GrEnFIn

Greening Energy
Market and Finance

Case Study on Renewable Energy Communities

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June 7th, 2021

DELAB®
ENERGY EFFICIENCY
& GREEN POWER

Project website: http://grenfin.eu

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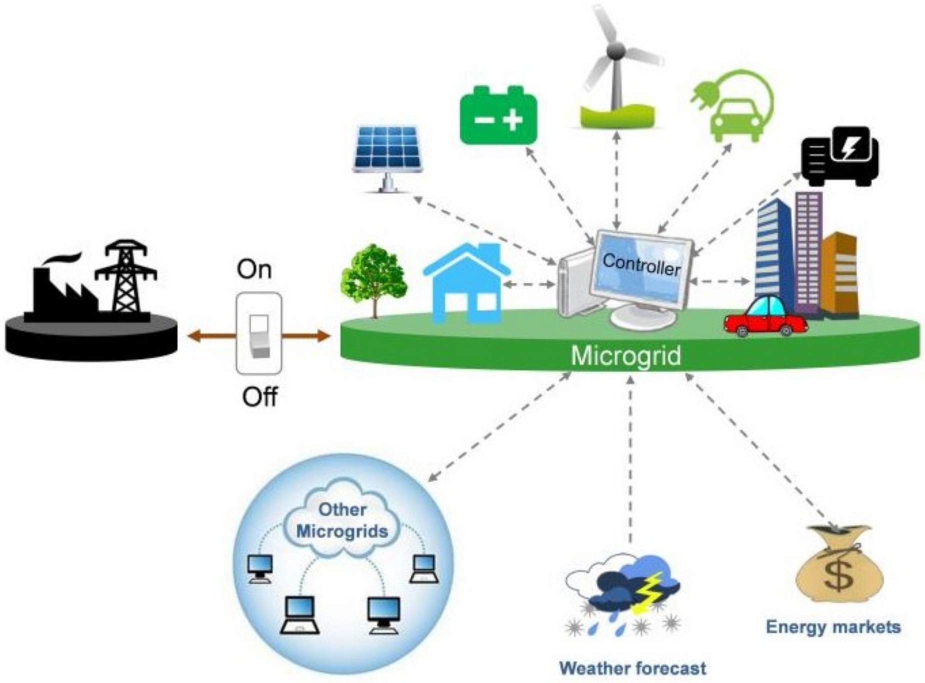
Renewable Energy Communities

- Local Energy Communities have been fostered for some decades now (District Heating, etc.).

- Enterprises typically managed by a local Public authority, a citizens-group or NGO, often in partnership with small and medium enterprises and energy utilities.

- RECs add the benefit of Green Energy sourcing.



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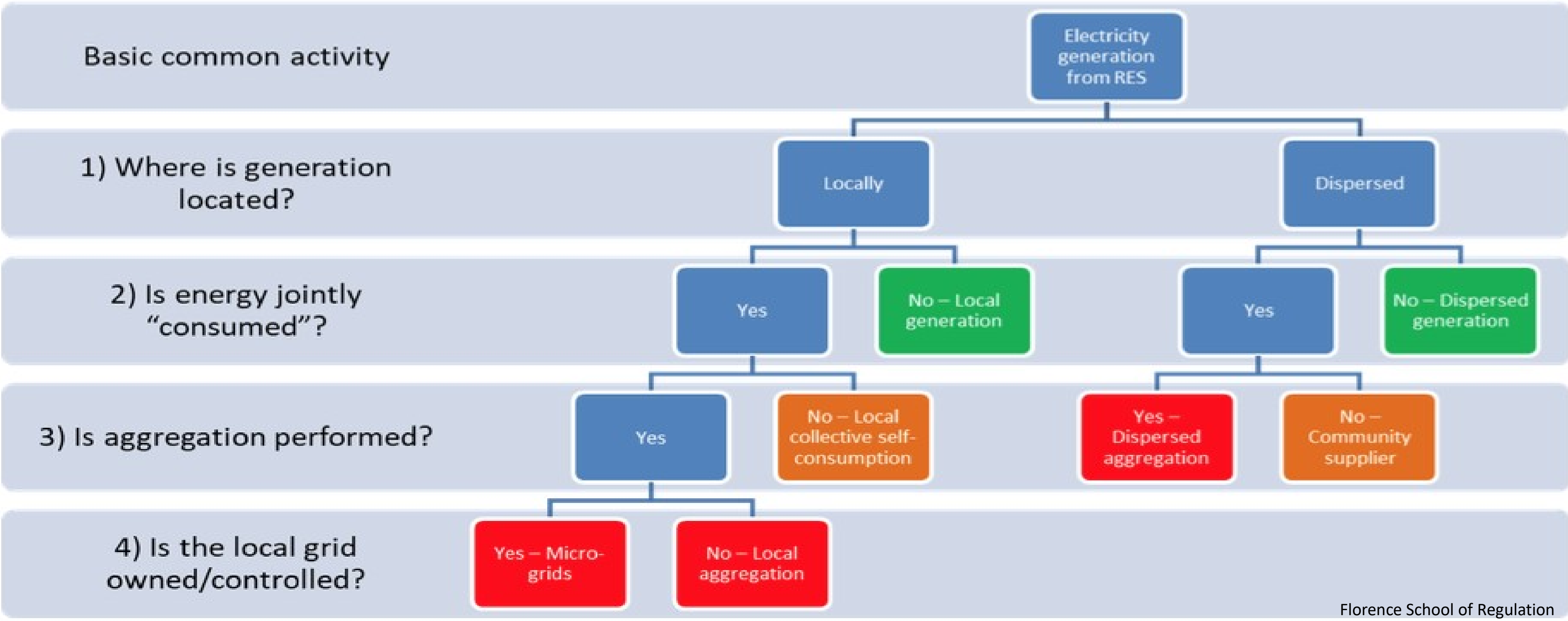
REC Possibilities



Clean Energy Package (2019, still being adopted and translated at national level) aims to stimulate Microgrids, where the produced energy is locally consumed

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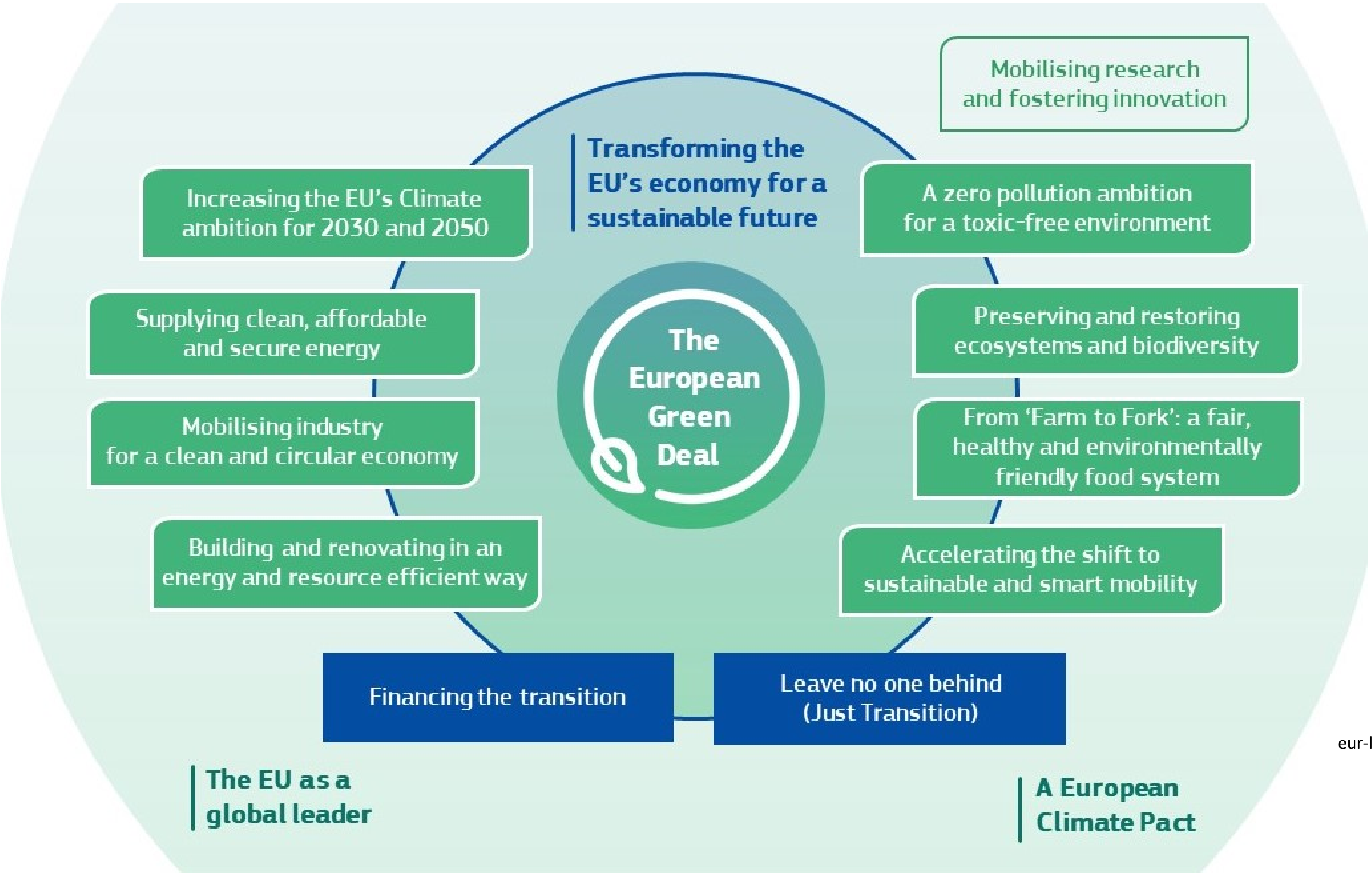
REC Context



eur-lex.europa.eu

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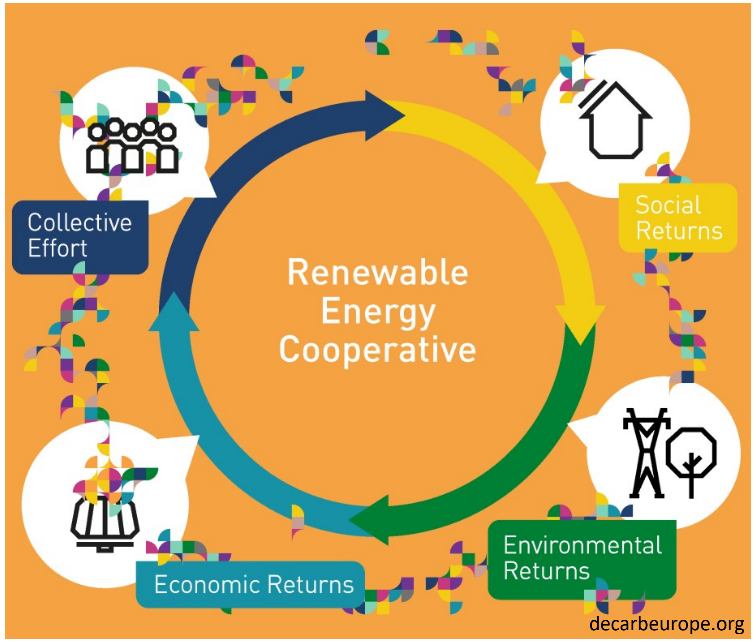
GE1

REC Advantages

- Energy system's improved efficiency, with fewer overall losses and waste
- Empowerment and accountability, greater transparency and flow control
- Green Energy sourcing and fewer GHG emissions from fewer transformation steps
- Local employment and circular economy



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Slajd 5

GE1 Gonçalo Elias; 2021-05-28

REC Opportunities

REC's are a growing phenomenon which involves a range of possible activities around renewable energy:

- Production;
- Supply;
- Storage;
- Distribution;
- Sharing;
- Aggregating;
- Consumption.

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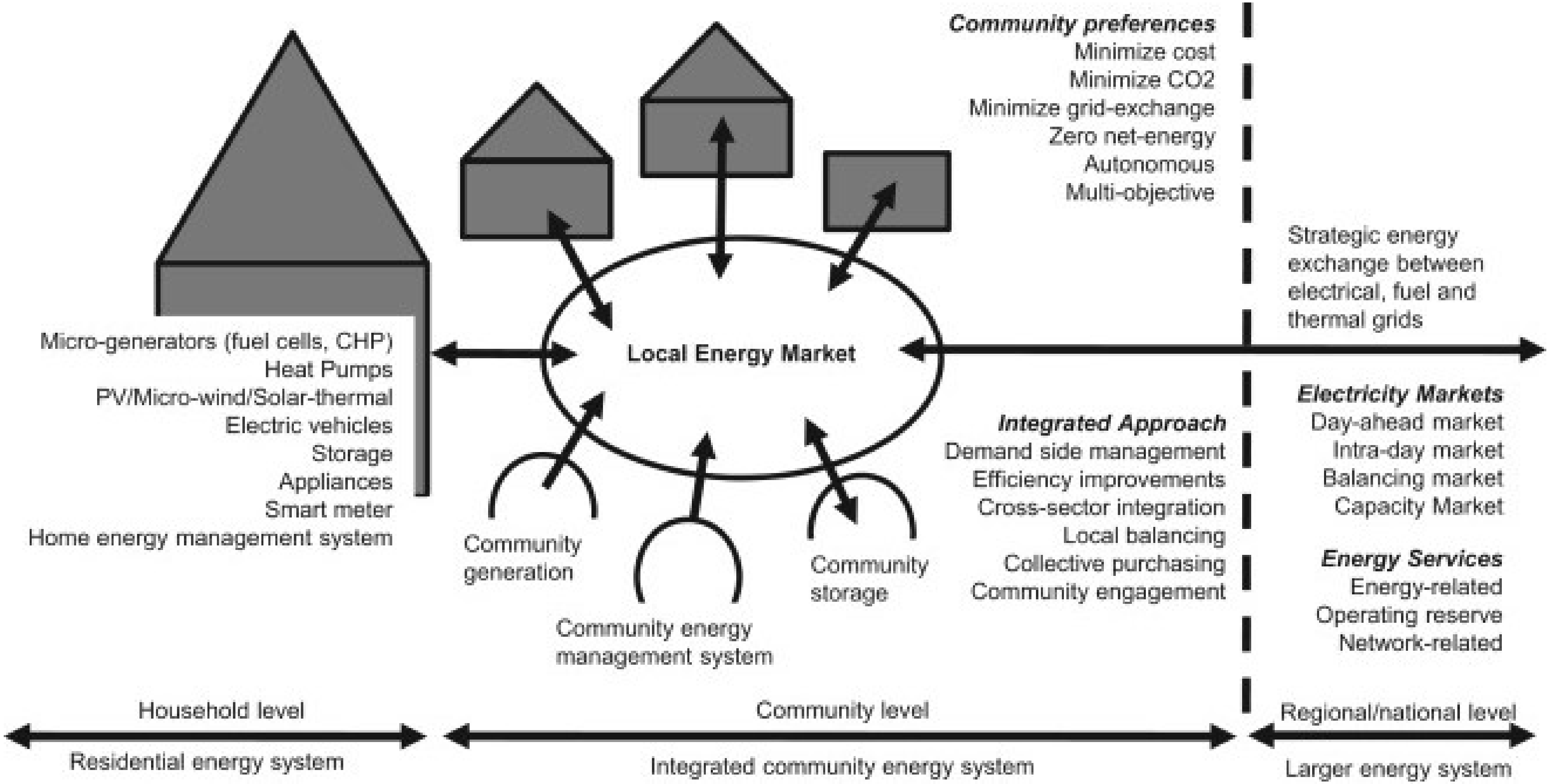
REC Structure: Context



Koirala et al., 2016

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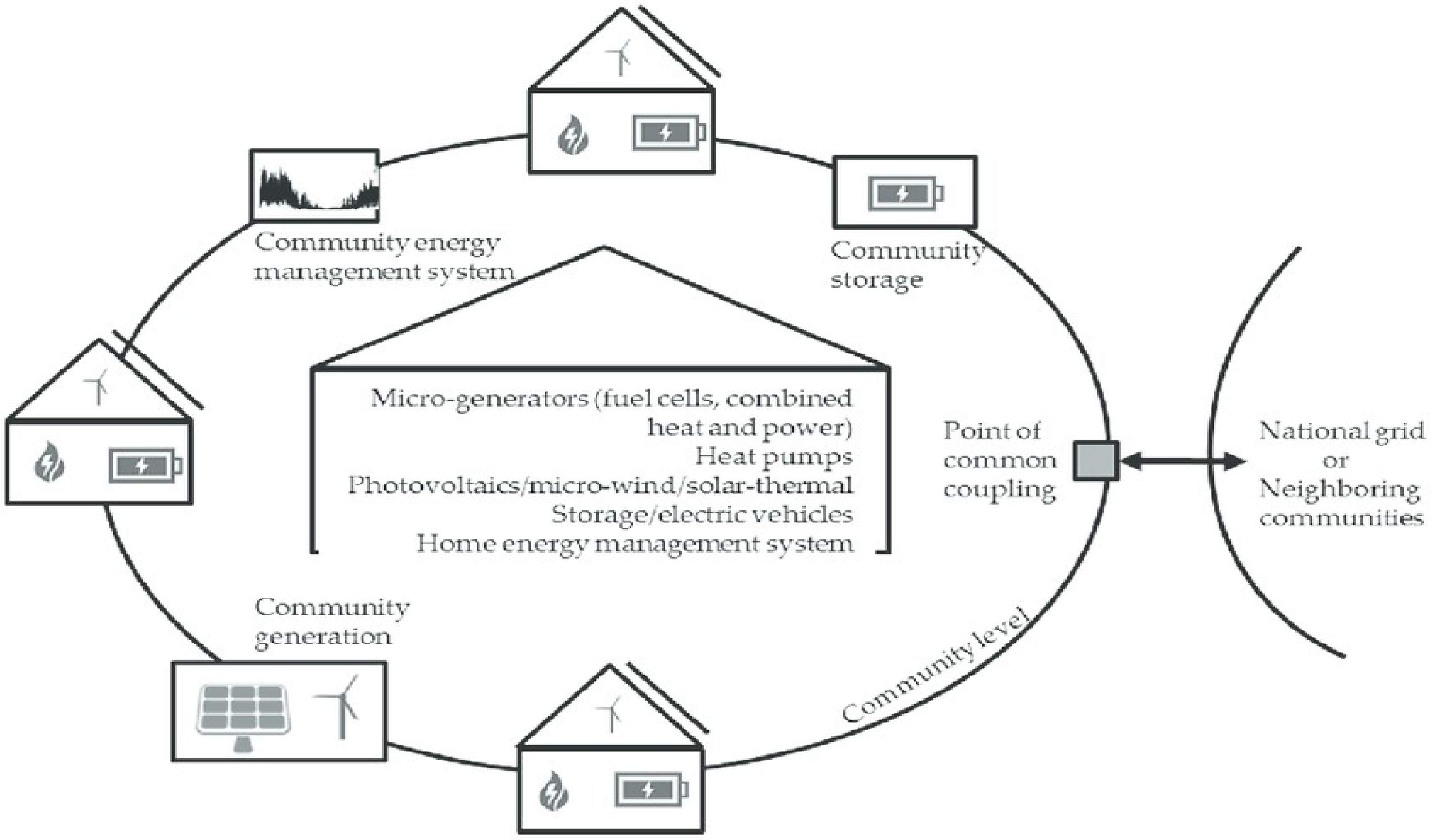
REC Structure: Functions



Koirala et al., 2016

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REC Structure: Agents

- Consumers: typically, many low-level units with little or no production capacity
- Prosumers: Existing middle-scale units with a history of consumption and with existing or eventual production capacity based on existing infrastructure
- Public Authorities: Existing consumption and eventual production capacity based on existing infrastructure
- Private Equity investors, Utilities, Consultants

Question: Who is the most important Agent?

REC Structure: Drives

- Consumers: Cheaper energy, lower carbon footprint
- Prosumers: Cheaper energy, lower carbon footprint, sale of the energy surplus
- Public Authorities: Cheaper energy, lower carbon footprint, reputation
- Private Equity investors, Utilities, Consultants: ROI, reputation

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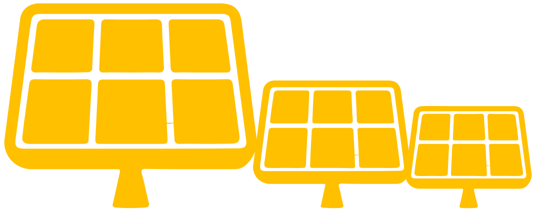
Prosumer

Person or group directly involved with the production of a good

(Toffler, 1980 - *The Third Wave*)

Adapted to



Substantial gap between:

- the high energy price the prosumer pays
- the low price of the energy surplus the prosumer sells (the energy the plant is generating in excess to the unit's consumption)

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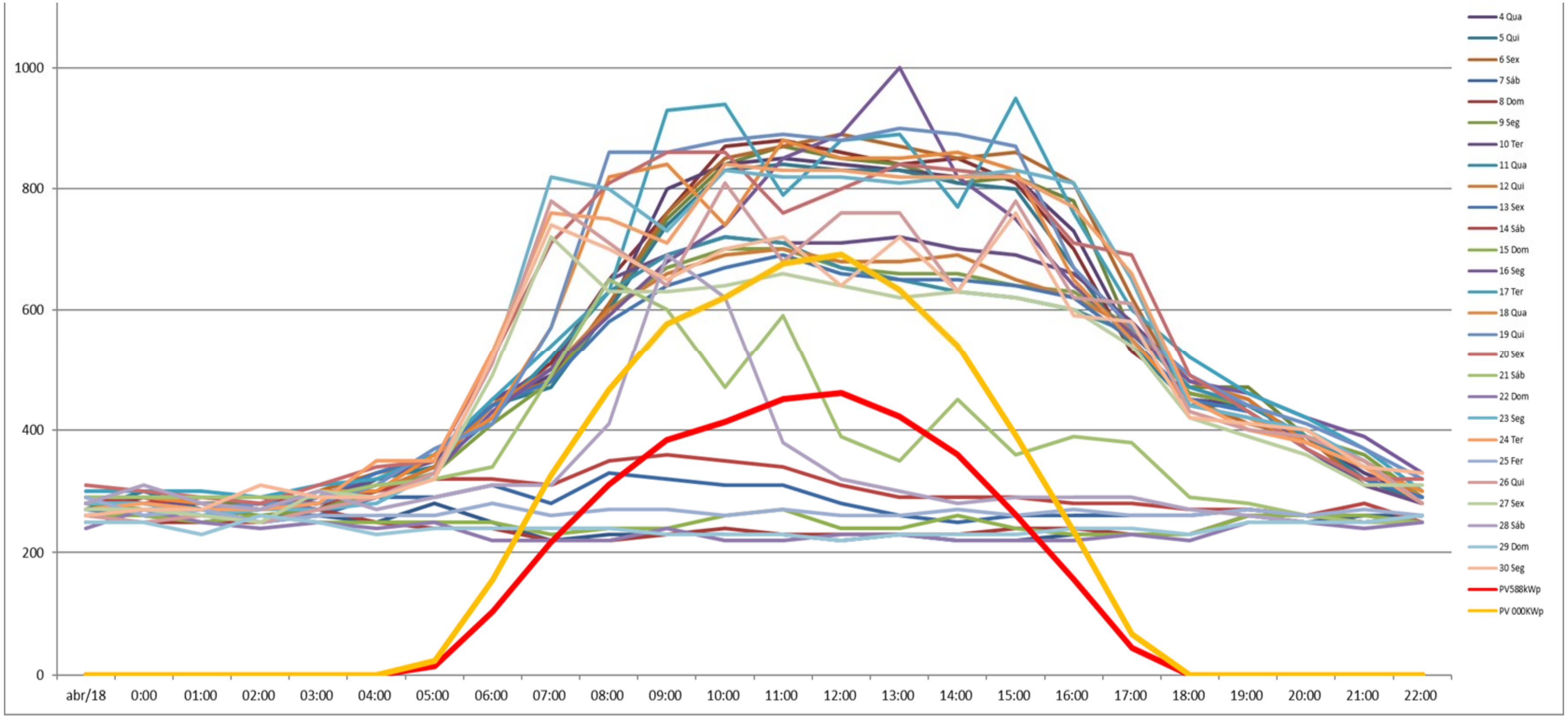
Prosumer



Prosumer’s baseload diagram and two different sizes of PV Plants

REC Implementation Design

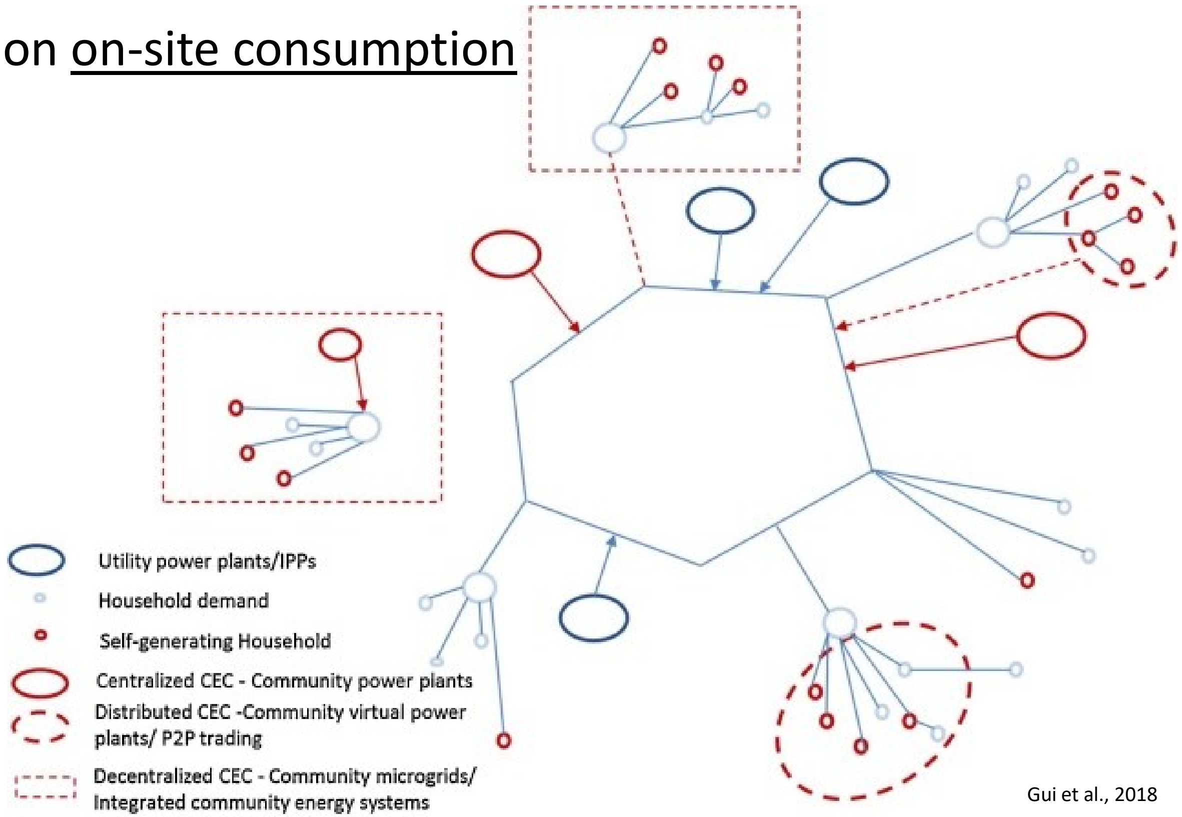
Wustenhagen et al., 2007

Input and acceptance must come from all agents at all levels

In Portugal, 1 MW limit for each (geographically continuous) REC

REC Implementation Design

- New production must be (geographically) near consumption sites
- Prosumers' sizing: focus on <u>on-site consumption</u>
- Public Authorities' infrastructures can be highly valued
- Several techs can be used but solar PV is currently the most viable



Gui et al., 2018

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REC Implementation Design – Case Study in Portugal

- Municipality wishes to take advantage of several infrastructures and propose a REC to the community
- Municipality manages six buildings with considerable consumptions and available rooftops for PV plants
- Some buildings located in densely populated areas and near private and public large consumers
- Municipality also manages seventeen schools with smaller consumptions with available rooftops for PV plants scattered throughout the territory

REC Implementation Design – Case Study in Portugal

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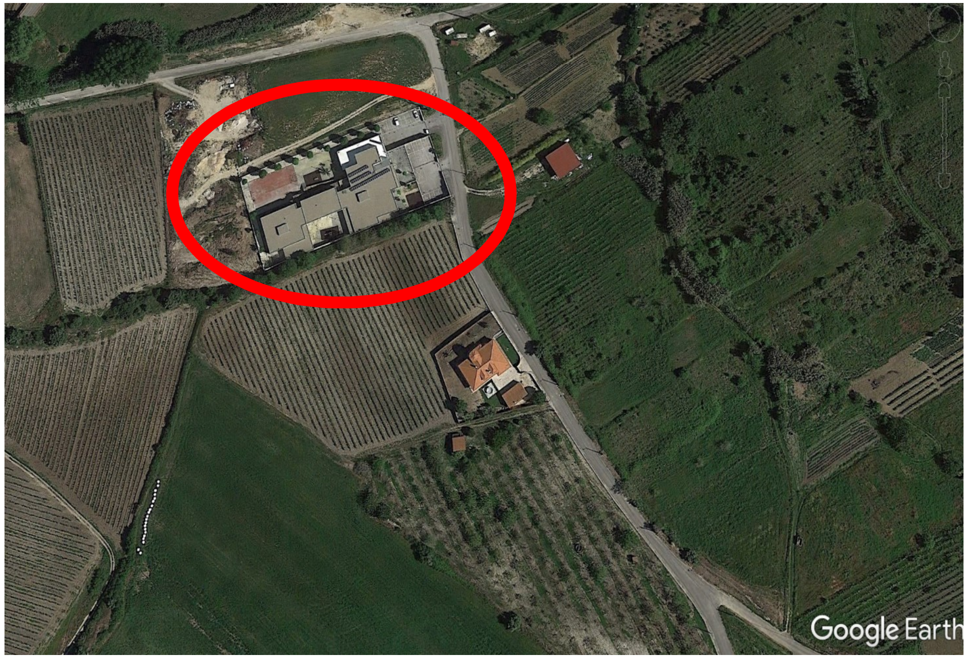
REC Implementation Design – Case Study in Portugal

Schools' size, and often considerable distance to other consumption possibilities, limit REC implementation on rural areas with smaller urban aggregates



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REC Implementation Design

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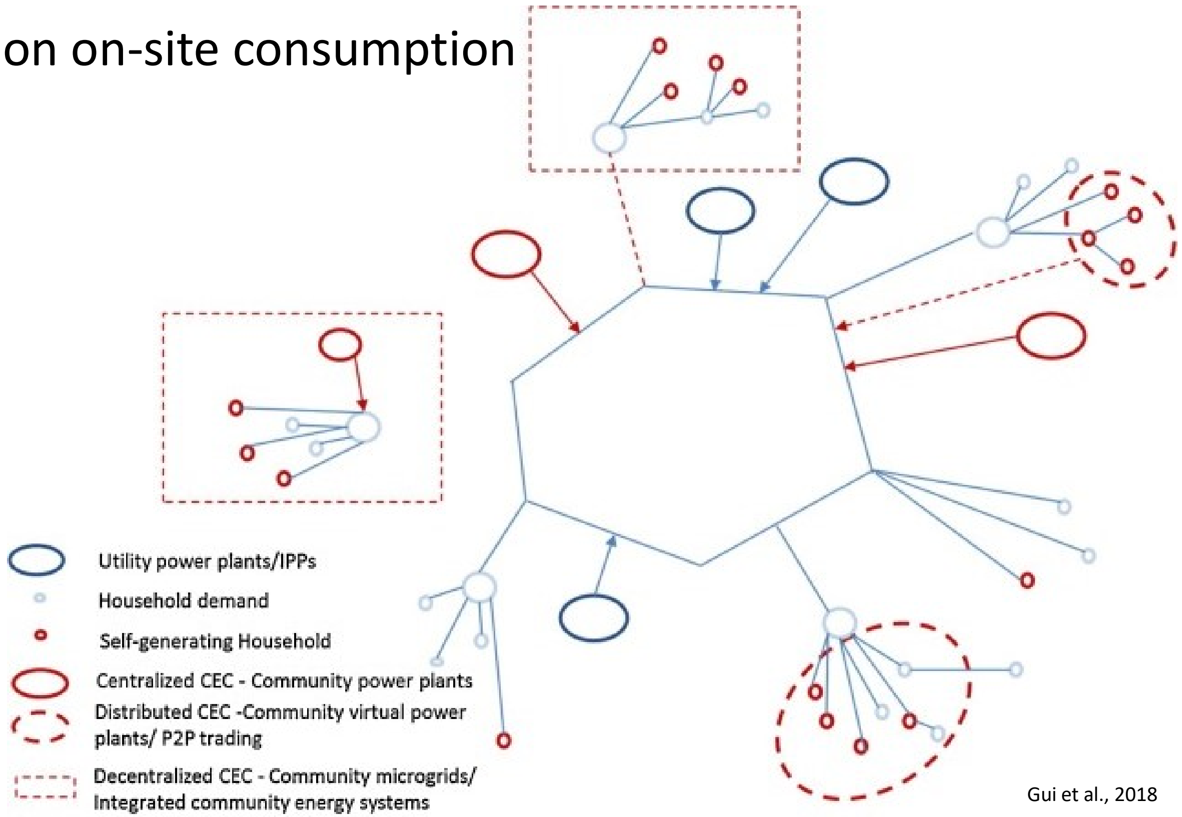

Gui et al., 2018

REC Implementation Design – Suggested Task I

- Design of a simplified REC based on Solar Photovoltaic project(s)
- Prosumers’ sizing: focus on on-site consumption.
- Selected the site, follow this methodology:
  - Calculate the site’s available area – Google Earth
  - Consider modules’ azimuth and slope (20° for flat surfaces)
  - Estimate plant’s power: around 1,5 kW per 10 m^2
  - Estimate plant’s Annual Energy Supply: PVGIS

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REC Implementation Design – Suggested Task I

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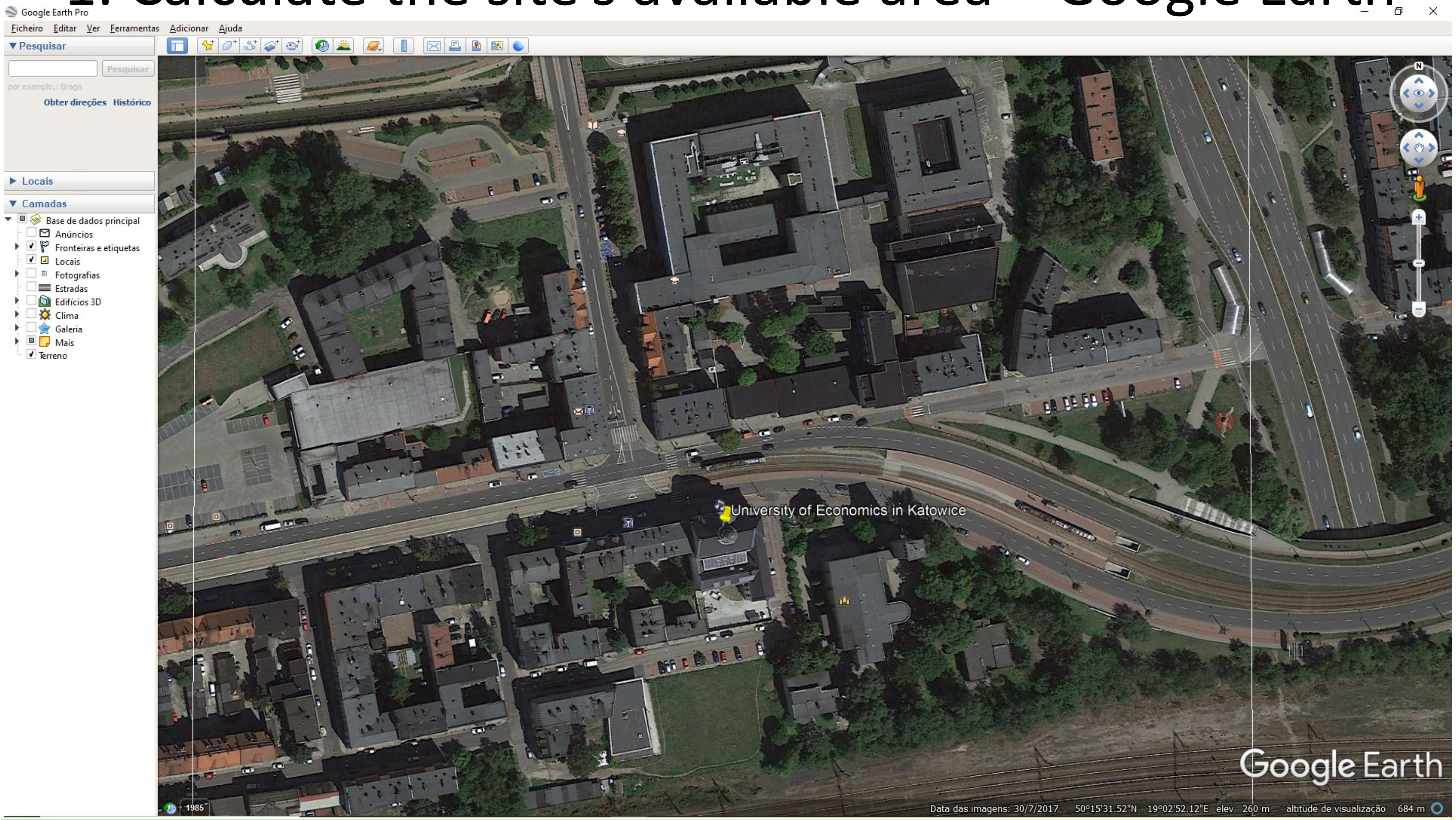
REC Implementation Design – Suggested Task I

1. Calculate the site's available area – Google Earth

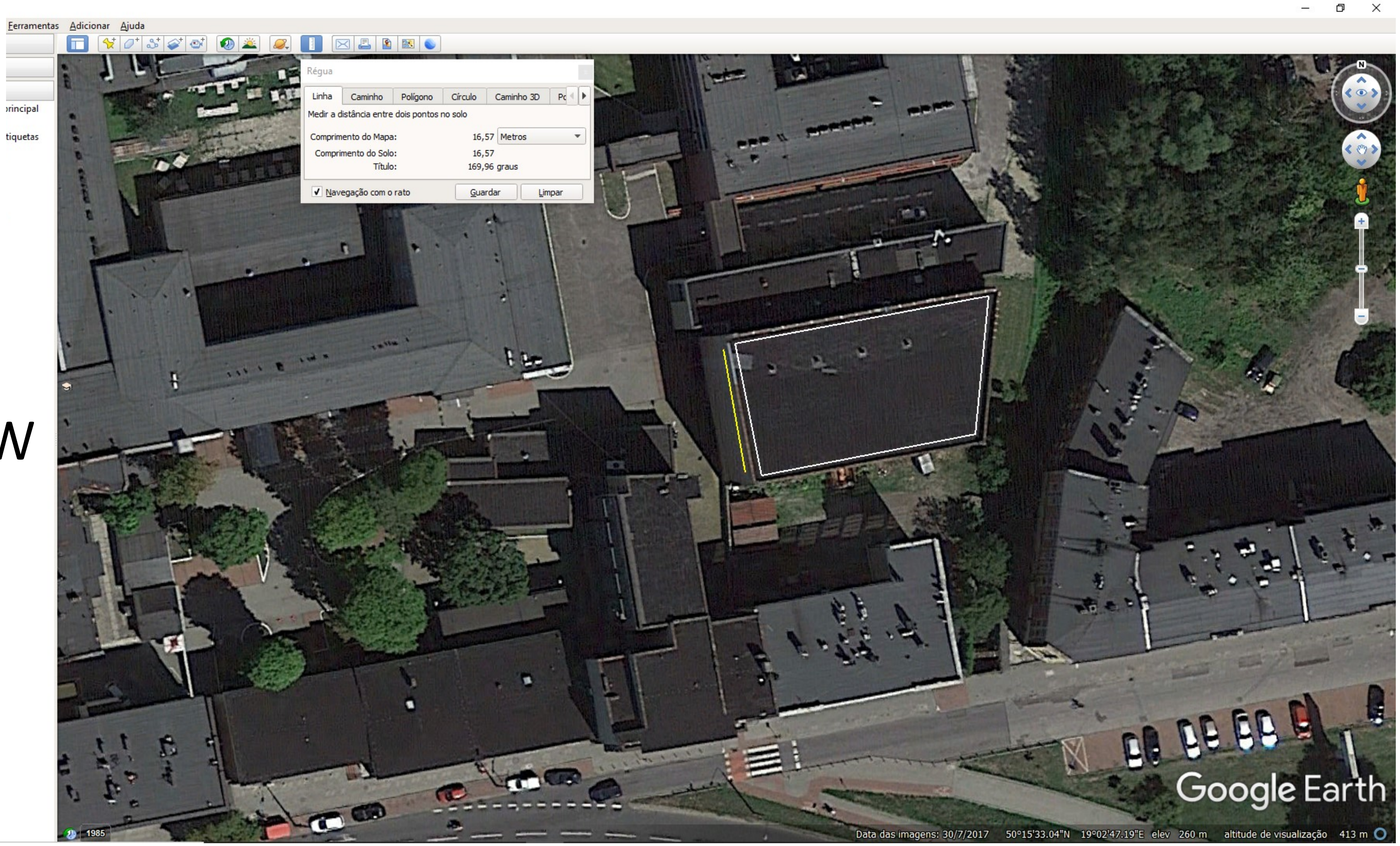


REC Implementation Design – Suggested Task I

1: Calculate the site's available area – Google Earth

2: Google Earth calculates Azimuth

3:
- $550m^2 \approx 82kW$
- Slope 20°
- Azimuth: 170° North is -10° South



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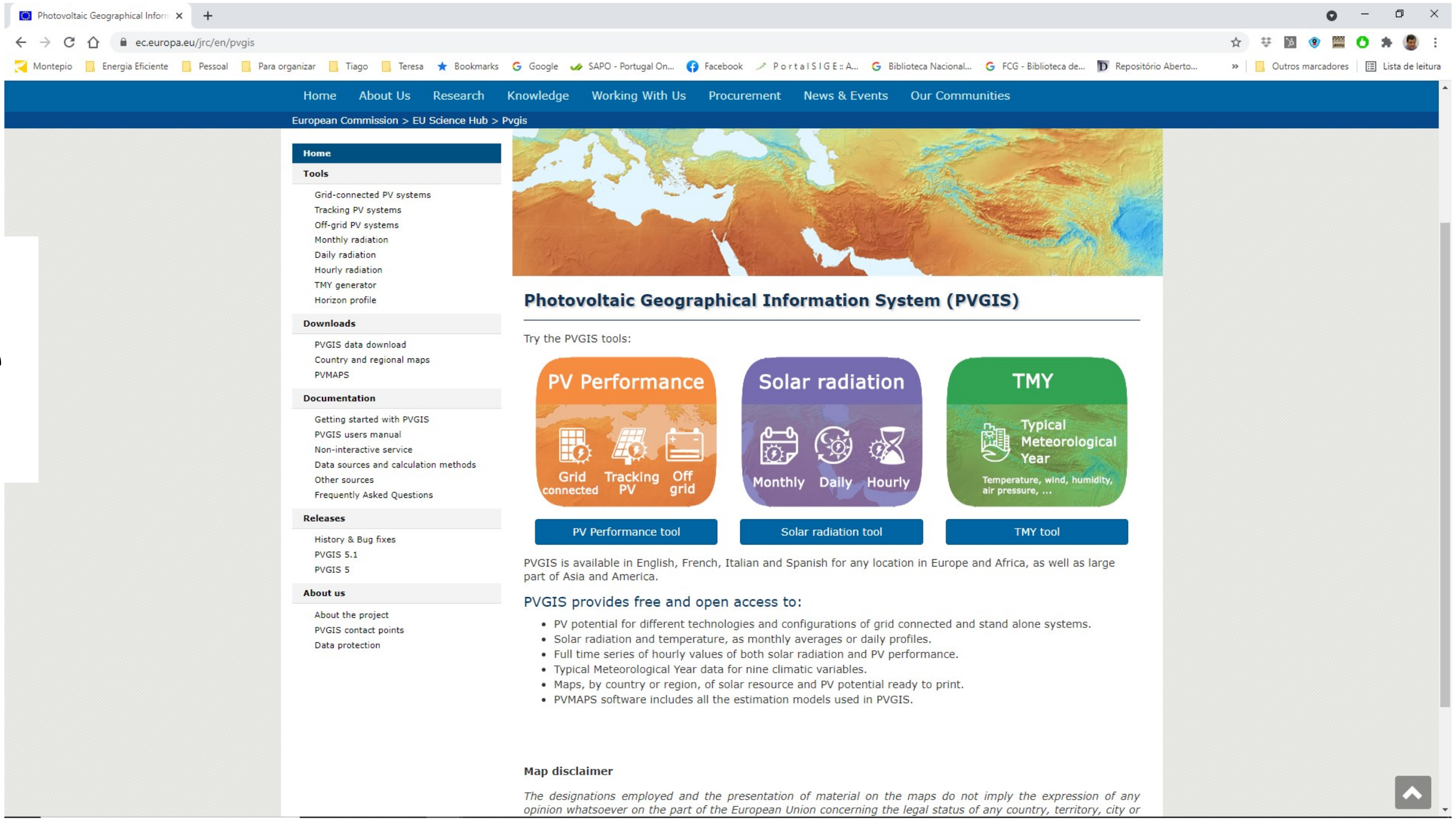
REC Implementation Design – Suggested Task I

4: Estimate plant's Annual Energy Supply: PVGIS
https://ec.europa.eu/jrc/en/pvgis

PV Performance Tool



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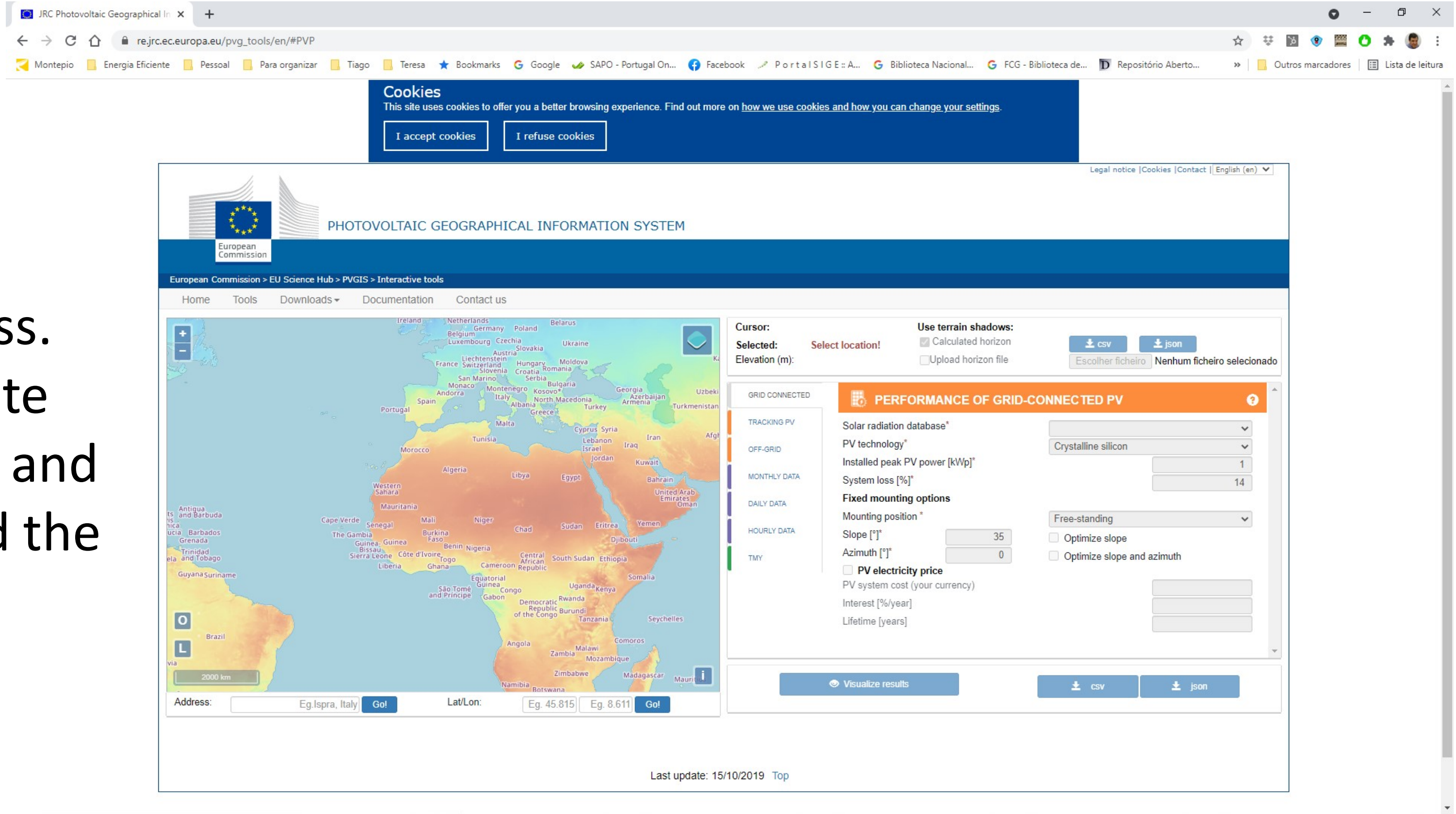
REC Implementation Design – Suggested Task I

4: Estimate plant's Annual Energy Supply: PVGIS

- Address.

I just wrote Katowice and identified the buildings



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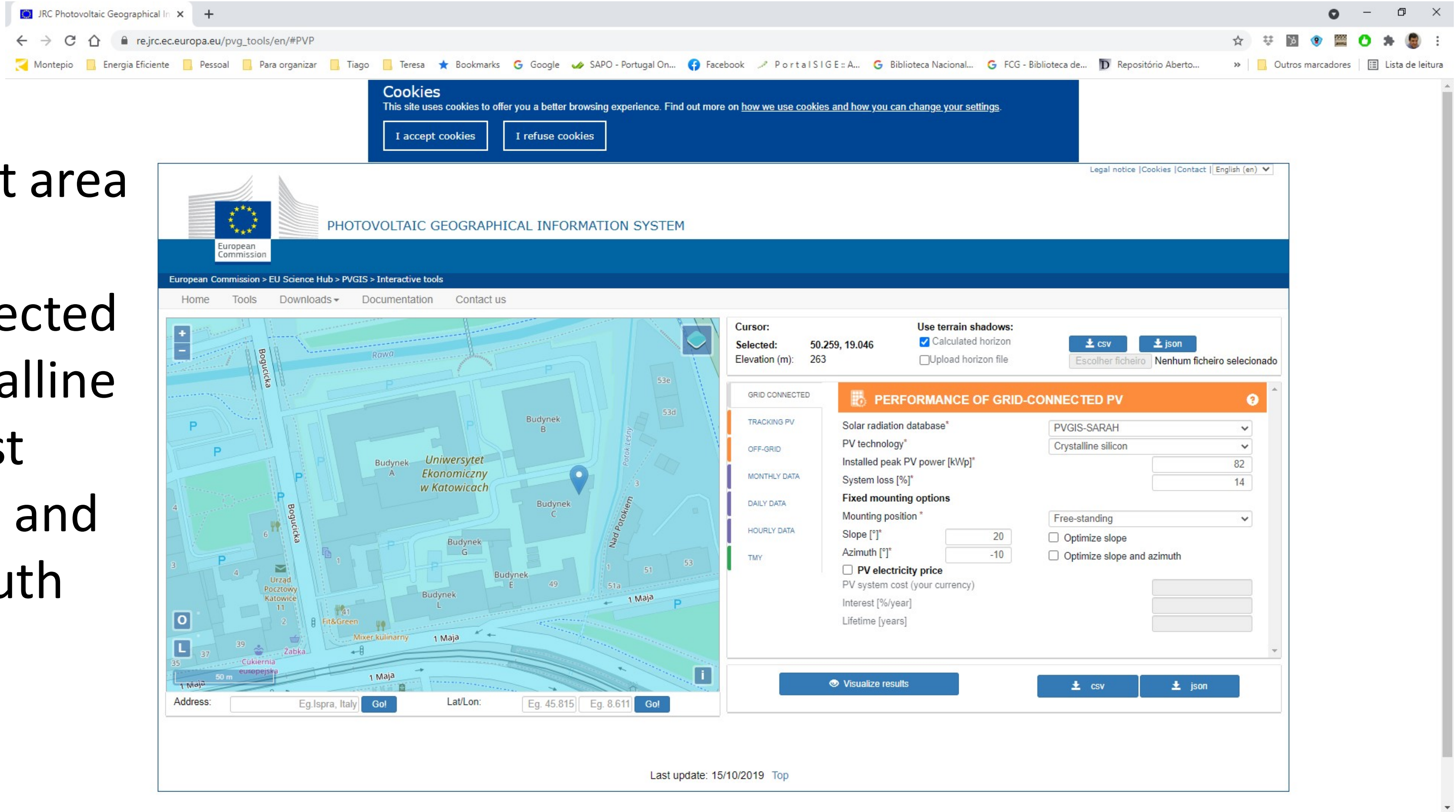
REC Implementation Design – Suggested Task I

4: Estimate plant's Annual Energy Supply: PVGIS

- Select area
- Grid connected
- Crystalline
- Adjust slope and azimuth



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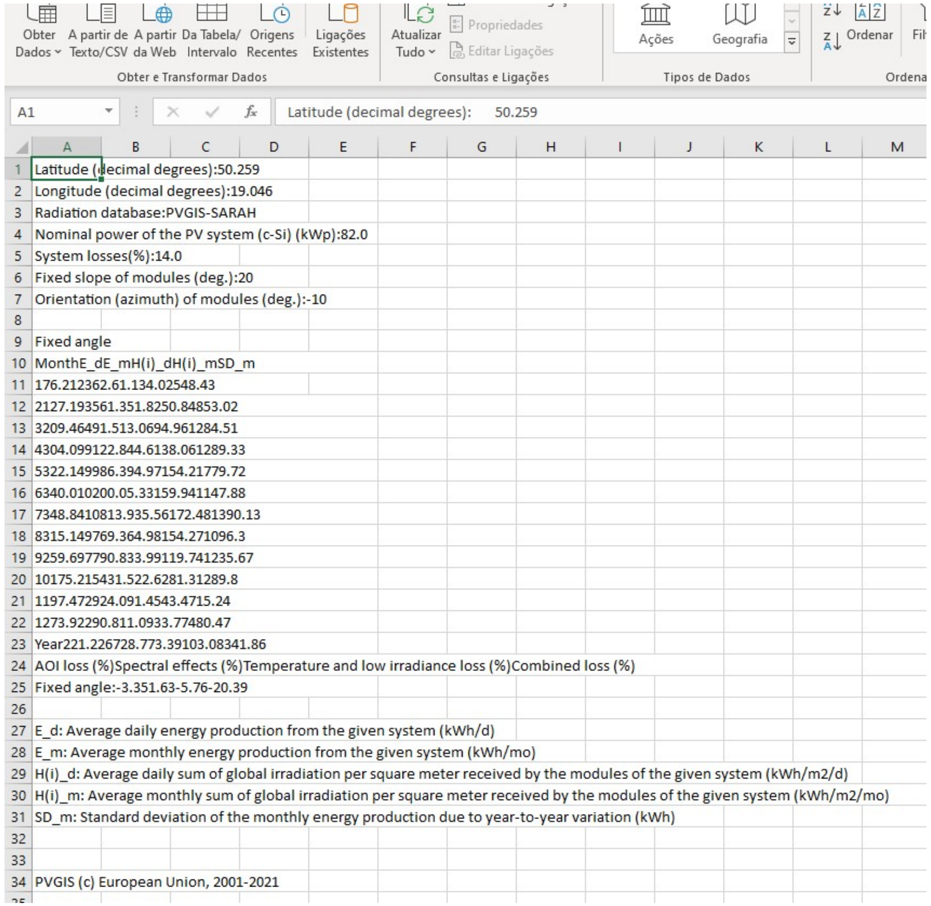
REC Implementation Design – Suggested Task I

4: Estimate plant's Annual Energy Supply: PVGIS

Comma separated values file: PVdata_50.259_19.046_SA_crystSi_82kWp_14_20deg_-10deg

- Select entire first column
- Data/Text to Columns
- Select Delimited > Next
- Tabs > Finish



	A
1	Latitude (decimal degrees):50.259
2	Longitude (decimal degrees):19.046
3	Radiation database:PVGIS-SARAH
4	Nominal power of the PV system (c-Si) (kWp):82.0
5	System losses(%):14.0
6	Fixed slope of modules (deg.):20
7	Orientation (azimuth) of modules (deg.):-10
8	
9	Fixed angle
10	MonthE_dE_mH(i)_dH(i)_mSD_m
11	176.212362.61.134.02548.43
12	2127.193561.351.8250.84853.02
13	3209.46491.513.0694.961284.51
14	4304.099122.844.6138.061289.33
15	5322.149986.394.97154.21779.72
16	6340.010200.05.33159.941147.88
17	7348.8410813.935.56172.481390.13
18	8315.149769.364.98154.271096.3
19	9259.697790.833.99119.741235.67
20	10175.215431.522.6281.31289.8
21	1197.472924.091.4543.4715.24
22	1273.92290.811.0933.77480.47
23	Year221.226728.773.39103.08341.86
24	AOI loss (%)Spectral effects (%)Temperature and low irradiance loss (%)Combined loss (%)
25	Fixed angle:-3.351.63-5.76-20.39
26	
27	E_d: Average daily energy production from the given system (kWh/d)
28	E_m: Average monthly energy production from the given system (kWh/mo)
29	H(i)_d: Average daily sum of global irradiation per square meter received by the modules of the given system (kWh/m2/d)
30	H(i)_m: Average monthly sum of global irradiation per square meter received by the modules of the given system (kWh/m2/mo)
31	SD_m: Standard deviation of the monthly energy production due to year-to-year variation (kWh)
32	
33	
34	PVGIS (c) European Union, 2001-2021

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REC Implementation Design – Suggested Task I

4: Estimate plant's Annual Energy Supply: PVGIS

- "E_m" column shows monthly production!
- We have a design of an affordable, clean power source
- We can assume this production will decrease around 0,7% per year

	A	B	C	E	G	I	K
1	Latitude (‹	50.259					
2	Longitude	19.046					
3	Radiation	PVGIS-SARAH					
4	Nominal p	82.0					
5	System lo	14.0					
6	Fixed slop	20					
7	Orientatic	-10					
8							
9	Fixed angle						
10	Month		E_d	E_m	H(i)_d	H(i)_m	SD_m
11	1		76.21	2362.6	1.1	34.02	548.43
12	2		127.19	3561.35	1.82	50.84	853.02
13	3		209.4	6491.51	3.06	94.96	1284.51
14	4		304.09	9122.84	4.6	138.06	1289.33
15	5		322.14	9986.39	4.97	154.2	1779.72
16	6		340.0	10200.0	5.33	159.94	1147.88
17	7		348.84	10813.93	5.56	172.48	1390.13
18	8		315.14	9769.36	4.98	154.27	1096.3
19	9		259.69	7790.83	3.99	119.74	1235.67
20	10		175.21	5431.52	2.62	81.3	1289.8
21	11		97.47	2924.09	1.45	43.4	715.24
22	12		73.9	2290.81	1.09	33.77	480.47
23	Year		221.22	6728.77	3.39	103.08	341.86
24			AOI loss (%)	Spectral effects (%)	Temperature and lo	Combined loss (%)	
25	Fixed angle:		-3.35	1.63	-5.76	-20.39	
26							
27	E_d: Average daily energy production from the given system (kWh/d)						
28	E_m: Average monthly energy production from the given system (kWh/mo)						
29	H(i)_d: Average daily sum of global irradiation per square meter received by the modules of the given system (kWh/m2/d)						
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31	SD_m: Standard deviation of the monthly energy production due to year-to-year variation (kWh)						

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REC Implementation Financial Model – Task II

Suggested Task II: Model a Potential REC community

1) A Prosumer wants project leadership, has PV potential but no willingness to invest;

2) Many consumers have no PV potential and no willingness to invest;

3) Rooftops and landowners have PV potential but no willingness to invest;

4) Industrial consumers may have PV potential and may have some willingness to invest;

5) Private Equity has willingness to invest, but demand control.

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REC Implementation
Financial Model – Task II

- Design a project for your REC (Task I)
- Agents: Define possibilities and respective Drives/Motivations
- Impacts: Define possible social (jobs, typically 1-2 per PV plant) and environmental (GHG emission factors vary widely per country) outcomes
- Financial Models for attracting Investors

Business Plan

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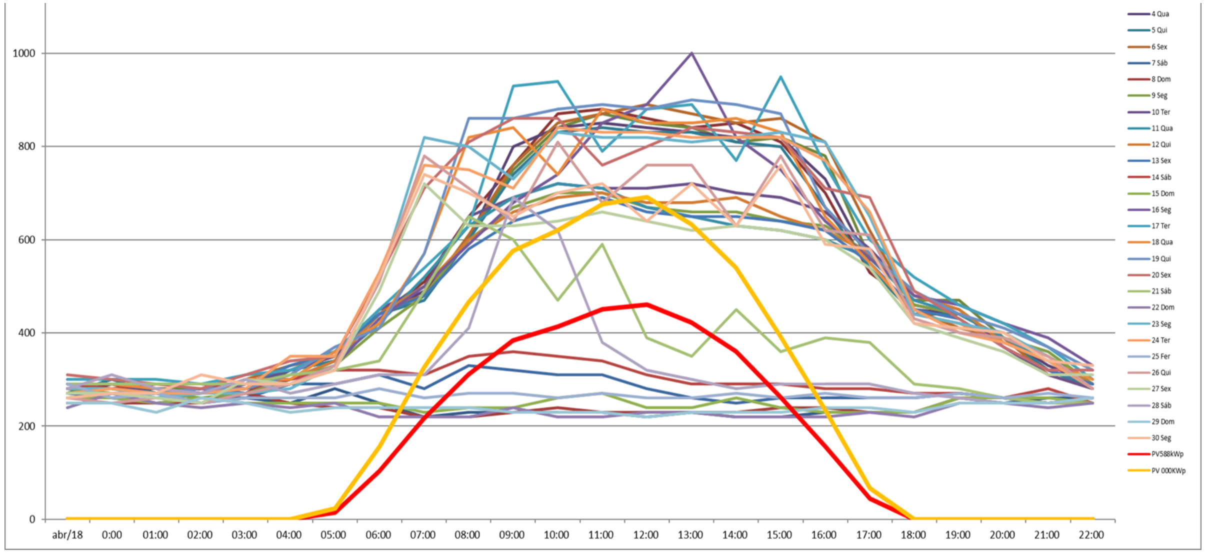
REC Implementation
Financial Model – Task II

Agent #1: Prosumer’s baseload diagram needed to assess how much energy will be consumed on-site and how much will be sold

For this exercise and on the lack of timely models, we will assume 80% of the electrical energy is to be consumed by the prosumer and 20% will be available for sale



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REC Implementation Financial Model – Task II

Agent #2: Small consumer

Is the chain's weakest link – each one has little influence

Pays the most expensive energy price

Not only one but many

Can be an influencer, an investor and a voter

EU policies are built towards his concerns

The most important Agent

Ideally, scenarios must be built considering the adoption of the REC by large numbers of small consumers, which consume between 3 and 15 MWh per year.

REC Implementation Financial Model – Task II

Agent #3: Medium-level producer

Necessary when no large production facility can be found

Prosumer model

Agent #4: Medium-level consumer

Can be of great relevance using energy surpluses

Prosumer model

In the lack of appropriate and timely data, we can assume these consumptions between 100 and 1500 MWh per year.

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REC Implementation Financial Model – Task II

Agent #5: Private Equity Investor

Necessary since most important agents are not willing to invest

ROI, IRR, NPV

Agent #6: Consultant / Manager

Operational expenditures

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REC Implementation Financial Model – Task II

Tariffs on the lack of substantiated data

Main Prosumer: 150€/MWh

Small Consumer: 200€/MWh

Medium or Industrial Consumer: 130€/MWh

Costs to be supported by Private Equity Investor

PV Plant: 650€/kW installed

Fee to pay to Grid Manager (usually a public entity): 40€/MWh

Fee to pay to System Manager: 24.000€/year

Fee to pay to System O&M&I: 24.000€/year

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REC Implementation Financial Model – GOALS

Project must be interesting to Private Equity Investor:
- Receives profits from sales to all agents
- NPV (4% rate) positive after 10 years
- IRR-20 years over 10%

Project must be interesting to Prosumers and consumers:
- At least a 10€/MWh decrease in the tariff of the Prosumer and for the medium-level consumer and 100€ for the small consumer
- At least one medium-level consumer and 20 small consumers adhere to the REC

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REC Implementation Financial Model – EXTRAS

- Project may simulate several scenarios, depending on its adoption by the community in the long-term

- Solar Plant may use PV modules with special Characteristics (monocrystalline technology); Investment rises to 750€/kW installed but losses on the PVGIS simulation reduce to 10% (instead of 14%)

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REC Implementation Design and Financial Model

Any questions?

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