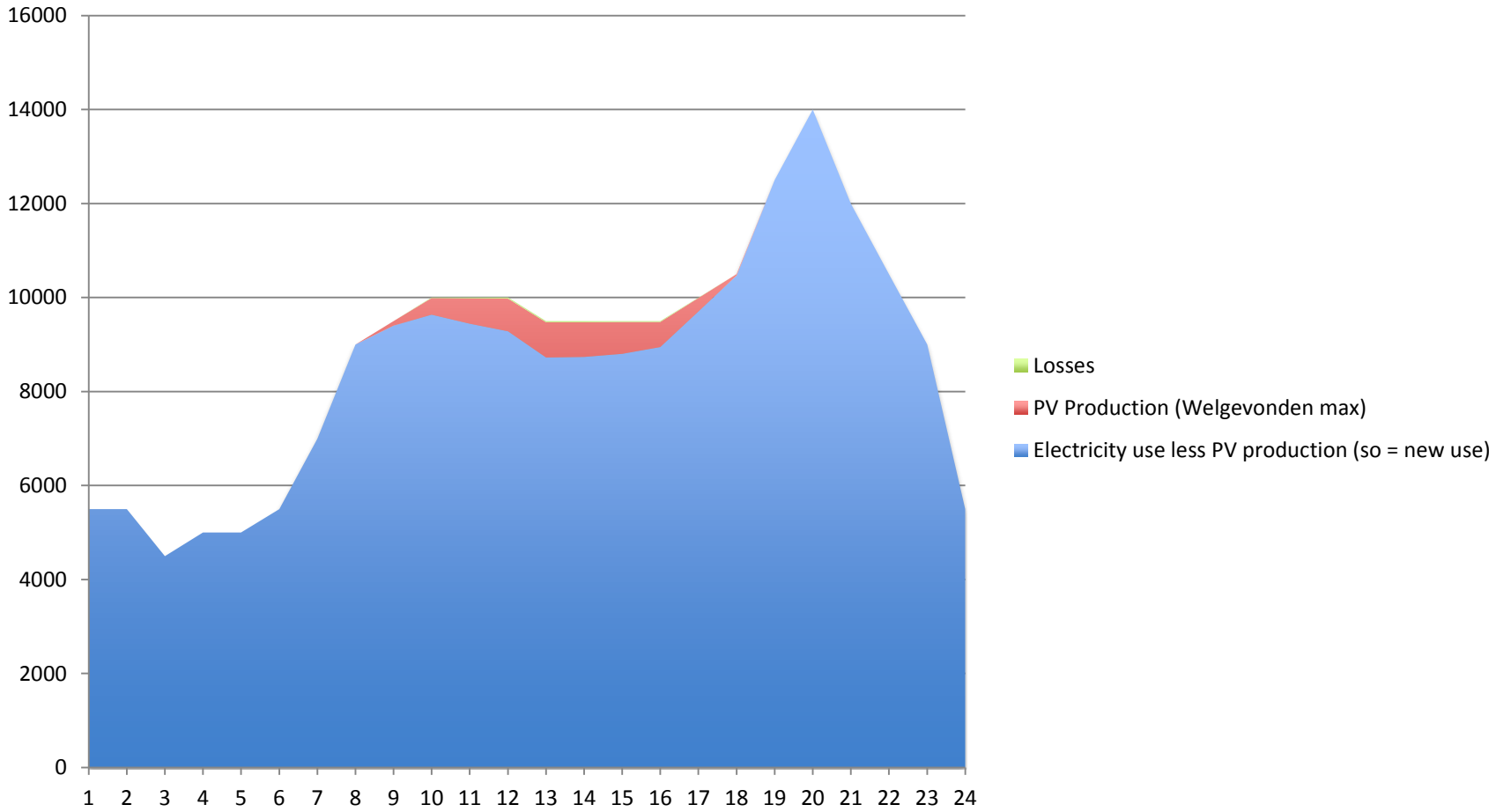


Impact on Electricity Usage in kW

- The next slides present the impact on the electricity usage by rooftop solar PV in the areas Welgevonden, Paradyskloof, Dalsig, Uniepark and Onder Papegaaiberg.
- The data is given in graphs that show the electricity output for the Cloetesville and Stellenbosch substation. Welgevonden is connected to Cloetesville and the remaining areas are connected to Stellenbosch substation.
- The graphs show the impact from July 2013 till June 2014 which is the municipal financial year 2013/2014
- Typical days for season are used to plot PV output for the particular month
- Note: the impact of rooftop PV is given without considering the rebound effect of people increasing electricity usage since they reduce costs by generating own electricity
- This research also does not look at the position of the rooftops:

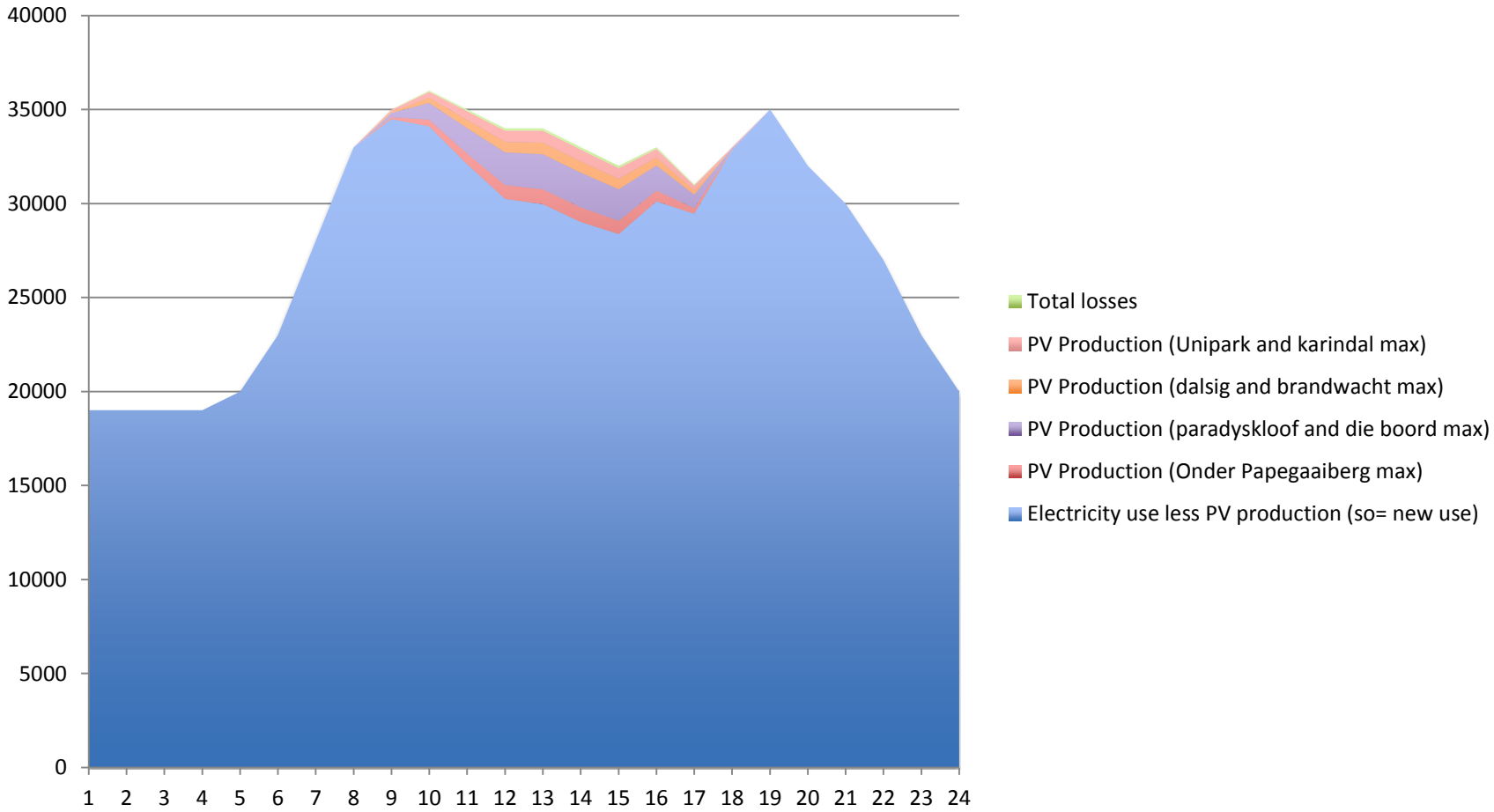
Tuesday 9 July 2013

Welgevonden



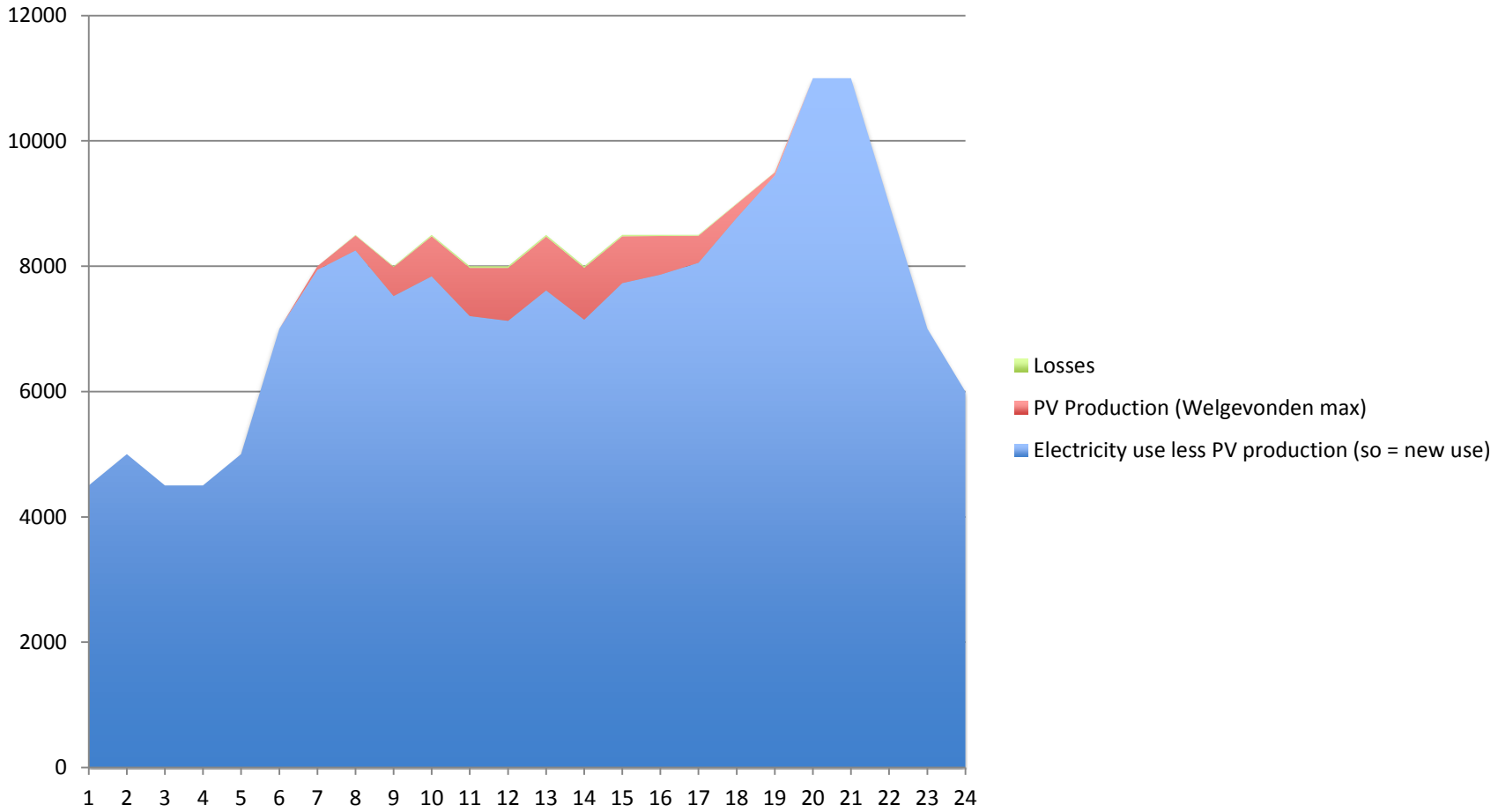
Tuesday 9 July 2013

Onder Papegaaiberg, Paradyskloof, Dalsig, Uniepark



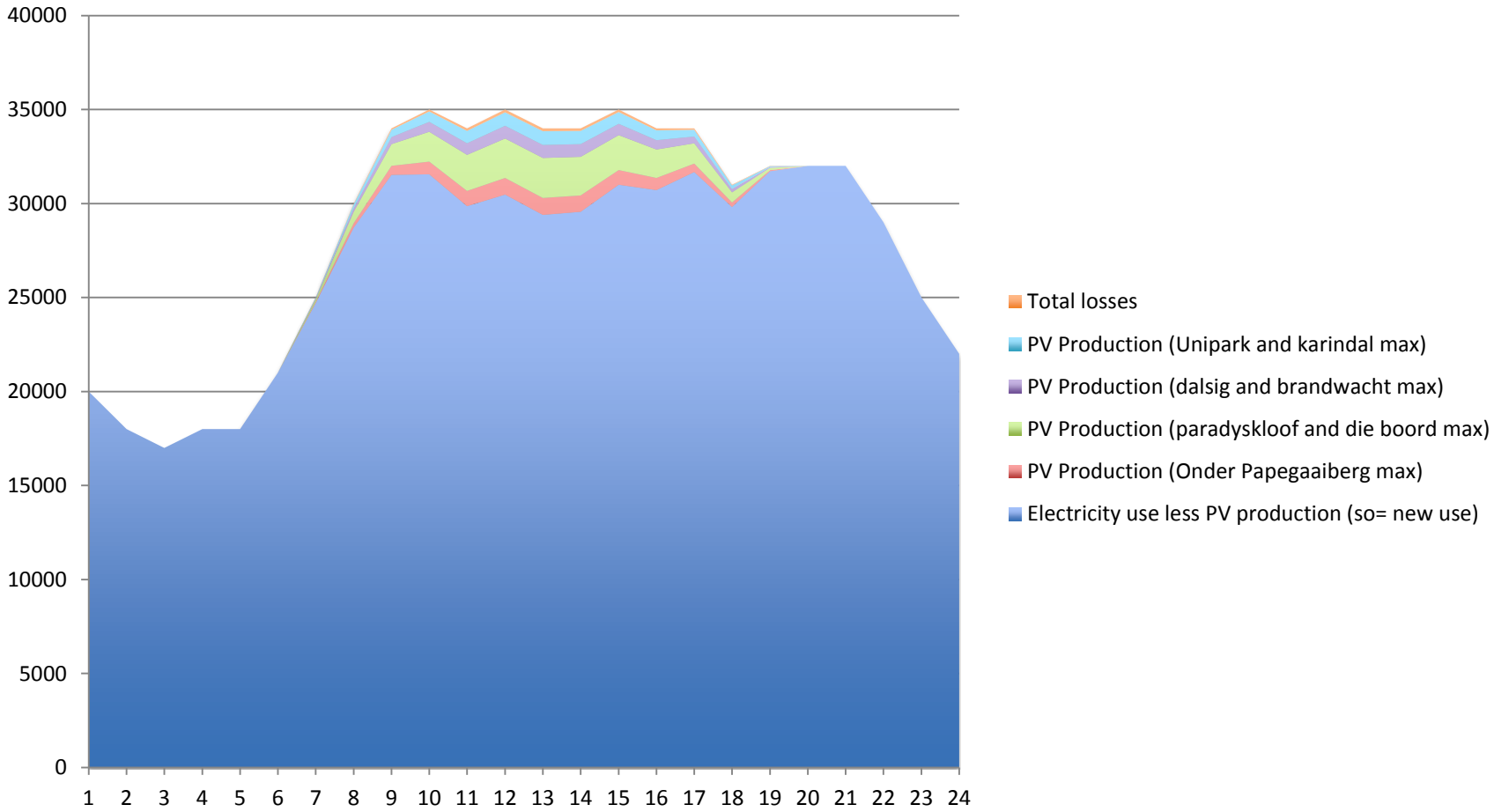
Monday 18 November 2013

Welgevonden



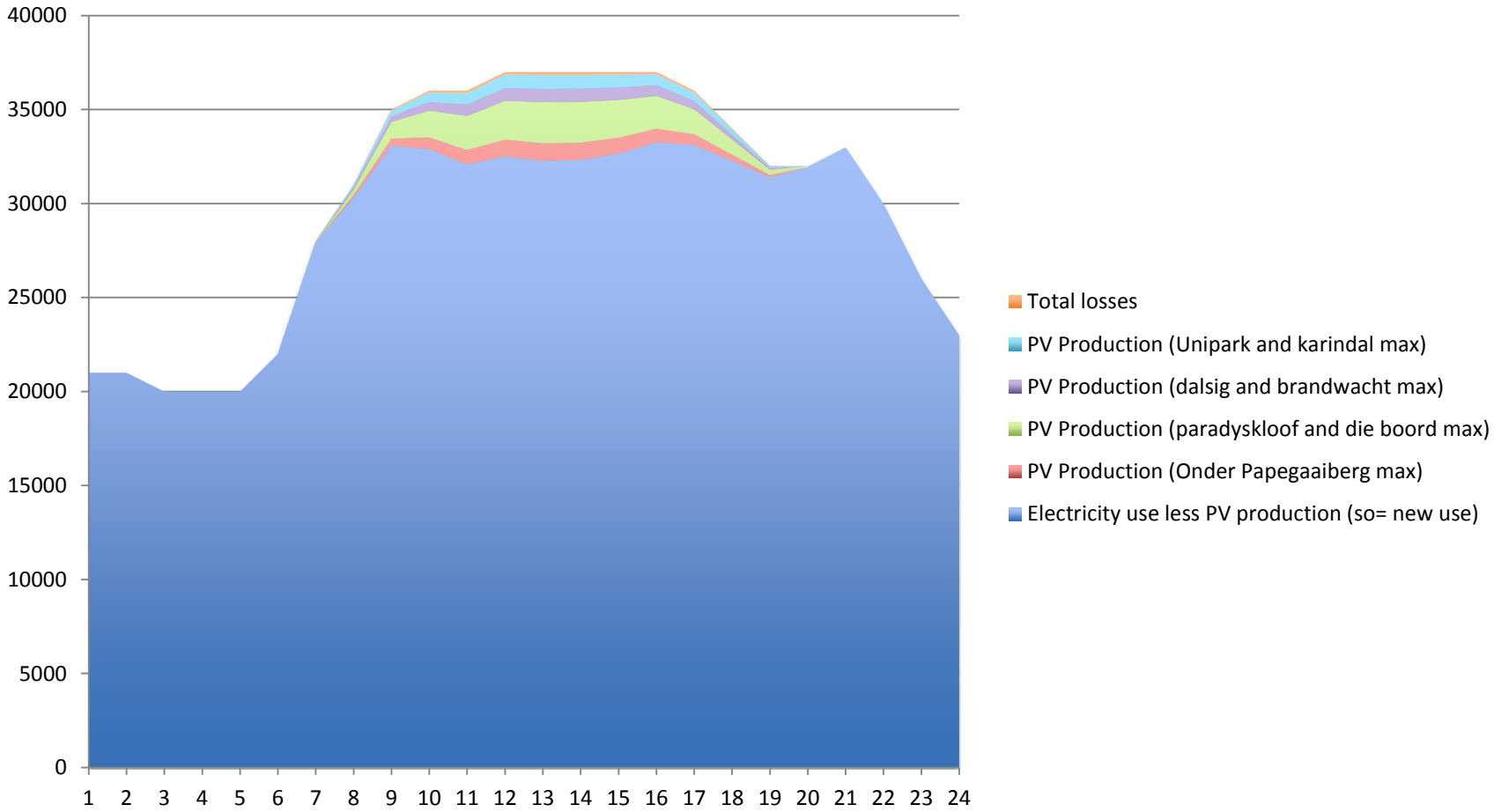
Monday 18 November 2013

Onder Papegaaiberg, Paradyskloof, Dalsig, Uniepark



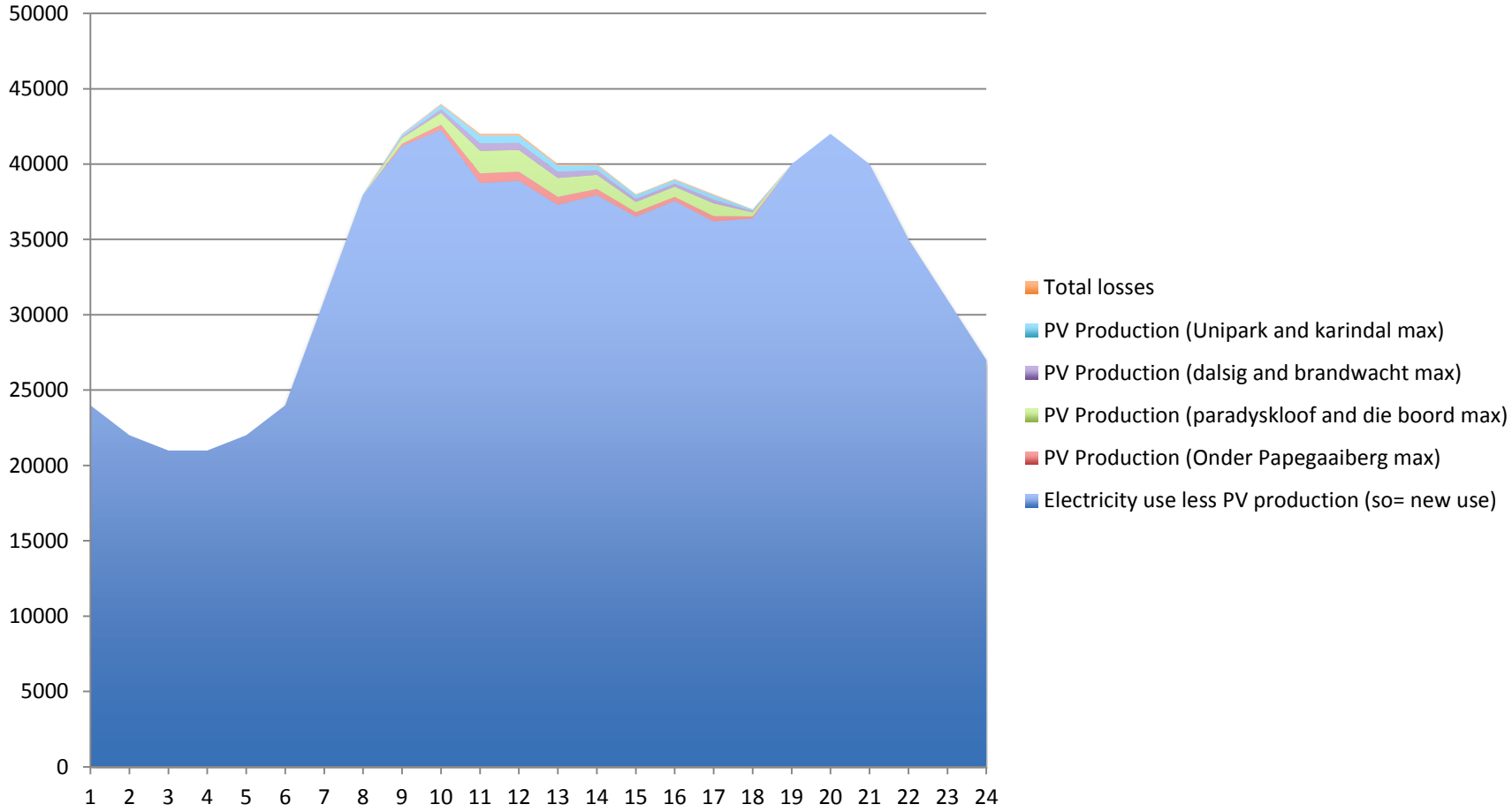
Wednesday 5 February 2014

Onder Papegaaiberg, Paradyskloof, Dalsig, Uniepark



Thursday 22 August 2013

Onder Papegaaiberg, Paradyskloof, Dalsig, Uniepark



Analysis 3) Financial Impact

- What is the benefit as a result of rooftop pv?
- What is the loss as a result of rooftop pv?
- Difference between the two outcomes is the actual financial impact

Financial Impact

- Electricity consumption data used from municipality for pre-paid and credit for whole of Stellenbosch for every month in the past 5 years.
- Filtered out the domestic users in identified high user suburbs

Financial Impact

- Eskom charges the municipality different tariffs at different hours: Off-peak, Standard and Peak
- Therefore we need to know what solar electricity is produced during which hours.
- This needs to be put into relative proportion according to max capacity of the grid in the different suburbs.
- The tariffs Eskom charges need to be multiplied by the amount of EG solar energy.
- This would show how much it would affect the municipality's bill to Eskom.

Solar generated in high-low season Savings for municipality

High Season	Tariff Hour	Tariff	Maximum PV in Stellenbosch sample system	Electricity produced per kWp	EG produced for kWp	Proporation EG produced per tariff hour	Savings on Eskom bill for municipality in Rand	Proporation of savings
Week	Off Peak	0,3383	0,0	0,0	0,0	0,0%	0,0	0,0%
	Standard	0,623	313574,1	186,7	1262721,9	11,3%	786675,7	14,4%
	Peak	2,0566	41430,9	24,7	166836,7	1,5%	343116,3	6,3%
Saturday	Off Peak	0,3383	41631,9	24,8	167646,3	1,5%	56714,7	1,0%
	Standard	0,623	26345,3	15,7	106089,1	1,0%	66093,5	1,2%
Sunday	Off Peak	0,3383	75560,4	45,0	304271,8	2,7%	102935,1	1,9%
Low Season								
Week	Off Peak	0,2929	0,0	0,0	0,0	0,0%	0,0	0,0%
	Standard	0,4617	1340990,6	798,2	5399993,4	**48,5%**	2493176,9	45,6%
	Peak	0,6708	282819,5	168,3	1138876,9	10,2%	763958,6	14,0%
Saturday	Off Peak	0,2929	182136,3	108,4	733439,1	6,6%	214824,3	3,9%
	Standard	0,4617	134486,9	80,1	541561,2	4,9%	250038,8	4,6%
Sunday	Off Peak	0,2929	328662,5	195,6	1323480,9	11,9%	387647,5	7,1%
Total		0	2767638,3	1647,4	**11144917,2**	100,0%	**5465181,7**	100,0%

Saving for municipality

- Appr. 5.5 Mln
- R 808 per kWp installed

Costs for Municipality: From household side

- What are households putting up?
- Maximum grid capacity/ installation capacity: 6765,14/ 3 kWp = **2255 installations**
- Depending on in which tariff block the top usage of households fall into and what will be taken off by PV
- Use PV planner: EG produce in winter: eg 300 average electricity usage: 1000

Average consumption per high user suburb

Average consumption kWh per high income suburb Stellenbosch	Jun-14	May-14	Apr-14	Mar-14	Feb-14	Jan-14	Dec-13	Nov-13	Oct-13	Sep-13	Aug-13	Jul-13	Total Average
Credit meters													
Uniepark & Karindal	1022,9	879,1	876,6	815,2	951,3	904,3	985,8	1418,9	1508,2	1418,2	1244,6	1239,3	1105,4
Die Boord & Paradyskloof	877,4	769,1	770,9	712,8	808,0	743,6	759,0	972,1	1095,1	1150,2	721,8	1195,6	881,3
Dalsig & Brandwacht	986,5	931,7	929,0	842,9	952,2	907,2	915,7	1201,7	1365,9	1300,4	1035,4	1212,3	1048,4
Onder Papegaaiberg	712,4	597,3	625,2	584,3	703,7	620,5	651,1	834,8	924,6	865,2	804,2	794,3	726,5
Total Average Credit	899,8	794,3	800,4	738,8	853,8	793,9	827,9	1106,9	1223,5	1183,5	951,5	1110,4	940,4
Pre Paid meters													
Uniepark & Karindal	1412,4	1221,2	948,7	1079,6	912,7	862,5	970,0	1032,5	1129,4	1250,1	1425,8	1277,2	1126,9
Die Boord & Paradyskloof	1071,4	890,5	786,7	765,8	763,8	753,0	752,8	741,3	783,4	956,0	972,2	951,3	849,0
Dalsig & Brandwacht	1217,2	978,9	922,8	866,9	832,7	801,4	788,3	917,9	897,6	1085,6	1194,5	1046,7	962,5
Onder Papegaaiberg	797,8	750,1	632,7	709,5	642,2	617,7	675,4	626,8	657,4	705,2	718,0	697,8	685,9
Welgevonden	631,1	549,5	474,4	478,6	454,4	431,0	433,7	462,2	514,9	579,8	638,3	568,4	518,0
Total Average Pre Paid	929,4	792,2	704,2	705,2	673,3	650,8	662,5	687,0	713,3	831,6	880,7	816,0	753,9
Total Average Pre Paid and Credit	962,9	836,2	776,7	759,5	787,5	743,5	776,0	931,5	1010,0	1049,4	970,6	1009,3	884,4

Sub- conclusion

- Average credit meters: 940 kWh month
- Average pre-paid meters: 750 kWh month
- Total Average: 885 kWh

- Problem: individuals don't invest because of average usage

- New direction needed: filter out the households in the high-user suburbs for whom it makes financially sense to invest

Discussion

- Is the argument of the municipality legitimate?
- What should be the role of the municipality regarding rooftop PV?
  - Resist because of fear for impact?
  - Active role: Embrace and collaborate, regulate to keep track
  - Passive: lessaiz-faire

Discussion

- Should electricity be fully cost recovery?
- If the surplus on electricity would be lost, should other departments not source funding from somewhere else or be cost reflective and sustain themselves?

Discussion

- Questionable if it makes sense for households to invest in rooftop PV
- If reduction of costs would be the reason would be the reason there are other more affective ways
- If you have a usage profile of 10.000 kWh a month: rather invest in SWH or other EE measurements or reduce electricity usage by switching off jacuzzi
- It is also questionable that when somebody can afford these amounts of electricity a month if they really care about reducing costs

Discussion

- If the reason would be as a response to Eskom's unreliable supply of electricity:
- You will still need the grid as a battery/ back up system, which does not work during load shedding
- Or you need to invest in batteries (which are costly to replace and unsustainable)

Thank you