Cycle of Round Tables – "APREN and the Universities" | Day of the Sun

Solar PV Production in Portugal

IST | 3rd of May of 2018

CENTER for INNOVATION, TECHNOLOGY and POLICY RESEARCH

Sónia Martins da Cunha

The impact of solar PV generation in cities

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Context

By 2030 **60%** of the world population will live in cities…

United Nations, The World's Cities in 2016

… and **one in every three** people will live in cities with at least half a million inhabitants.

United Nations, The World's Cities in 2016

On average cities account for more than **75%** of a country's GDP.

U.N. Habitat

Cities consume about **75%** of global primary energy.

U.N. Habitat

80% of the world's GHG emissions (direct and indirect) come from cities.

U.N. Habitat

In 2016 only **3%** of the worlds primary energy came from renewable sources

BP Statistical Review of World Energy 2017

Solar potential in urban areas


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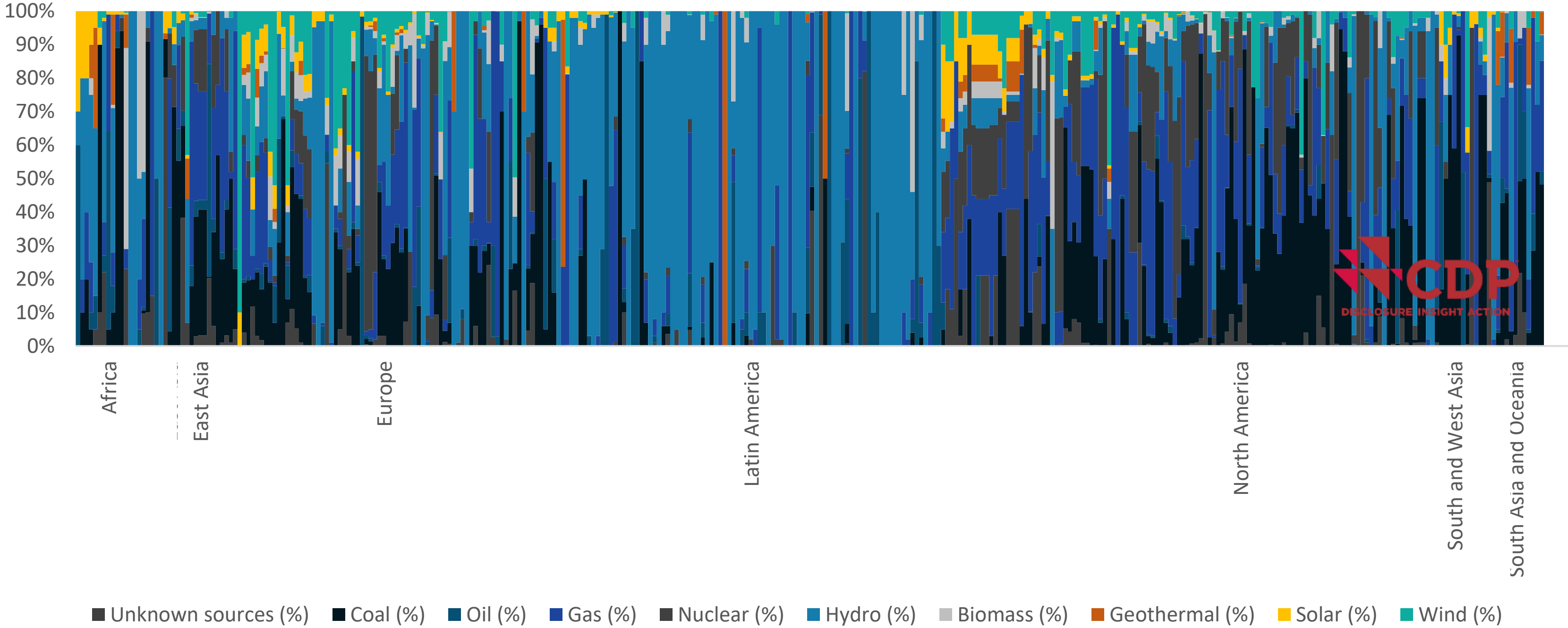
Cities

More than 100 cities now mostly powered by renewable energy, data shows

The number of cities getting at least 70% of their total electricity supply from renewable energy has more than doubled since 2015

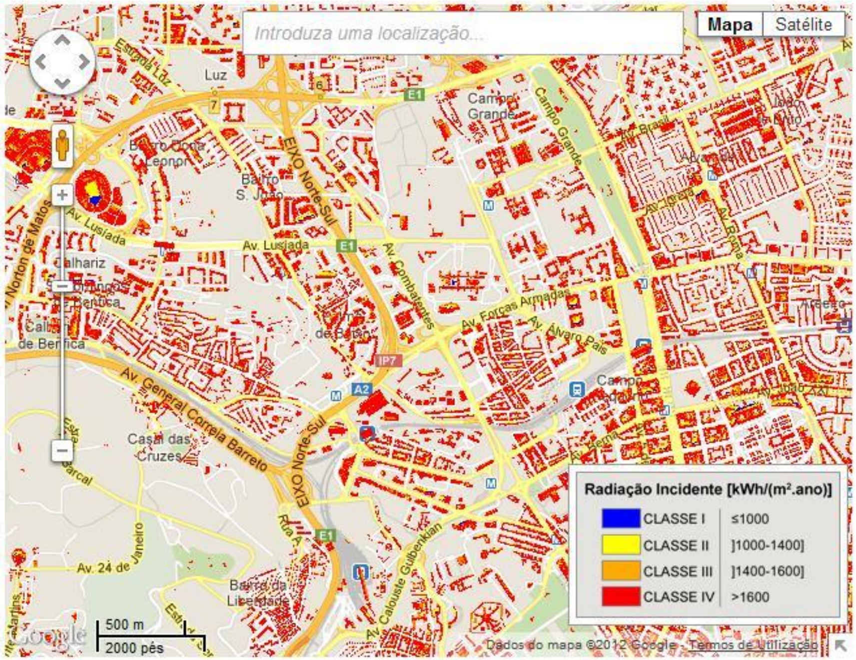


Solar potential in urban areas

	Urban planners	Distribution grid operator	Electricity sellers	Business owners	Citizens
+	Urban resilience Urban energy efficiency Urban air quality	Decrease grid loses Grid stability	Become load flexibility aggregators New business opportunities	Reduce electricity related operation costs	Decrease utility (electricity) costs Reduction of heat island effect and cooling needs
-	Visual impact	Increase in load frequency	Sell less electricity	Depending on the activity and installed power, payback times may be too high.	Large initial investment Visual impact Glare risk

Solar potential in urban areas
Lisbon

Estratégia Solar de Lisboa (2018-2021) aims to achieve 8 MW of installed capacity in the city by 2021.



Carta Solar, Lisboa E-Nova

Solar potential in urban areas

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By Diana Neves, Ian Scott and Carlos Santos Silva

A policy brief

Potential for Solar Photovoltaic (PV) adoption in Portugal

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Assessment of the techno-economic performance of PV panels in Porto, Lisbon and Faro.

- For different typical consumers profiles of different economic sectors;
- Considering the best case scenario in terms of energy tariff and PV orientation;
- Discounted payback time
- Self-sufficiency rate

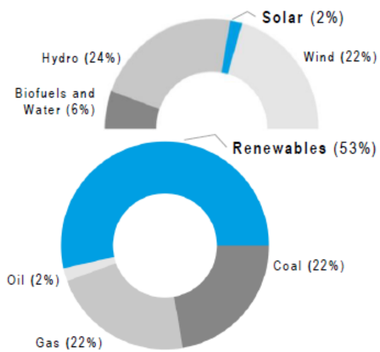

Figure 1.
Portuguese energy mix (i)

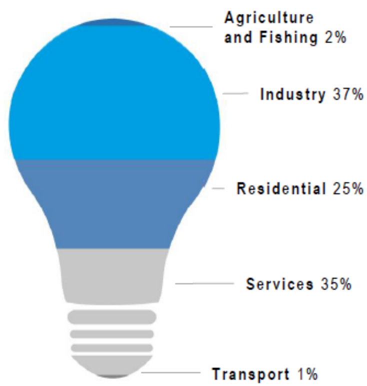

Figure 2.
Electricity demand per economic sector (ii)

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Residential

- Paybacks between 5 to 8 years
- Self-sufficiency rates between 6% to 20%

(depending on the size of the family and house occupation and electric equipment profile)

Services sector

- Highest potential for self-consumption
- Highest avoided costs
- Lowest payback times

Industry

- Paybacks between 4 to 7 years

(depending on the industry)

Faro reports the highest potential and Lisbon and Porto perform similarly.

Family A: Working couple, only home at night; optimal PV capacity: 0,25 kWp

Family B: Working couple, with two small children, benefit from time-of-use tariffs; optimal PV capacity: 0,25 kWp

Family C: Working couple, with three young children, half-day presence at home; optimal PV capacity: 1,5 kWp

Retail: Working-day demand, night and weekends with baseline consumption; optimal PV capacities 50-360 kWp

Hotels Working-day demand, increased consumption on weekends and holidays; optimal PV capacities 5-40 kWp

Industry Working-day profile, low demand on weekends; or a 24/7 profile; optimal PV capacities 20-1380 kWp

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- Policies should focus in providing **impartial information on KPIs** to minimize the investment risk for consumers.
- A **national simulation platform**, GIS based, would be a useful tool.
- If every residential consumer in Portugal installed 250 Wp it would represent:
  - An increase of **1.34 GW** of installed power;
  - A **246%** increase in production when compared with 2016;
  - **4.3%** solar contribution in electricity demand;
  - **326 kton** of CO_2 emissions avoided;
  - A **2.7M€** total private insvestment.
- Legislation and regulation for **new energy trading models**, specially peer-to-peer trading, must be advanced.

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Assessing the potential of solar energy use in urban neighbourhoods

By Sónia Cunha, Claudia Sousa Monteiro, André Alves Pina, Carlos Santos Silva

- Increase of world energy consumption.
- Increase of GHG emissions.
- Concerns for Energy security, equity and environmental sustainability.
- Decrease in photovoltaic panel costs.
- Large urban solar production potential.

Assessment of opportunities and constraints in large scale deployment of solar microgeneration in urban areas

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Assessing the potential of solar energy use in urban neighbourhoods

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Lisbon, Portugal

442 ha
3145 buildings

SusCity project

Construction period

- <1919
- 1946-1960
- 1961-1990
- 1991-2005
- 2006-2011

Building use

- Residential, multi-family
- Residential, single-family
- Non-residential

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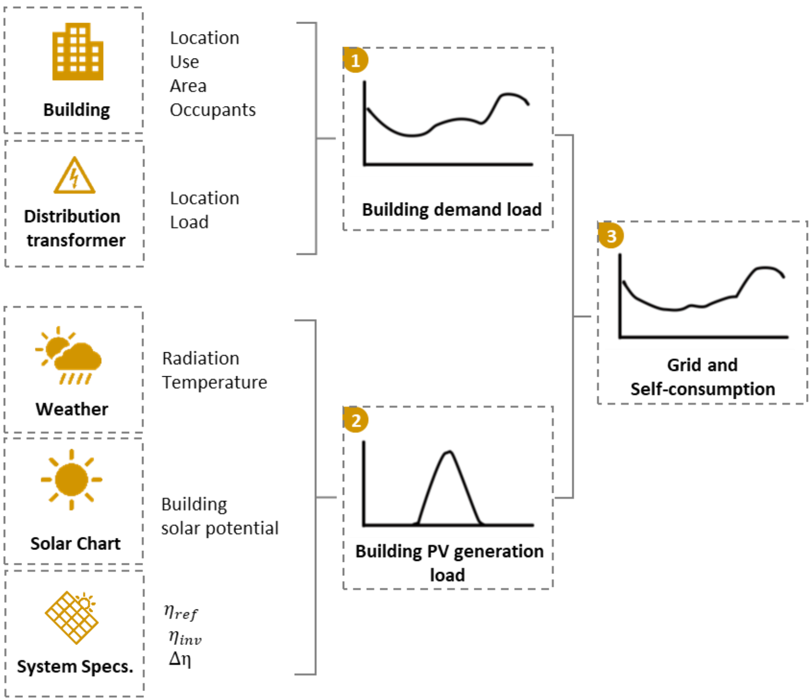

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Tuesday, 16th of June 2015

Building electricity consumption

Building electricity production

Building net electricity consumption

Residential
Non-residential

Grid consumption
Excess production

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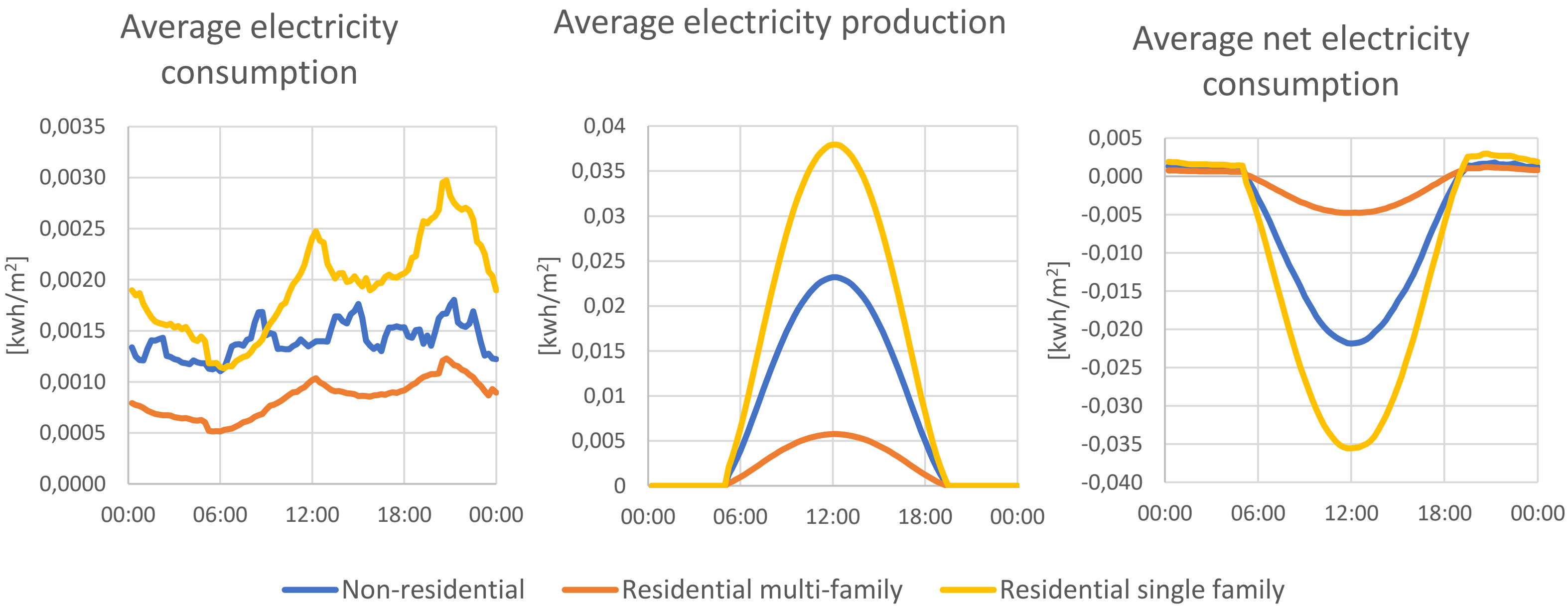

This approach enables the geographical visualization of consumption and production dynamics at an urban scale.

Research on

Integrate small-scale PV (after FIT) – the case of Portugal – P3

By Guido Lorenzi and Carlos Silva

Motivation

- Progressive reduction of FIT for small scale PV systems in Portugal made the sale of electricity to the grid unfavourable.

→There is a need to increase self-consumption.

Possible solutions

- Installation of batteries to store extra production – adapt supply to demand.
- Implementation of demand-response strategies to shift the DHW load – adapt demand to supply.

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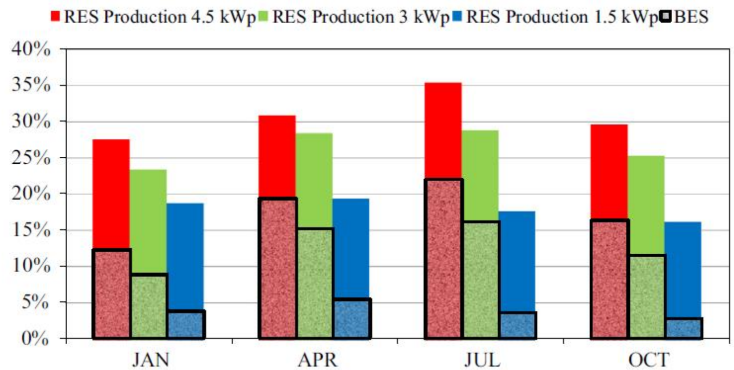
Modelling assumptions

- Model of a domestic **PV system** in Lisbon integrated with a **battery system** and **a smart DHW boiler.**
- Dual tariff scheme for energy purchase.
- Energy dispatch based on MIN operating cost.
- Test on 4 weeks in different conditions (seasons).



Conclusions

- Equipment cost not considered
- No optimization of the energy management
- Both strategies reduce the electricity bill
- DR has better performance than BES
  No charge/discharge efficiency
  No need to have the batteries charged

	(Actual) Storage capacity:	Specific cost (levelized):
Battery Energy Storage (BES)	5.12 kWh (DoD=80%)	10.1 c€/kWh$_{charged}$
Demand-response (DR)	4.4 kWh	1.24 c€/kWh$_{shifted}$

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Blockchain influence on energy price - An analysis of different levels of flexible demand

By Diana Neves, Ian Scott and Carlos Santos Silva

Context

The new decentralized paradigm is expected to promote growth in peer-to-peer (P2P) markets and decentralized energy trading platforms, where consumers, producers, and prosumers trade directly with each other.

Research questions

→ What are the benefits of P2P energy markets over centralized ones?

→ To what extent is the market price structure influenced by different flexibility availability?

→ **Which are the implications for P2P blockchain design?**

Methodology

Development of energy system model, using an optimization algorithm to fit different combinations of **microgeneration surplus**, **flexibility availability** levels and **market price** structures.

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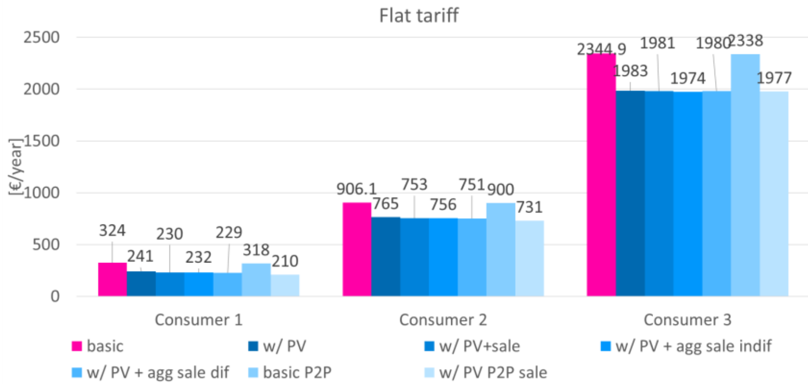
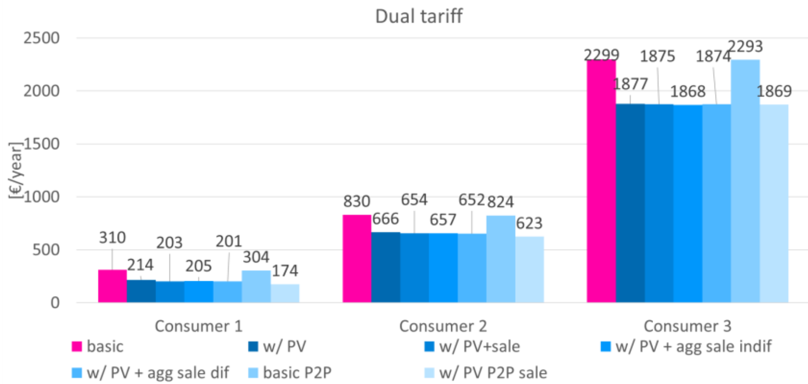
Aggregation: less than 1% benefits on the costs

P2P: benefits from 1% to consumers and up to 14% for prosumers

	Self sufficiency Rate [%]	Energy absorbed [kWh/year]
Consumer 1 Working couple Home at night PV capacity: 500 Wp	25.6	244.2
Consumer 2 Working couple + 2 kids Home at night PV capacity: 750 Wp	15.6	263.7
Consumer 3 Working couple + 3 youth Presence at home PV capacity: 1500 Wp	15.4	44.1





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- Which are the benefits of **market size** and **consumer diversification** in energy trading?
- How will active **flexibility** per user influence the decentralized market design?
- Does **blockchain** approach enable lower costs than aggregation platforms?
- Does the **blockchain** approach need to be continuously aided by a centralized energy market, in order to assure the security of supply?

General conclusions

- Cities are major electricity consumers and play an important role when planning a more sustainable future.
- It is important to provide citizens with unbiased data on KPI to reduce investment risk.
- Large scale deployment of PV panels can create new market dynamics and new business opportunities.
- Legislation needs to be updated in order to create opportunities for these new businesses to be created.
- Integration of new electrical systems can change the way we consume electricity.

Thank you!

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