

IMPACT OF EMBEDDED GENERATION

What will PV installations cost the municipality?

*Sharing Of Renewable Energy And Energy Efficiency Innovations And Benefits:
Small Scale Embedded Generation Workshop*



CENTRE FOR RENEWABLE AND SUSTAINABLE ENERGY STUDIES

Karin Kritzinger
25 November 2014
Victoria Hall, Caledon





RENEWABLE & SUSTAINABLE
ENERGY STUDIES



UNIVERSITEIT
STELLENBOSCH
UNIVERSITY

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.





Outline

- Background
- Studies
- Load Profiles
- Individual data
- Investment decision





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Background

News24 | OLX | PriceCheck | Property24 | Kalahari.com | Careers24 | Spree

news24
Breaking News. First
News24.com Home 4-11-24, 22:32

US and China announce 'historic' climate accord
The US and China have announced an action plan on greenhouse emissions as part of a 'historic' pact that was acclaimed by climate scientists but denounced by US

News | Opinions | Business | Sport | Tech | Motoring | Travel | Lifestyle | Video

74 000m² Cape office park goes solar

2014-02-03 14:56

Vernon Pillay

[f](#) [t](#) [g+](#) [e](#)

Cape Town - With electricity prices increasing substantially commercial sectors are investing in multimillion rand solar systems hoping to decrease the dependence on electricity, an office park in Cape Town is in the process of installing a R22m solar system.

Black River Park is a 74 000m² office space and is home to various brands.

The Black River Park solar PV (photovoltaic) system consisted of an initial 700kW solar-panel arrangement. The second phase will consist of an additional 500kW system that will cover most of the remaining roofs at the park.

Sola Future Energy is behind this initiative and argues that there is enormous worth in PV systems for commercial buildings. Sola's managing director Chris Haw says that the PV system works especially well with buildings that



Black River Park. (Sola Future Energy)

Background

HOTEL & RESTAURANT HOME BEVERAGES COLUMNIST ENVIRONMEN
RESTAURANTS CSI TECHNOLOGY TOURISM

SP - 17.3151 ▲ (1.08) ICE:BRENT CRUDE NEAR - 79.520 ▼ (-0.20) Provided By INET I

Lourensford invests in solar energy for wine
October 1st, 2014 by Andrew Moth | Categories: [beverages](#), [environmental](#),
[government](#), [industry](#), [products](#), [restaurants](#), [technology](#), [tourism](#)





Background

The screenshot displays the WSP website's navigation and content for a specific project. At the top left is the WSP logo. To its right are navigation buttons for 'AFRICA', 'WHO WE ARE', 'WHAT WE DO' (highlighted in blue), and 'INVESTORS'. Below these is a breadcrumb trail: 'AFRICA > WHAT WE DO > PROJECT CASE STUDIES > VODACOM CENTURY CITY SOLAR POWER - CAPE TOWN, SOUTH AFRICA'. On the left side, there is a sidebar with a 'PROJECT CASE STUDIES' header and a link to the current project. The main content area features the project title 'VODACOM CENTURY CITY SOLAR POWER - CAPE TOWN, SOUTH AFRICA' in large blue text, followed by the subtitle 'The largest single-roof photovoltaic solar array in Africa.' Below the text is an aerial photograph of the Century City building, showing its extensive roof covered in solar panels.



Background



Background



Background



Background



Background



Background

You've got 3 questions right?




1. What did it cost ?
2. What does it do ?
3. What does it entail?

If you're interested in turning your meter backwards;



David Lipschitz

Yesterday 

Suppose you could save 30% on your electricity bill, but the City of Cape Town said no! And suppose they have been saying no since 2003?

Would you be prepared to save 30% of your bill and pay 1/2 of this (ie save 15% of your bill) to the City and let the City NOT buy some electricity?

The overall saving is still 30% in electricity. 15% is for your account and 15% is for the City for allowing this to happen.

Example: you are paying R3,000 per month in electricity. You can save R900 per month, but the City won't let you do it, because they might lose money (there are other variables at play but the City isn't interested in them).

So you have R900 per month overall savings and you give R450 per month to the City for allowing you to save the other R450. If the City makes 100% profit on electricity sold to you then the profit on R3000 is R1500. If you save 30%, then the City only makes R1,050, but then you pay R450 (of your R900 savings) and the City makes R1,500. The City still makes R1,500 per month from you but you save R450 per month!

Any takers?

[Like](#) · [Comment](#) · [Share](#)

4 people like this.



South Africa

Author: Antoinette Slabbert | 12 June 2014 00:05

Metro to "punish" residents for switch to renewable energy

Cape Metro requests tariff hike above Nersa guideline.

PRETORIA - Residents of Cape Town need to pay more for electricity to compensate for decreased sales as high-end domestic customers switch to renewable energy – with full support of the city council.

This was the argument put forward during public hearings held by the National Energy Regulator (Nersa) about municipal applications for electricity tariff increases that exceed the guideline of 7.39%. Cape Town applied for an increase of 7.63%. Tariff increases at all municipalities take effect on 1 July.

Leslie Recontre, Cape Town director of electrical services told the hearing that while commercial sales

Article tools

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With no capital gains tax on share dealings, you benefit more from your retirement.


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- 1 [Eskom expected to miss another Medupi deadline](#)
- 2 [Telkom finally 'gets' convergence](#)
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- 4 [Magnus Heystek got it very wrong](#)
- 5 [Bridge's creditors looks at 18c in the rand](#)



Wildpoldsried produces 321% more energy than it needs

Wildpoldsried, a small village in Germany produces 321% more energy than it needs, and sells it for \$5.7 million.





Outline

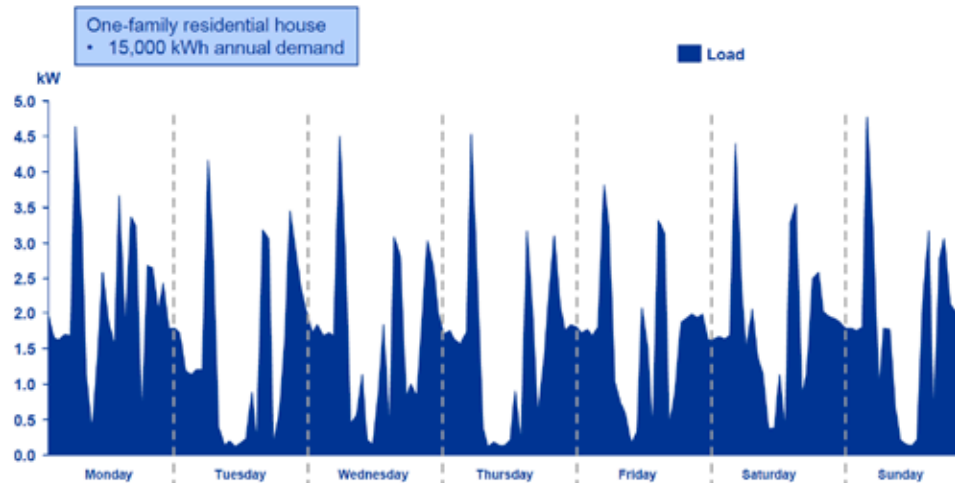
- Background
- Studies
- Load Profiles
- Individual data
- Conclusion



Eskom – Tobias Bischof- Niemz



Residential load profile has peaks in the morning and in the evening (example winter)



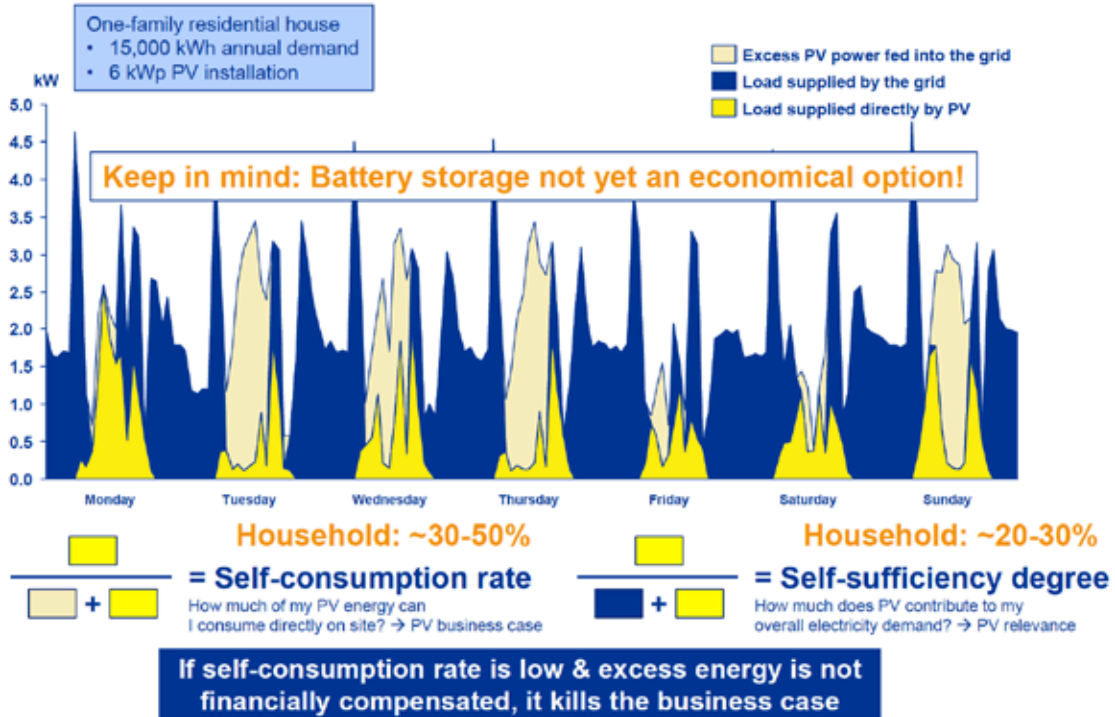
Source: Eskom EPMD analysis

13





Residential load profile generally does not match PV – excess PV to be fed back into grid



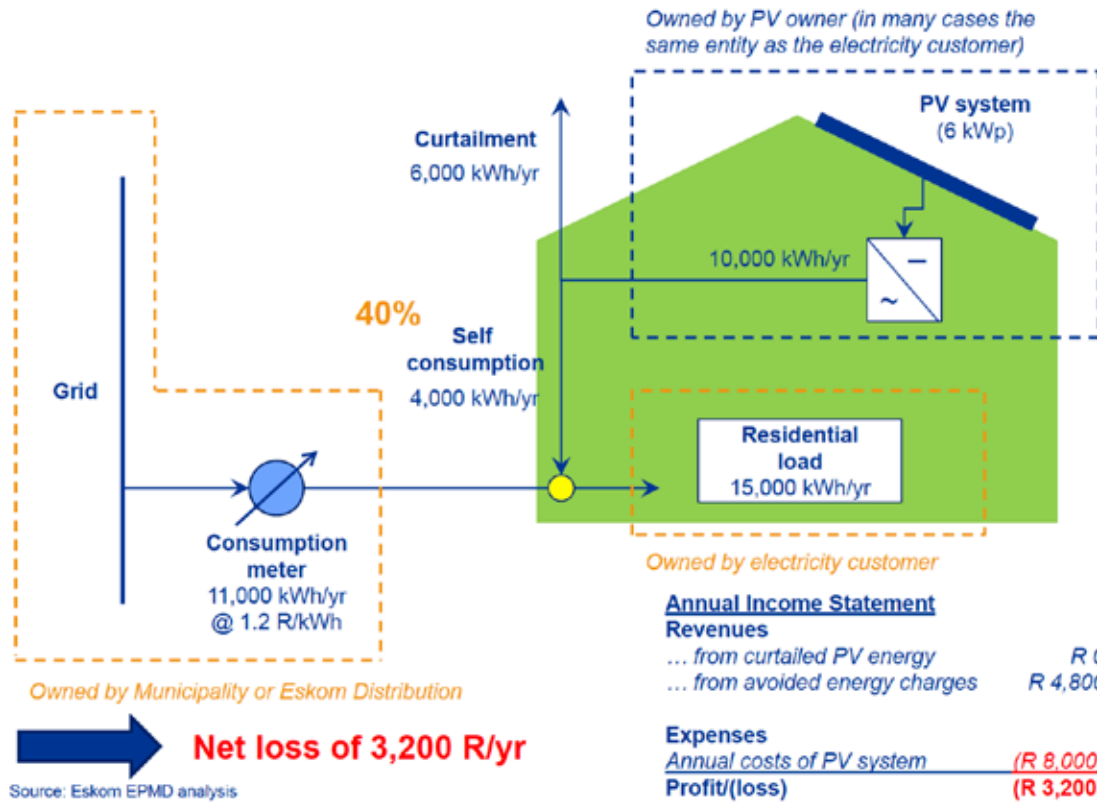
Source: Eskom EPMD analysis



Eskom – Tobias Bischof- Niemz



Low self-consumption rate of residential customers (typically) kills the PV business case



17



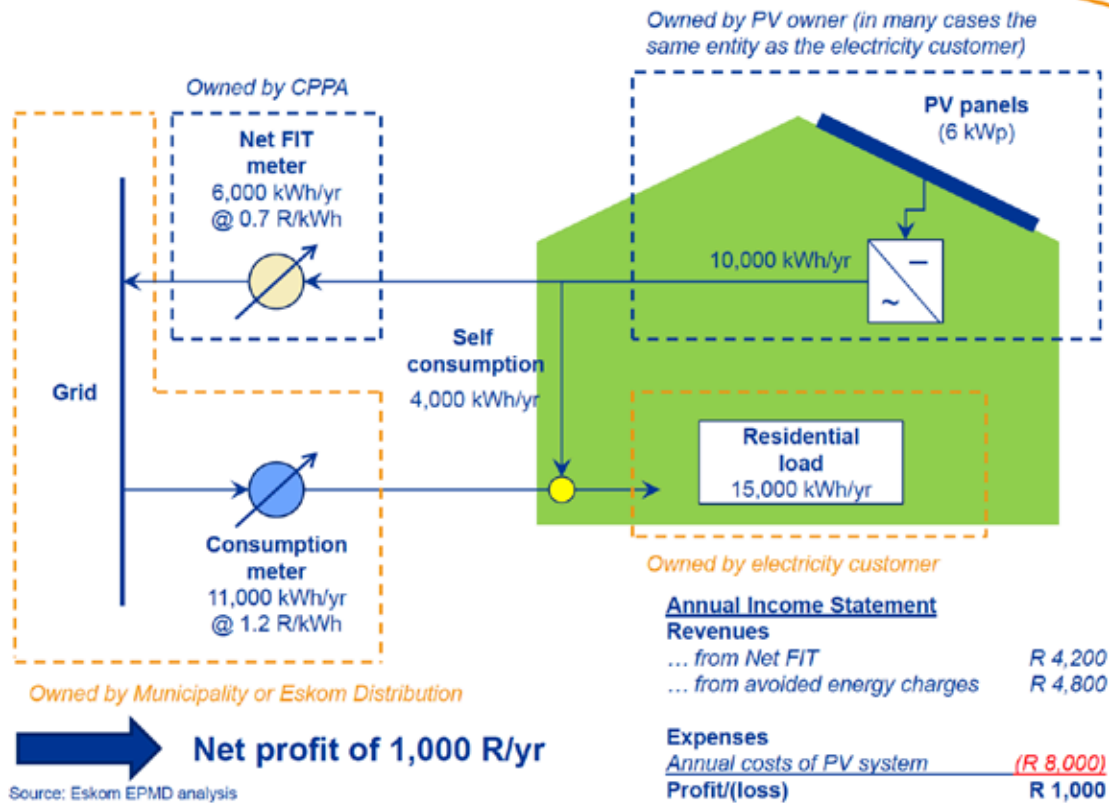
Eskom – Tobias Bischof- Niemz



How would the business case for a residential customer look like with Net FIT?



Informal food for thought



Annual Income Statement

Revenues	
... from Net FIT	R 4,200
... from avoided energy charges	R 4,800
Expenses	
Annual costs of PV system	(R 8,000)
Profit/(loss)	R 1,000



Eskom – Tobias Bischof- Niemz



Proposal: Net Feed-in Tariff with nation-wide central off-taker (“CPPA”)



Informal food for thought





SEA – Revenue Impact model

resource_269.xlsx

75%

Search in Sheet

Home Layout Tables Charts SmartArt Formulas Data Review Developer

Font: Calibri (Body) 11

Alignment: abc, Wrap Text

Number: General

Format: Conditional Formatting, Styles

Cells: Insert, Delete, Format

Themes: Themes

V7

City electricity load profile and revenue impact analysis

Background:

This tool has been developed by Sustainable Energy Africa (SEA), with funding from the Renewable Energy and Energy Efficiency Partnership (REEEP), and is available at no cost. This tool calculates the financial losses to municipalities in South Africa resulting from the uptake of embedded PV generation and energy efficiency interventions by their customer base. The tool has the ability to project these financial losses over 10 years (year 0, 3, 5 and 10) by sector, for the residential, business and industrial sectors. It incorporates current electricity load data and shows the impact of the various interventions on an hourly basis on this - refer to 'Summary' and 'Summary weekend' sheets. All options include embedded PV for each sector, as well as landfill gas, pumped storage (or any other load balancing) can also be inserted. There is also an option for residential load shifting. A fixed service charge option has been included for PV customers the residential sector only, to demonstrate its potentially positive effect on municipal electricity income.

Instructions:

Rename and save file as 'City revenue impact from RE and EE tool Oct 2013'. This will complete the coloured cells in the sheet. Refer to the 'Load Profile' sheet columns G to R (in orange) for typical commercial, residential and industrial load profiles. Detailed instructions can be found here: [Detailed instructions can be found here](#). When all the fields have been completed, click on the arrows below. High level results are displayed in the 'Results Summary' worksheet. For detailed results refer to the 'Results Summary' worksheet.

Current annual consumption		Current # of customers		Current average usage/customer (kwh)	
Residential (mid-high)	1 902 721 000 kwh yearly	Resid.	150000		
Commercial buildings	755 610 000 kwh yearly	Commerc.	20000		
Industrial	5 972 429 000 kwh yearly	LV			
		MV			
		MV TDU			
		HV TDU	6000	6000	945404

Load Data

Average monthly consumption (mid-high user) 951 kwh

Hourly Load Data

Insert the average loads for the intake points used. The total hourly loads can be adjusted using the adjustment factor below to scale up to 100% of the load.

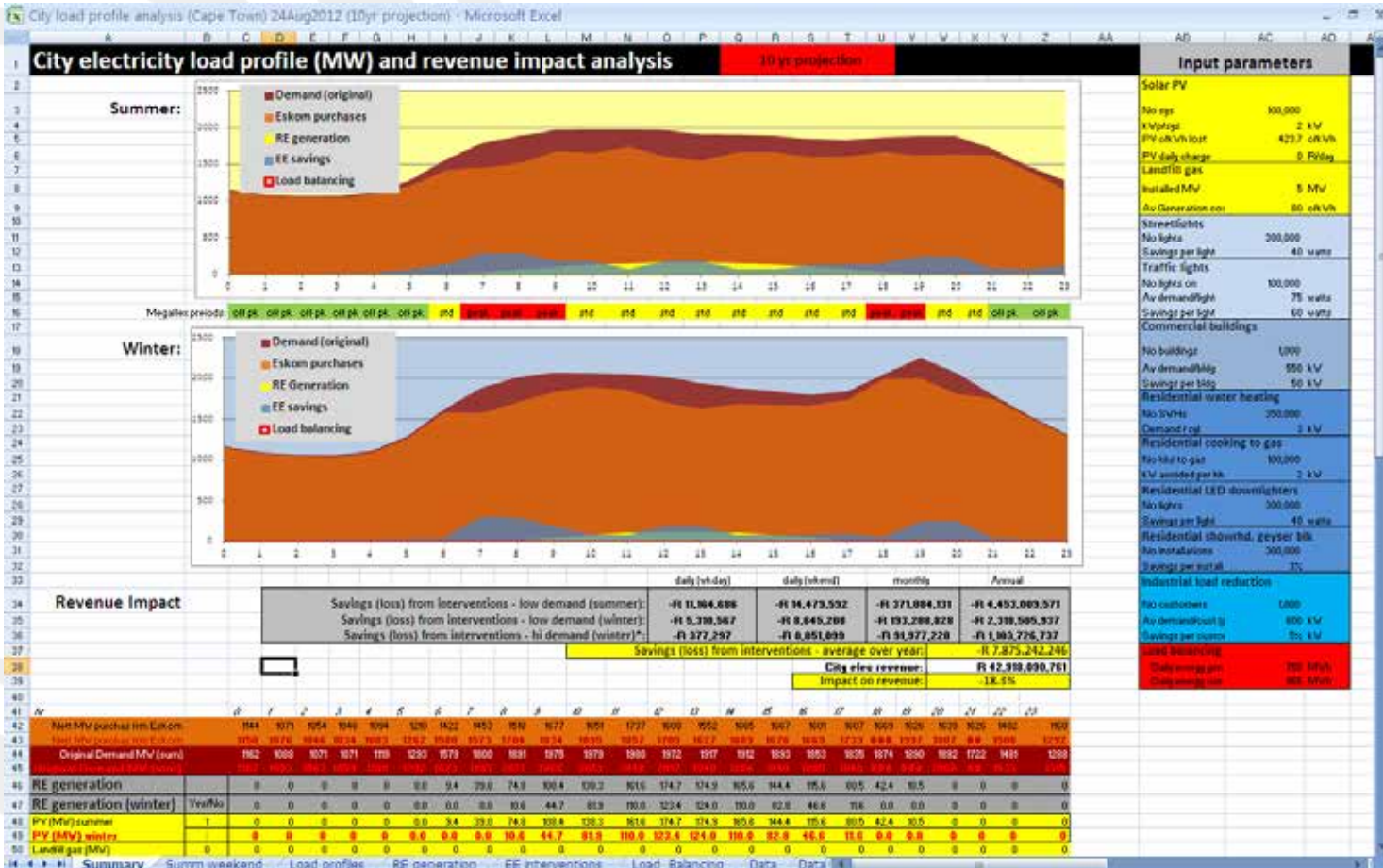
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Weekday Winter (MWh)	1100	1261	1244	1264	1260	1043	1111	1219	1220	1232	1219	1228	1108	1033	1061	1091	2091	2212	2371
Weekday Summer (MWh)	1120	1080	1067	1081	1154	1388	1692	1730	1792	1804	1910	1941	1774	1739	1723	1722	1729	1758	1823
Weekend Winter (MWh)	1315	1244	1212	1210	1242	1305	1431	1706	1977	2042	2018	1955	1977	1858	1716	1723	1775	1964	2182
Weekend Summer (MWh)	1107	1060	1033	1038	1098	1100	1234	1448	1627	1652	1642	1603	1610	1531	1463	1436	1481	1507	1636
Adjustment factor	1																		

Residential load shifting (optional)





SEA – Revenue Impact model



SEA – Revenue Impact model



A 50-85% uptake of EE interventions would be realised across all the economic sectors over the next 10 years.

PV uptake varies between municipalities – Cape Town 15-50% residential; 15-50% commercial; 3-15% industrial. EThekweni 3-15% residential; 15-50% commercial; 3-15% industrial. Ekurhuleni – 2-15% residential; 15-50% commercial; 15-50% industrial. Large scale uptake is only expected thereafter, as the financial case improves.

Uptake of PV in the commercial sector could be as high as 15-50% if current tariff conditions continue to apply.

Assuming the above uptakes, the overall revenue losses in 10 years' time for the metro electricity departments are projected to be between 3-11% (Cape Town), 5-15% (Ekurhuleni) and 8-15% (eThekweni). The main areas where these losses will occur are residential solar water heating and EE across all the economic sectors. The impact of PV is relatively minimal, except potentially in the sections of the commercial sector where the energy tariff is particularly high (usually small commercial tariff customers).

The overall impact of revenue loss on the poor is a question of political decision making, but up to 80% of the cross subsidisation of the low income tariff could be affected, or up to half of the total amount of revenue allowed to be transferred to the rates account.



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SEA – PV financial feasibility model

resource_270.xlsm

Home Layout Tables Charts SmartArt Formulas Data Review Developer

Calibri (Body) 11

14

PV cost benefit analysis tool

Background

This tool has been developed by Sustainable Energy Africa (SEA), with funding from the Renewable Energy and Energy Efficiency Partnership (REEEP). The tool has been developed for municipalities in South Africa and is available at no cost. It calculates the payback period (PP) for PV installed at different times into the future for each sector. The results can be used to assist with developing uptake projections for PV in each sector. These uptake projections should be used in conjunction with the City Impact from RE and EE tool Oct 2008 developed by SEA, which calculates revenue losses municipalities can experience in future as a result of customer RE and EE installations. It takes into consideration all costs for PV, generation, electricity tariffs, taxes and subsidies into the future, and the PPA using various repayment options.

Instructions – Detailed instructions can be found here.

Rename and save file as 'PV cost benefit analysis - uptake scenarios(SAU)'. This will enable the macros to function. Fill in all cells marked in yellow.

All prices should be R/Z inclusive.

Recommended values:

The current (2014) cost of PV for various sectors:

Sector	Size (kWp)	Cost per kWp
Residential	3	8 217 000
Small commercial	4.5	8 217 000
Large commercial	400	8 18 000
Industrial	400	8 19 000

Electricity generated:

Location	Electricity generated/year/kWh
Bloemfontein	2050
Cape Town	2192
Durban	3170
Johannesburg/Orlando	3071
Norwalk	2160
Port Elizabeth	2088
Stellenbosch	2070

% Backflow exported/used: Refers to the percentage of electricity exported onto the grid or not used by installer.

Repayment options: Three options are provided, no loan, short term and long term loans.

When all values are inserted, click on 'Calculate payback period' button below. Results can be viewed in the 'Result' sheet.

Note: The tool only accommodates 1 type of commercial (small or large) to be run at a time. Simply run the model again with the other commercial data type.

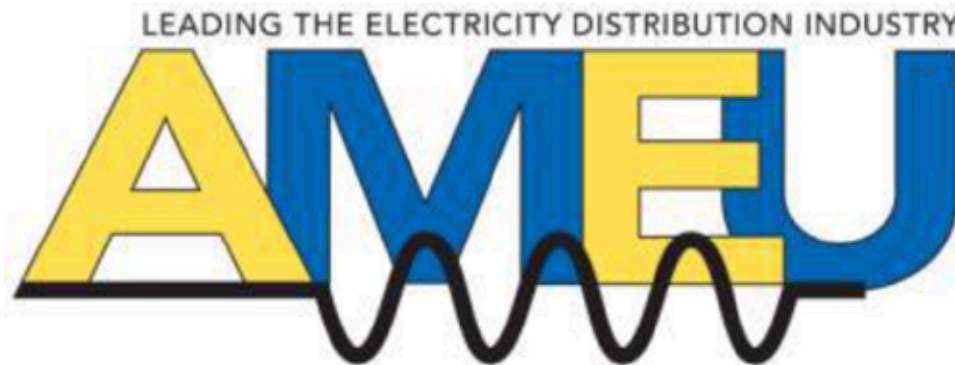
Note: Only change yellow cells

	Residential Install now	Commercial Install now	Industrial Install now
Cost/kWp installed (no battery)	8 27 000	8 25 000	8 18 000
Size of system (kWp)	3	4.5	400
Electricity generated/year/kWh	1 871	1 871	1 871
Regional subsidy	80	80	80
Maintenance	80	80	80
SAZ exemption	80	80	80
Overpayment (equity) (%)	0%	0%	0%

Year	Normal Electricity increase Rate
1	2.2%
2	2.2%
3	2.2%
4	2.2%
5	2.2%
6	2.2%
7	2.2%

PV System analysis	
Length of generation life (year)	20
Cost per year	1.08%

A PERSPECTIVE ON DISTRIBUTED GENERATION IN MUNICIPAL NETWORKS THE REVENUE IMPACT OF SOLAR GENERATION



Author and Presenter: Kevin Kotzen B.Sc Elec Eng - Researcher at GreenCape
Co-Authors: Bruce Raw, Peter Atkins

GreenCape

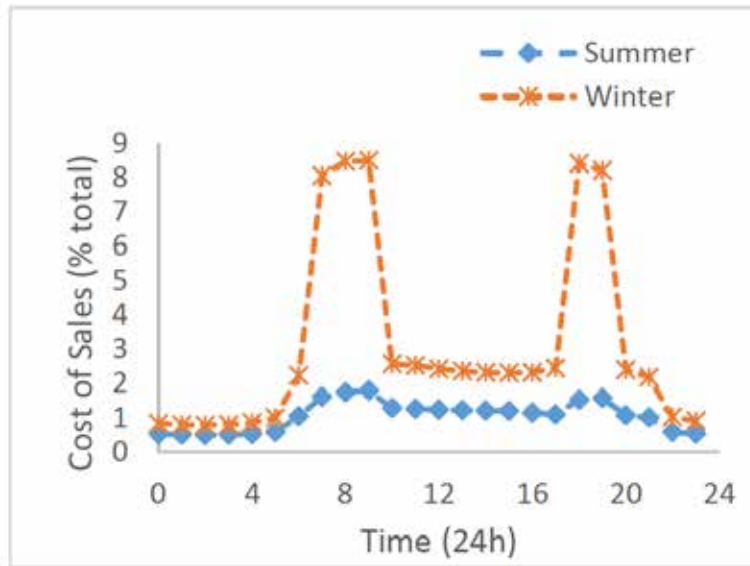


Figure 6: Municipal cost of sales throughout the day. Cost is shown as a percentage of the total daily expenditure.

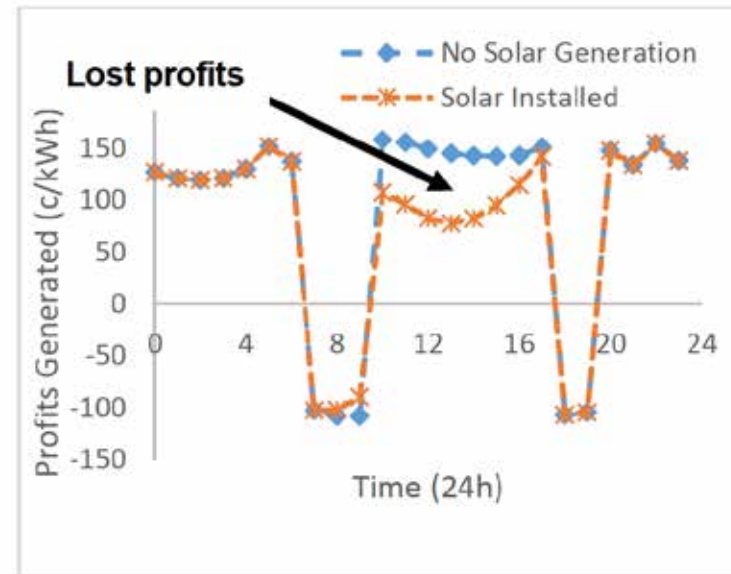


Figure 10: High demand (winter) unit profits generated with and without solar embedded generation



Mott McDonald

**SMALL SCALE ON-GRID SOLAR PHOTO VOLTAIC EMBEDDED GENERATION
IN SOUTH AFRICA
METHODOLOGIES TO STIMULATE THE MARKET**



**Author & Presenter: Paul Tuson PrEng BSc MSc MBL – Studies Team Leader -
Mott McDonald South Africa**

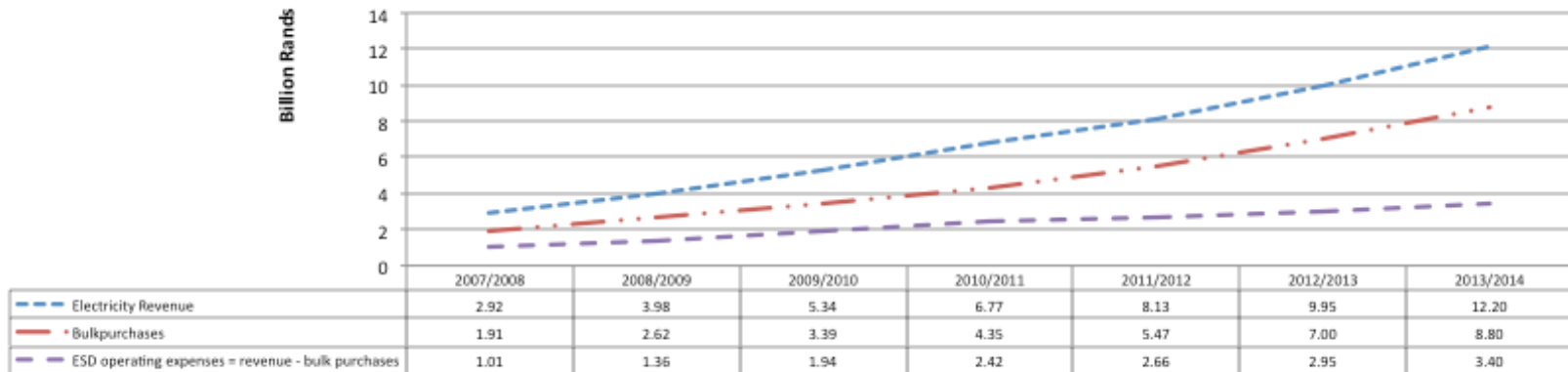
The author of this paper proposes that all three SSPVEG mechanisms (self-consumption, Net-Metering and FIT) are adopted in South Africa but that a phased approach may be less threatening to all stakeholders involved.

City of Cape Town

Potential impact on municipal revenue of small scale own generation and energy efficiency

Hilton Trollip, Vivienne Walsh, Sumaya Mahomed, Brian Jones

Cape Town Electricity Department framing budget
 Source - BUDGET For the financial period 2010/11 to 2012/13





City of Cape Town

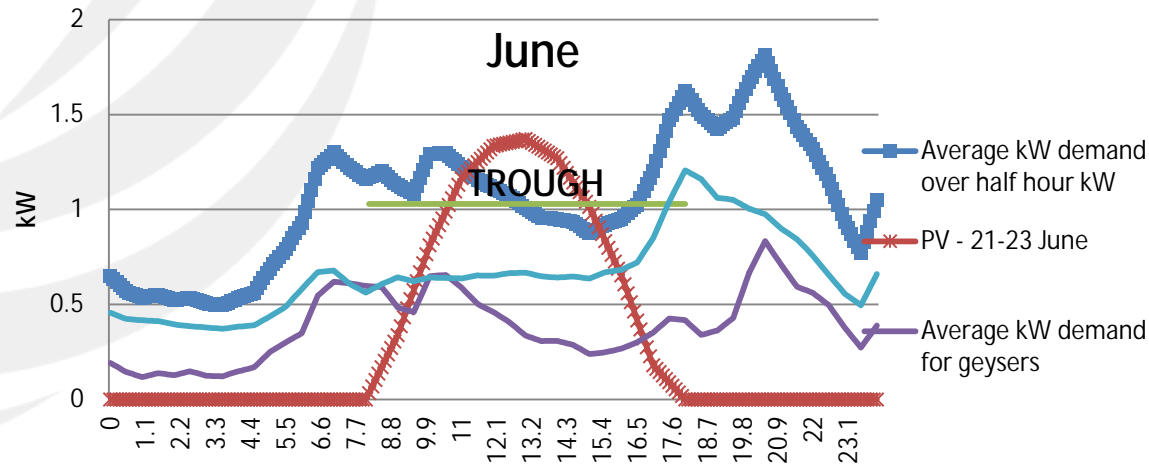
Presenting PV own-generation as a most-costly option among other renewable energy/energy efficiency options that could be adopted at significant scale suggests that a combination of PV and other options could lead to **revenue losses of between 17% and 25% of ESD operating expenses from the residential sector alone** and significant additional potential losses driven by similar dynamics in the commercial sector.





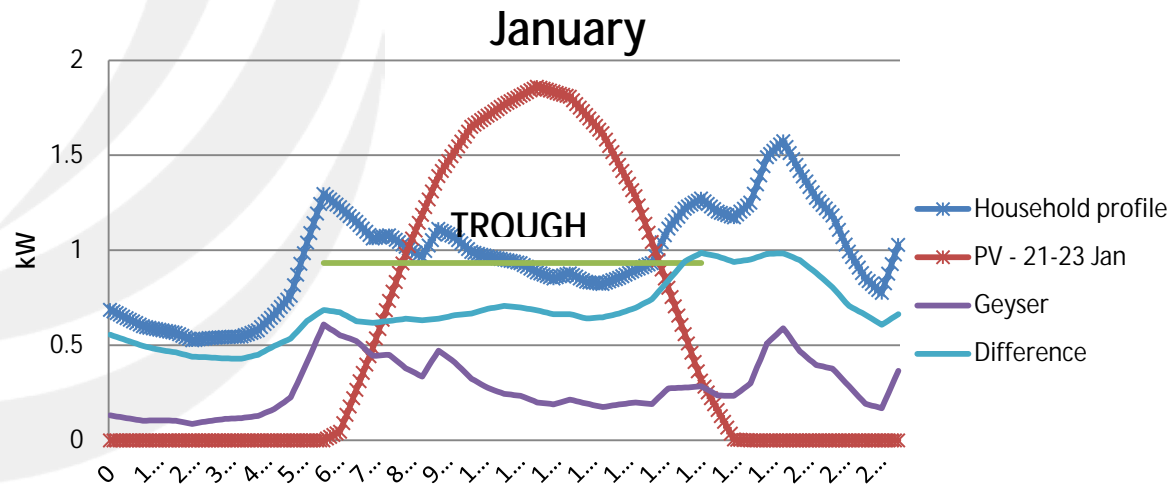
City of Cape Town

Figure 7 – Average typical PV production winter profile overlap with household load profile

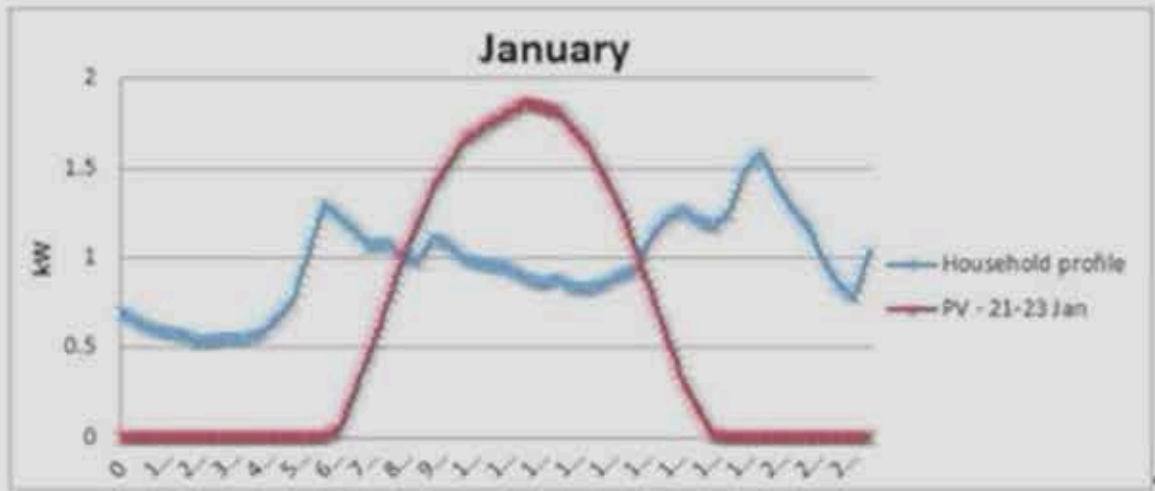


City of Cape Town

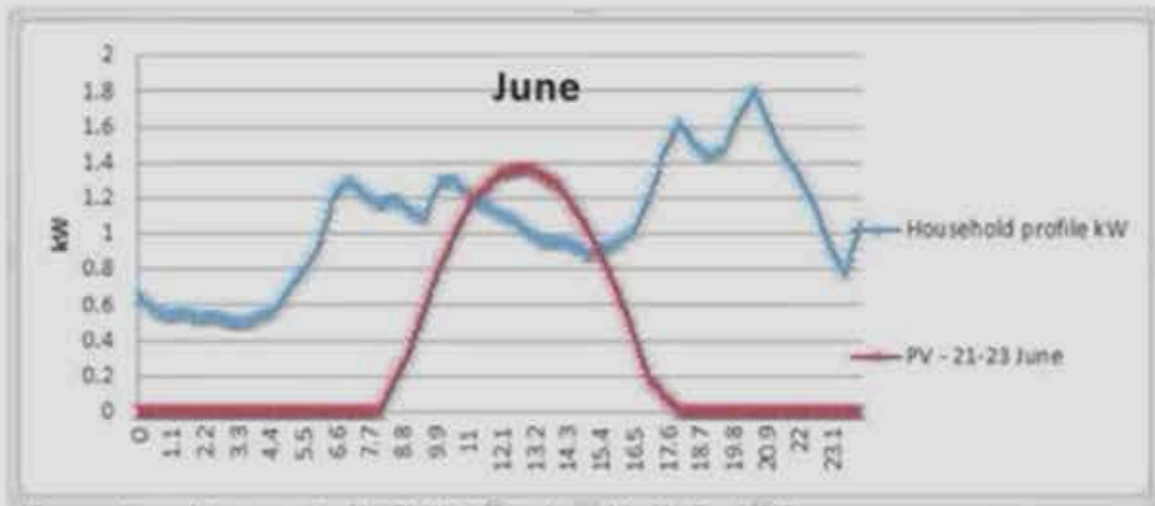
Figure 8 – Average typical PV production mid-summer profile overlap with household load profile



Typical Generation and Consumption Profiles



Generation: from 2 kW (peak) DC array



Consumption: average of 25 households which use 748kW per month

[Source: from data generated by PVWatts² and provided by Davis³]





Unlocking the Rooftop PV Market in South Africa

March 2013

Josh Reinecke

Corli Leonard

Karin Kritzinger

Dr Bernard Bekker

Prof Johannes L van Niekerk

Joschka Thilo



Centre for Renewable and Sustainable Energy
Studies



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crses@sun.ac.za
<http://www.sun.ac.za/crses>

Potential uptake of rooftop PV

Conservative		Erven	PV ins (kWp)	Gen (kWh)
	Residential Single Phase	3	6	8 874
	Residential Three Phase	0	0	0
	Light Commercial	2	20	29 582
	Heavy Industrial	3	120	177 496
Total		8	146	215 954

Table 8-3: Conservative uptake scenario

Generous		Erven	PV ins (kWp)	Gen (kWh)
	Residential Single Phase	15	30	44 374
	Residential Three Phase	1	8	20 412
	Light Commercial	5	50	73 957
	Heavy Industrial	9	360	422 022
Total		30	448	560 765

Table 8-4: Generous uptake scenario

Impact of PV on Riversdale

- Rooftop PV will reduce electricity sales
- By how much?
 - Understand Riversdale's current electricity revenue
 - Understand potential uptake of rooftop PV in Riversdale
- By only a small amount
 - Conservative uptake – 146kWp: 0.2% of electricity sales
 - Generous uptake – 448kWp: 0.66% of electricity sales
 - All rooftops – 9 840kWp: 11% of electricity sales
 - Note: max 1 384kWp allowed for Riverdale (NRS097-2-3)



Load Forecasting in the New Era of Uncertainty

Omar Siddiqui

Senior Technical Executive

Research Advisory Committee

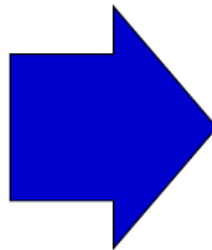
Phoenix, Arizona

October 28, 2014

Load Forecasting – The Story in Brief

Status Quo Methods

- Econometric regressions of variables highly correlated to electricity demand
 - Population
 - Weather
 - Economics
- Decades of successful practice in utility planning
 - Short term (week ahead)
 - Long term (years ahead)



Challenges

- Traditional variables becoming less correlated
- Disruptive technologies gaining effect on load
 - Rapid pace of change
 - Sparse data or experience with these new variables
- Demand becoming more variable, *less predictable*
- Unprecedented changes

Implication

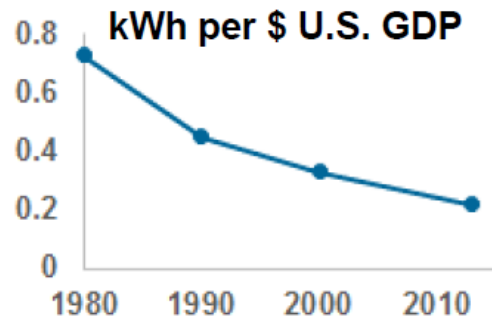
Load forecasting methods must adapt to new era of uncertainty or risk continued divergence from reality and sub-optimal investment and planning decisions

New Era of Load Uncertainty – Macro Drivers

Structural Changes in Economy

Load growth decoupling from economic growth

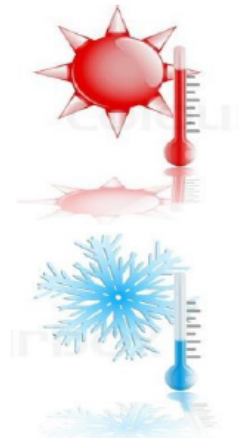
Sustained effect of recession: “new normal” stagnation



Weather Anomalies

Increasing frequency of extreme weather occurrences

Diminishing predictive value of historical weather data



Peak Demand Outpacing Energy

U.S. 1.2% peak demand growth vs. 0.8% energy growth (next 10 years)

Greater penetration of central air conditioning

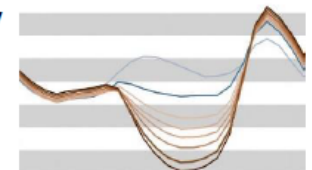
Localized needle peak phenomenon



Ramping for Renewables

Increasing solar and wind penetration puts pressure on other resources (supply and demand) to flex

“Duck curve” effect – steepening ramp rates



Disruptive Changes in Electricity End Use

Energy Efficiency

\$6 Billion spent on EE programs in 2012 in U.S.



8 – 11% energy savings potential from EE programs in 2035 (EPRI)

Codes & Standards: 7% energy savings impact of EISA in 2030

Variable Speed Heat Pumps

Over 30% energy savings in EPRI field studies

Flexible operation for DR, but may *increase* peak demand at max loading conditions



Enhanced comfort and control

Consumer Electronics

Proliferation of chargeable devices

TVs more efficient, more ubiquitous; 2.9 TVs per home (2.5 people per home)

Power is the limiting factor



Energy Controls

Growth of sophisticated, intuitive devices and apps for energy and demand management

Reshaping load curves



Disruptive Changes in Electricity End Use (Cont'd)

Plug-in Electric Vehicles

PEV sales growing faster than hybrids a decade earlier

200,000+ PEVs sold in U.S.

Projected to exceed 5% of new vehicle sales by 2020



Solar Photovoltaic

More solar installed in U.S. in last 18 months than prior 30 years

5x increase projected in U.S. over next 3 years

New residential PV system installed in U.S. every 4 minutes

Capacity value – questionable



Electrification

Advances in electric process heating, separations, and heat pump technologies for emissions reduction and productivity improvement



Natural Gas DG

Impact of \$4/MMBtu wholesale prices on economics of natural gas DG



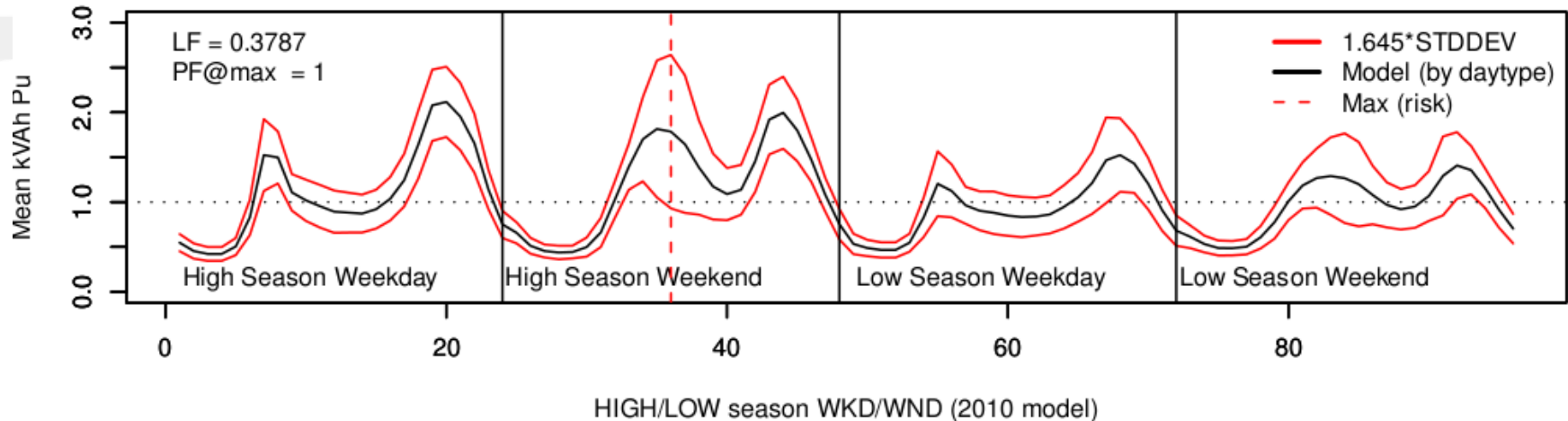


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Profile view

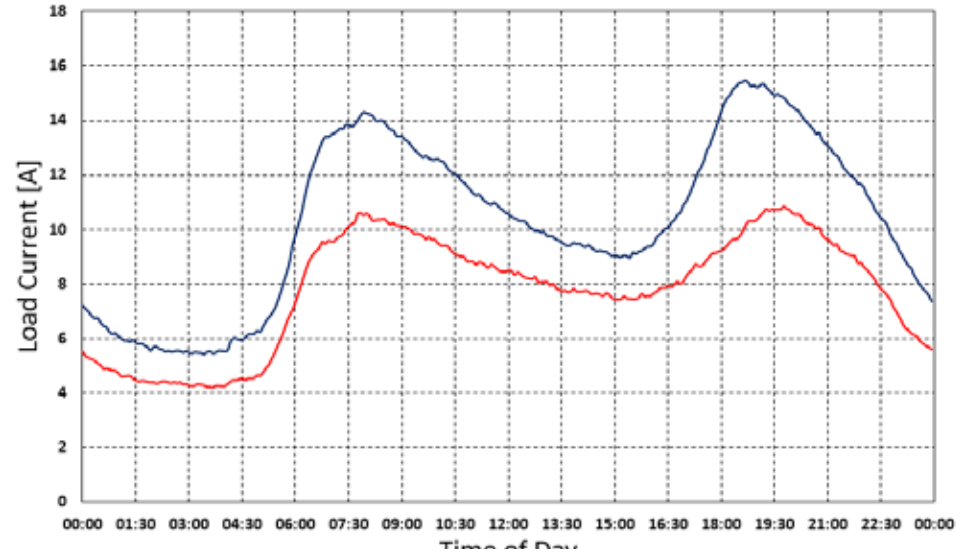


- A “seasonal version” of same DPET load shape will be found in GLF load sub-class library.
- A “localised” version of GLF will be found in DProfile mixer for same given consumption level
- All the tools referencing this consumer class (ie demographic) are based upon same underlying load models.
- Their visualisation may differ depending upon the analytic required for their application.

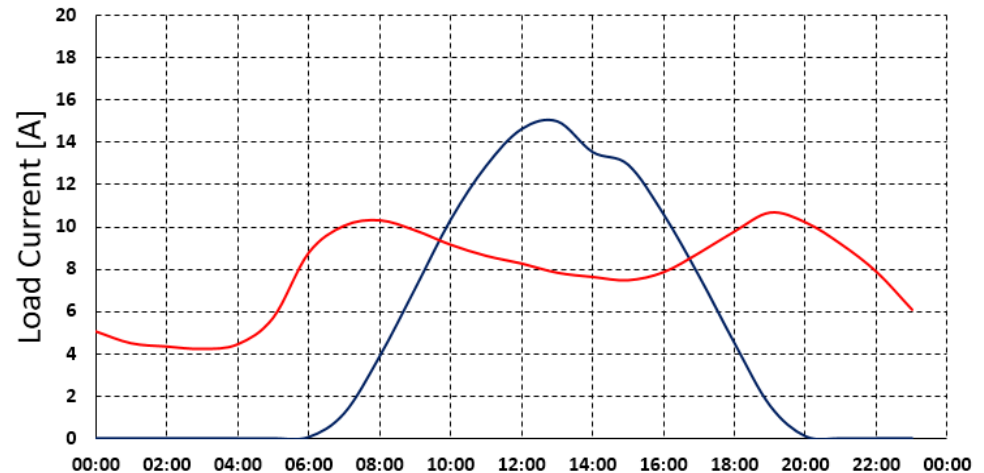
Scenarios Selection

- Characteristic load profiles
 - LSM 7-8
 - Variation of load and generation
 - Single-phase vs. three-phase
 - Solar Water Heating
(Excluded in first phase)

Moreletta Park Load Profile



Moreletta Park Summer Load Profile with solar PV



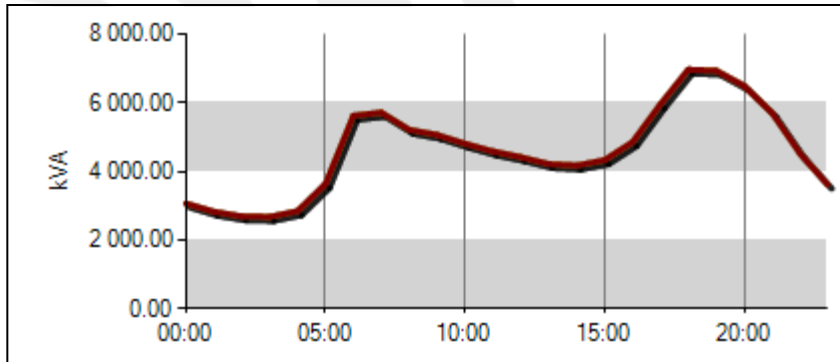
Time of Day Dr Gerhard Botha - Eskom
 — Solar PV — Summer Load



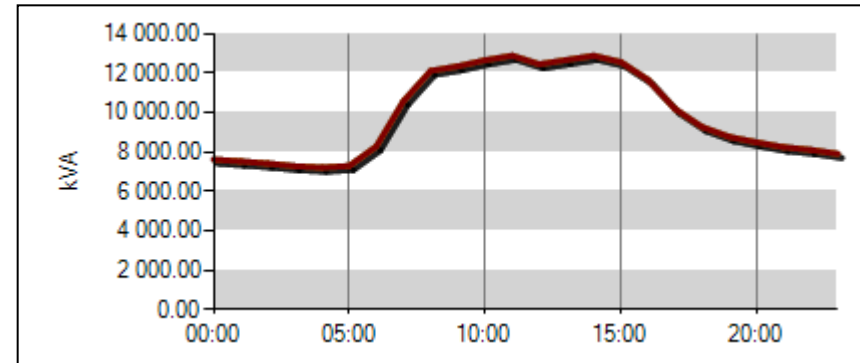
Supply Options and Resultant Profiles

Option 1

Transformer 1: HI Res, Low Income, Med Income

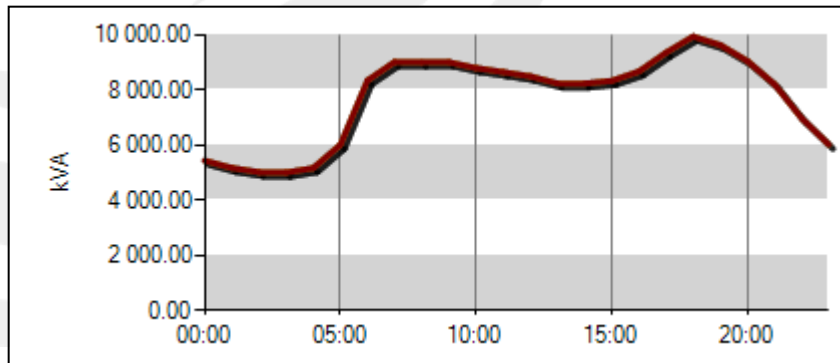


Transformer 2: Industrial, Office Park, CBD

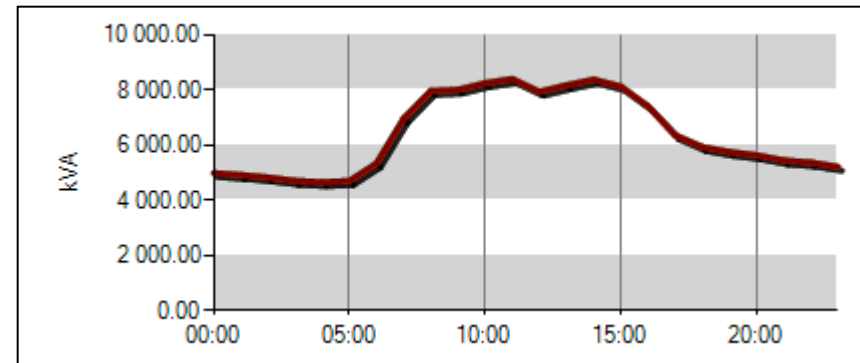


Option 2

Transformer 1: CBD, HI Res, Low Income



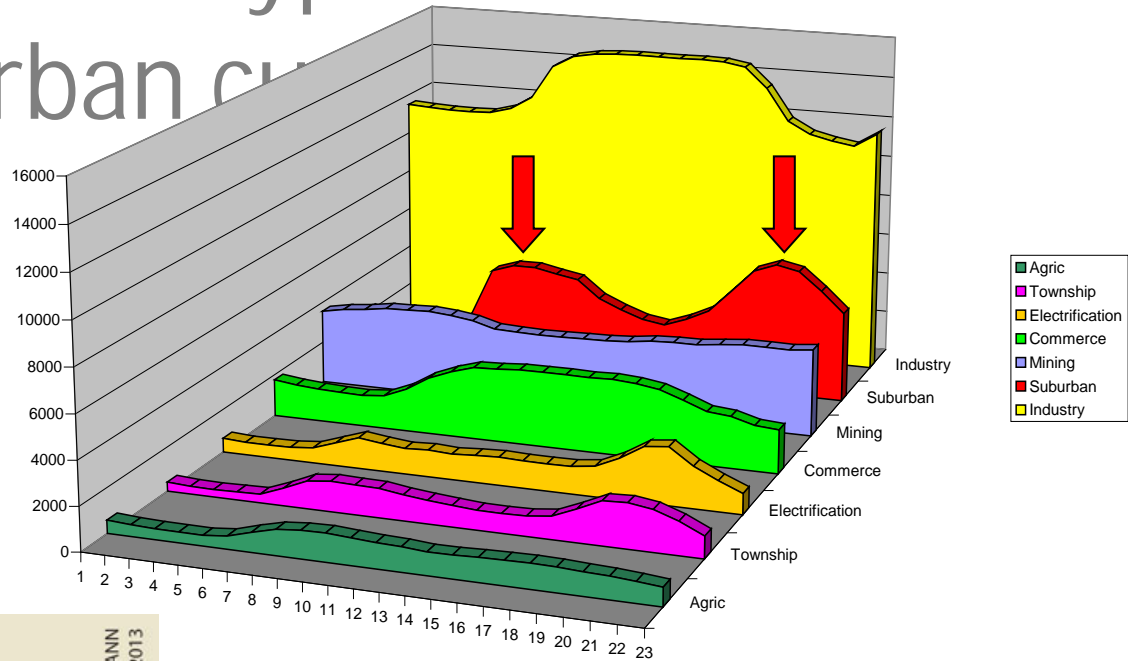
Transformer 2: Industrial, Office Park, Medium Income



Average weekday peak electricity usage of a typical residential suburban customer

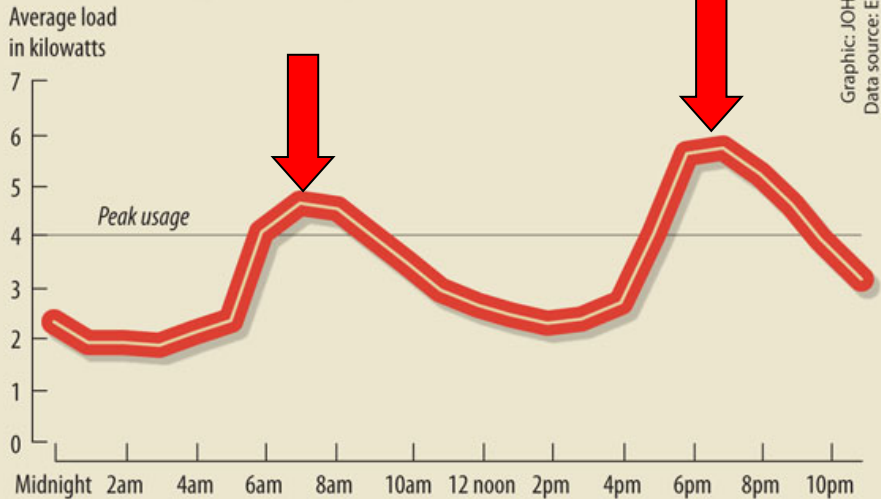


- The residential sector uses about 17% of the total electricity generated in South Africa



Peak electricity usage in 2013

Daily profile of a typical Eskom high-consumption residential customer

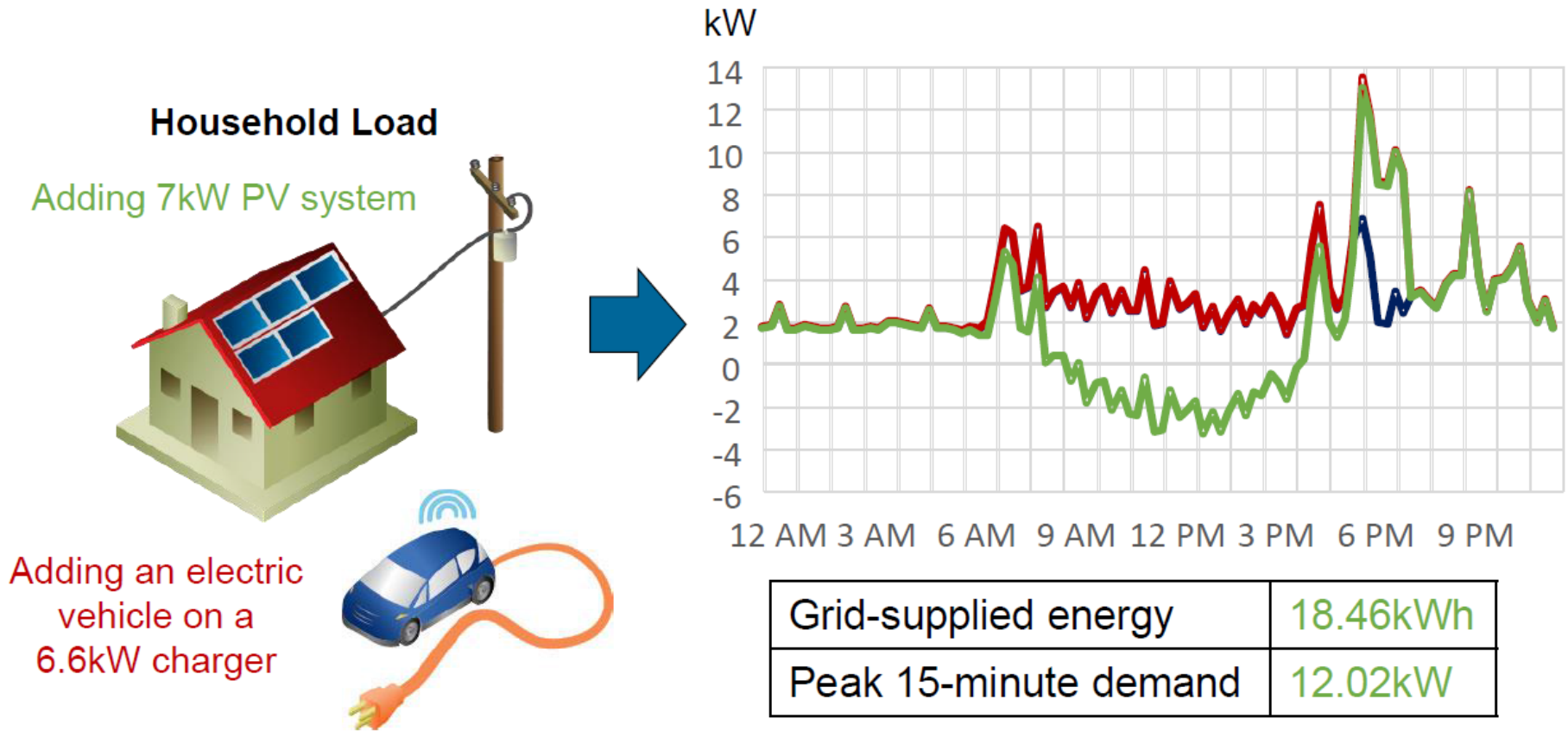


- From 7am to 10am in the morning, and 5pm to 9pm in the evening – periods of peak demand in South Africa – residential demand is up to 35% of the total demand required.

Source:
• Total End Use Consumption – Eskom ISEP/DSM
• Eskom Integrated Demand Management

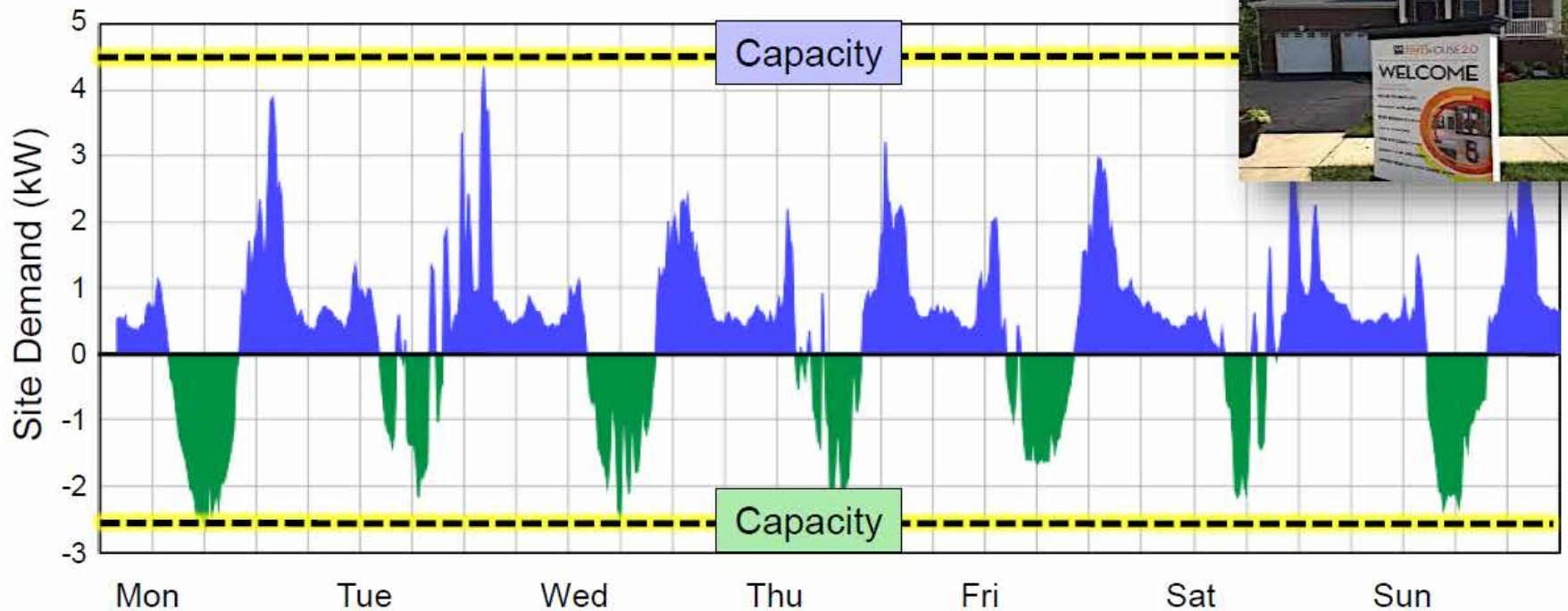
Vashna Singh

New Residential Resources



- New types of sources and loads may alter required capacity and energy
- Lack of diversity in generation/use increases capacity requirements

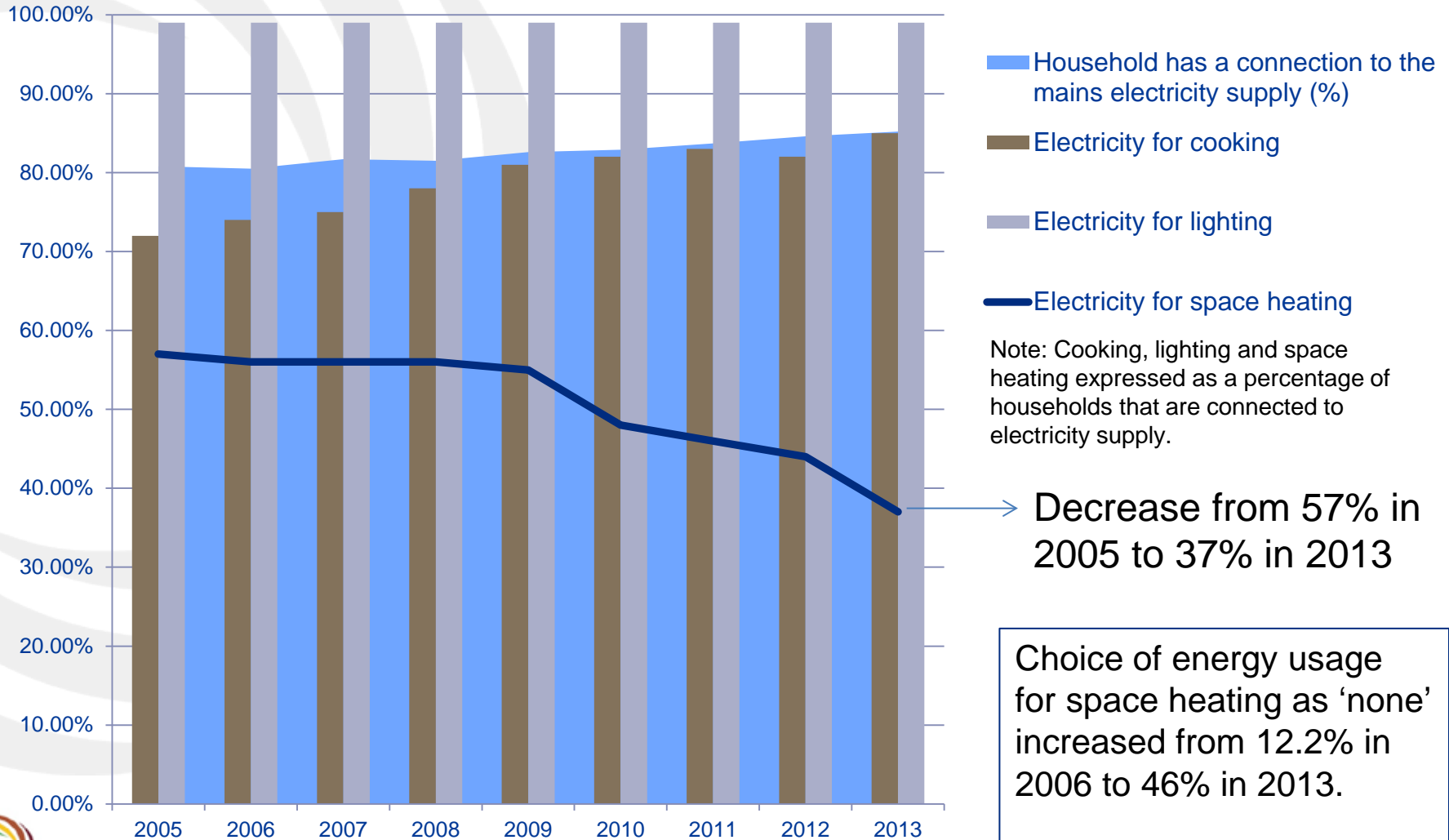
Zero Energy Home but Not Zero Capacity Home



Customer Sited Generation Will Impact Local and System Level T&D Infrastructure Planning



Households usage of electricity



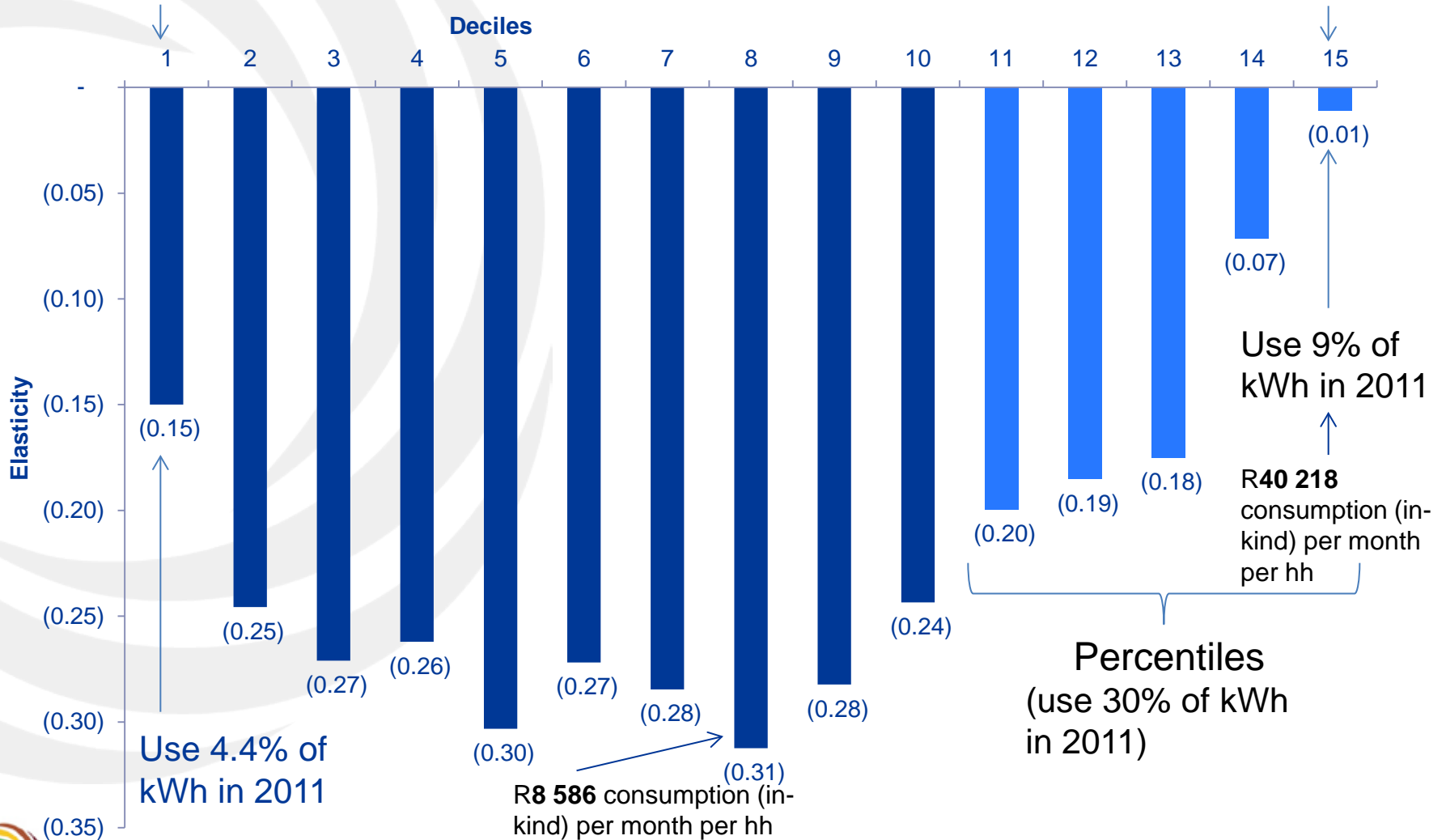


Direct price elasticity of demand

Poorest 10%

Richest 2%

Deciles





Outline

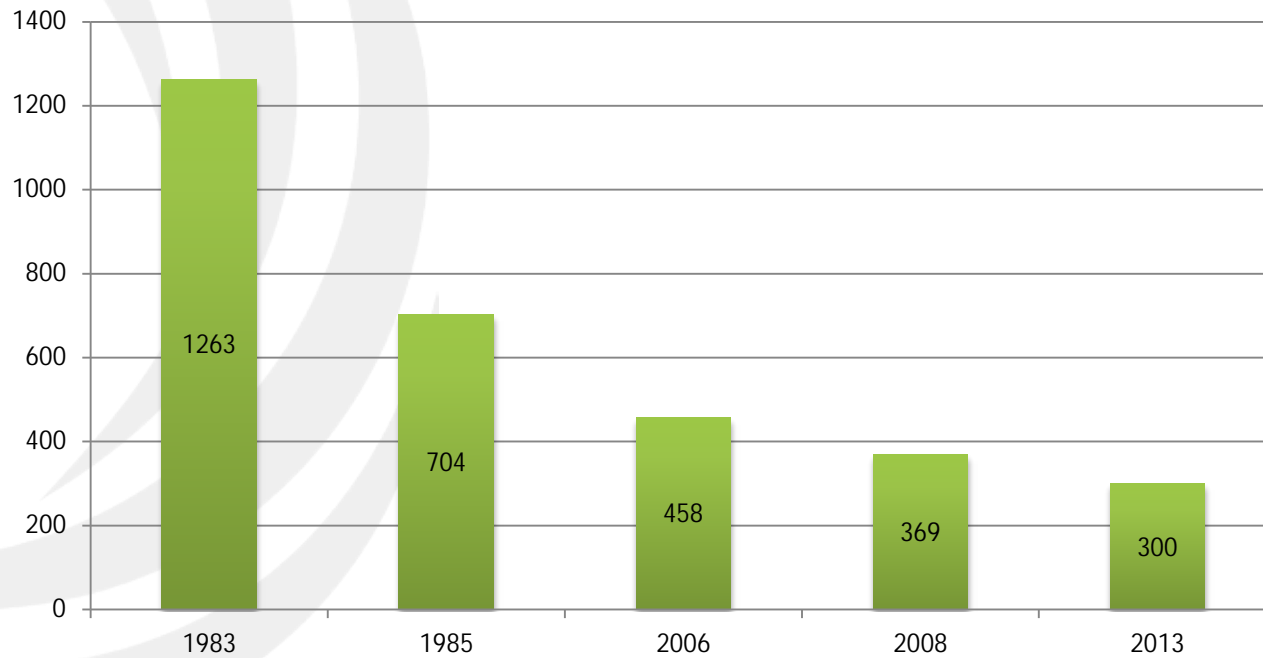
- Background
- Studies
- Load Profiles
- Individual data
- Investment decision





Energy Efficiency

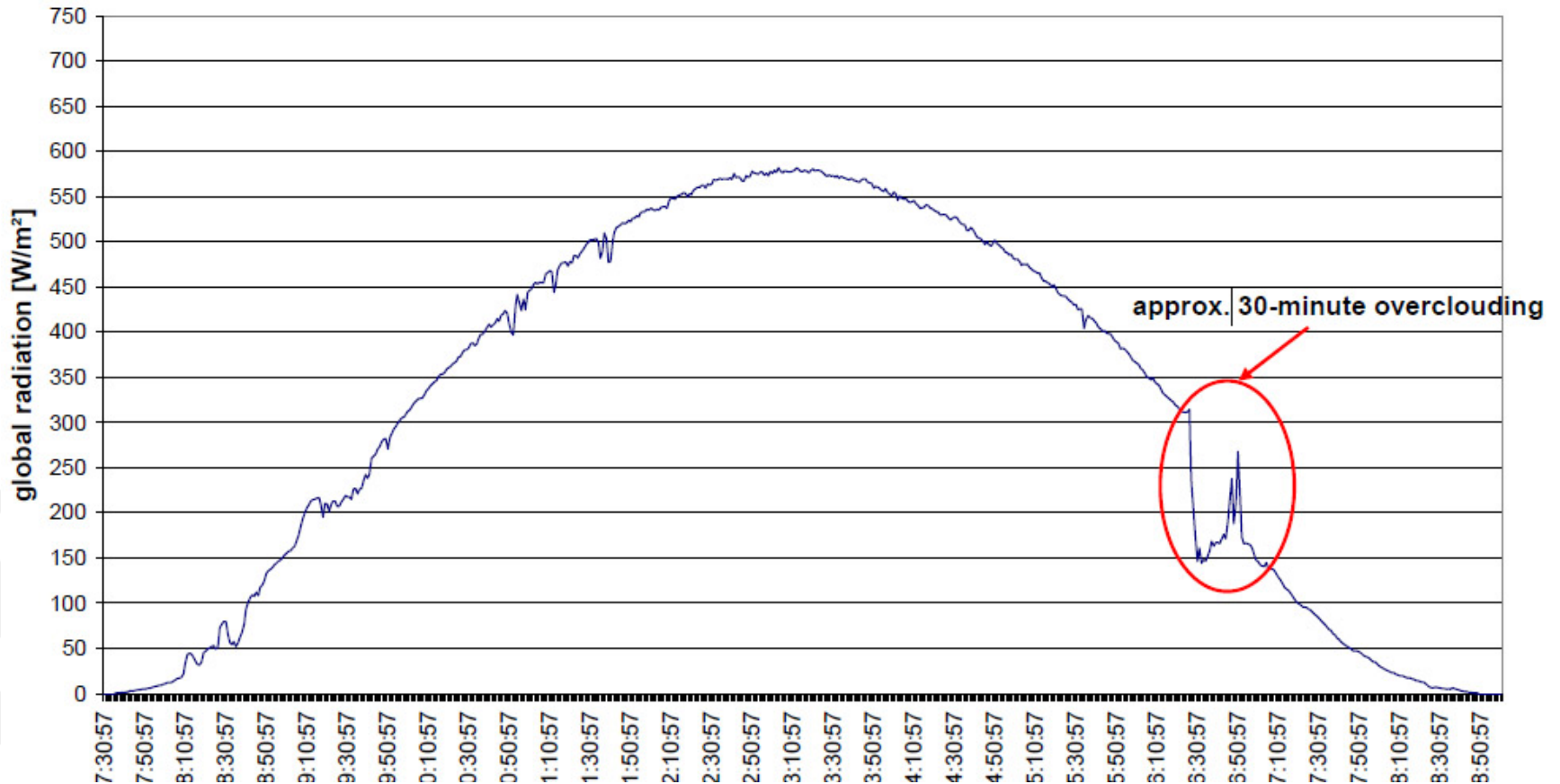
Average monthly consumption per year





PV generation and load

measured with pyranometer





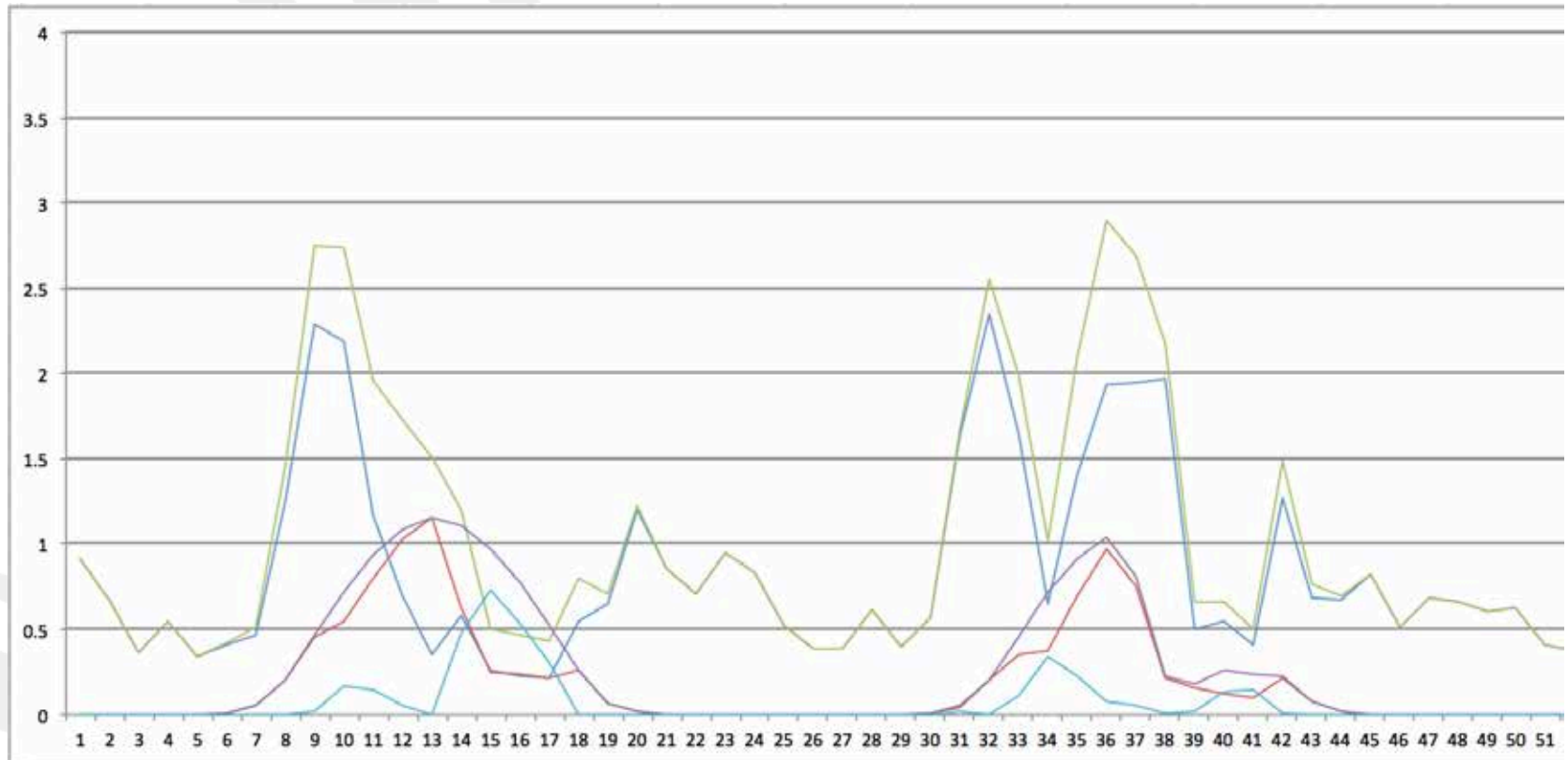
PV generation and load

	Consumption from CoCT	Consumption from PV	Total Consumption	PV Production	PV Fed in
Dec-13	506	127	633	219	92
Jun-14	898	89	988	150	60



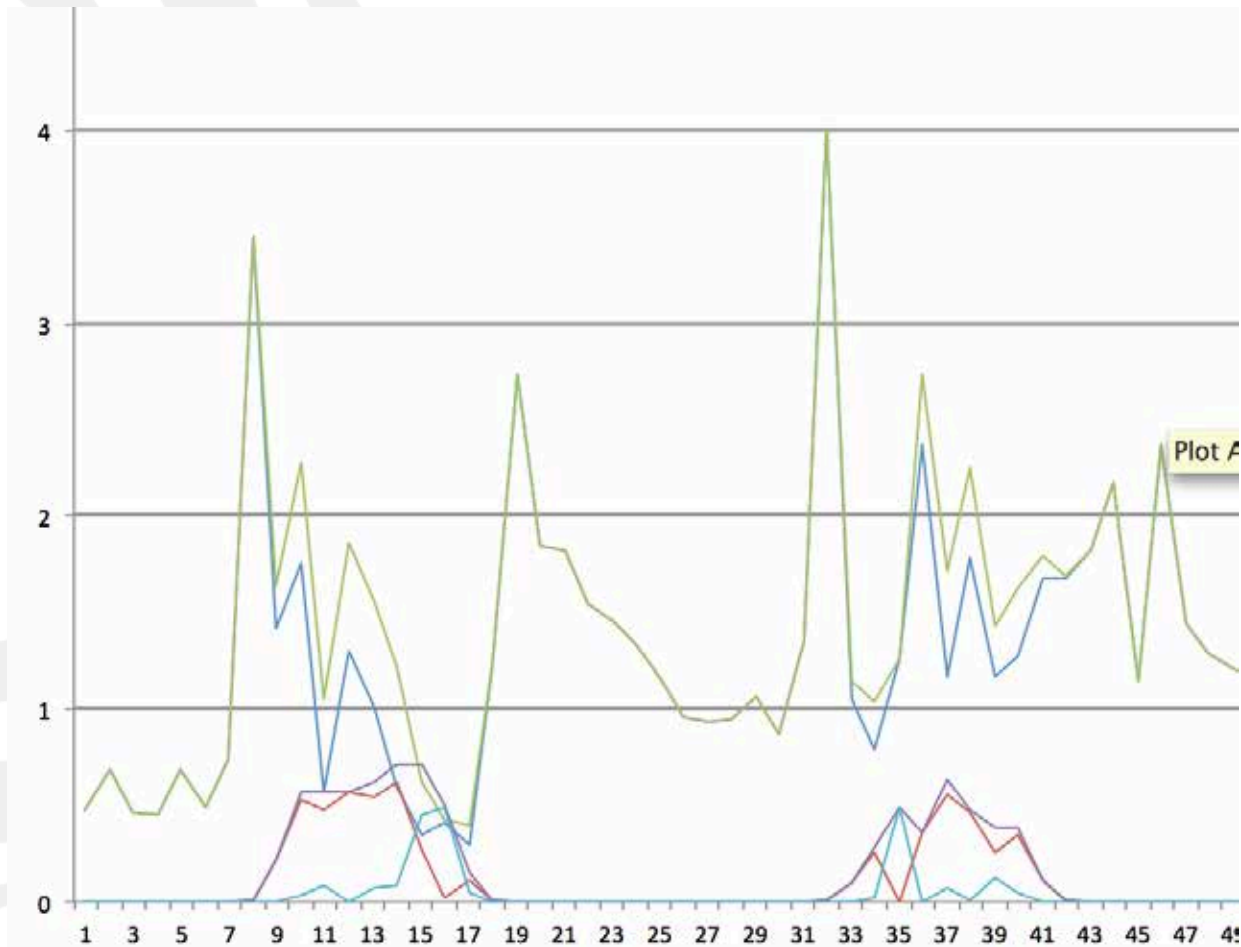


Dec 1 & 2





June 1 & 2





Outline

- Background
- Studies
- Load Profiles
- Individual data
- Investment decision



Investment decision

- Installation cost
- Admin cost (time)
- New meter
- Sign off
- Tariff



Thank you

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