the Learning Network on Sustainable energy systems

The Learning Network on Sustainable energy systems is funded by the European-ACP-EU Edulink II

Implemented by the ACP Group of States Secretariat

Funded by the EU

Sustainable energy for all system design tool: the E.DRE tool, Estimator of Distributed Renewable Energy load/need and production potential

EMANUELA DELFINO | Politecnico di Milano| Design Department | DIS
CARLO VEZZOLI | Politecnico di Milano| Design Department
MICOL POLON

LeNSes project ambition

EU funded project (Edulink 2013-16)

promoting a new generation of African and European designers (and design educators and researcher) ***capable o****f effectively* ***design*** *and diffuse systems and services to extend the access to Sustainable Energy for All, based on the promising models of Sustainable Product-Service System and Distributed Renewable Energy system*

System Design for Sustainable energy for All Method

AIM

To support design processes for the development of sustainable PSS applied to DRE, adaptable to specific design requirements and usable in existing design processes

USERS

designer, design office, designer within a company

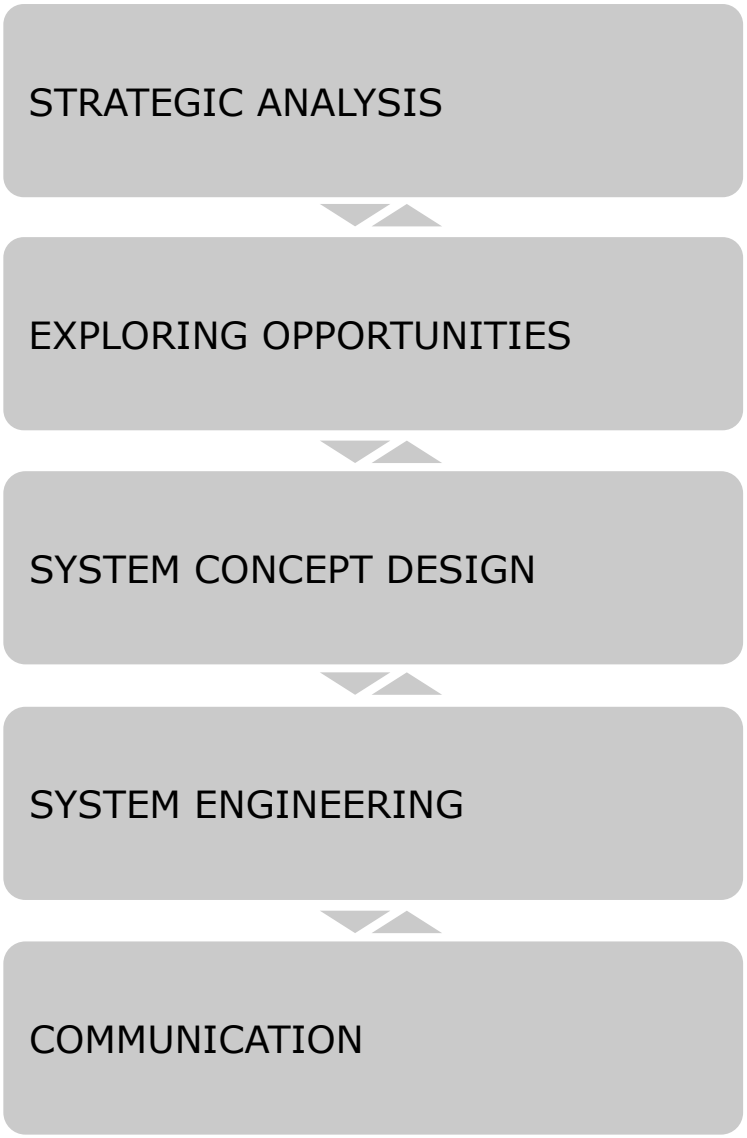
TOOLS

free to download at *lenses.polimi.it*

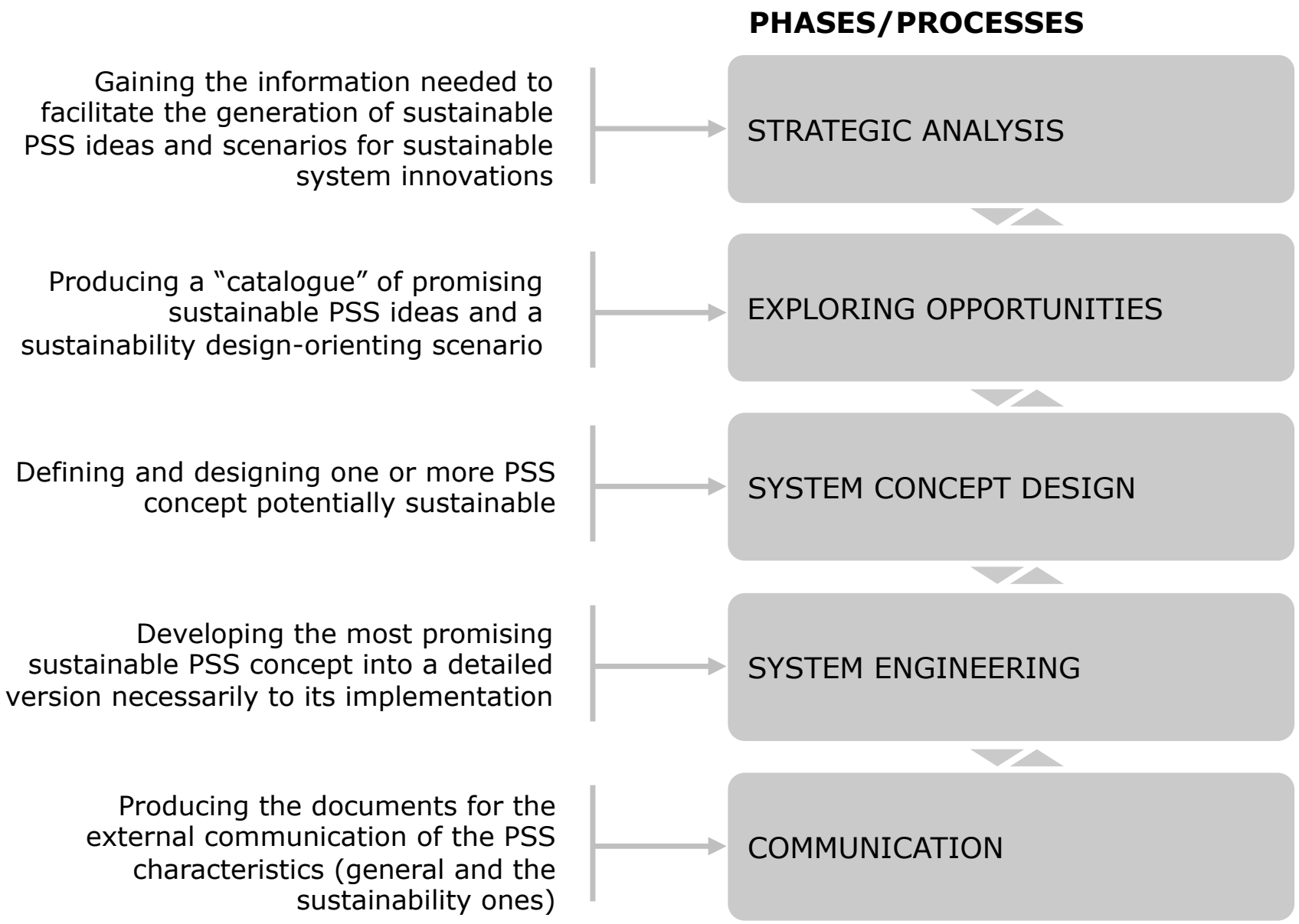
BASED ON

Method for System Design for Sustainability (developed in the LeNS project: *lens.polimi.it*)

PHASES/PROCESSES



Objectives


PHASES/PROCESSES
Gaining the information needed to facilitate the generation of sustainable PSS ideas and scenarios for sustainable system innovations
STRATEGIC ANALYSIS
Producing a "catalogue" of promising sustainable PSS ideas and a sustainability design-orienting scenario
EXPLORING OPPORTUNITIES
Defining and designing one or more PSS concept potentially sustainable
SYSTEM CONCEPT DESIGN
Developing the most promising sustainable PSS concept into a detailed version necessarily to its implementation
SYSTEM ENGINEERING
Producing the documents for the external communication of the PSS characteristics (general and the sustainability ones)
COMMUNICATION

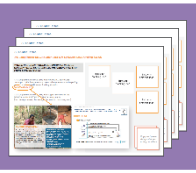
Tools

PHASES/PROCESSES

SD4SEA innovation map

SD4SEA framework and guidelines

Scenario for S.PSS & DRE



Sustainable Energy 4 All idea table

S.PSS & DRE Innovation Diagram

E.DRE: Estimator for Distributed Renewable Energy

STRATEGIC ANALYSIS

EXPLORING OPPORTUNITIES

SYSTEM CONCEPT DESIGN

SYSTEM ENGINEERING

COMMUNICATION

Estimator For Distributed Renewable Energy (E.DRE)

Integration in the method

AIM

- to calculate the user energy load/need
- to estimate the Energy system size and its energy production potential

PHASES/PROCESSES

STRATEGIC ANALYSIS

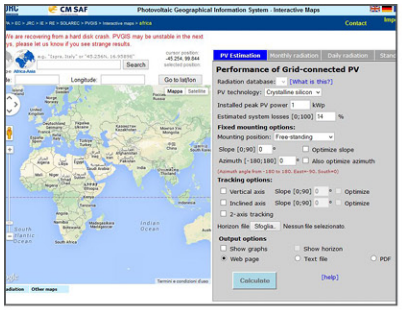
EXPLORING OPPORTUNITIES

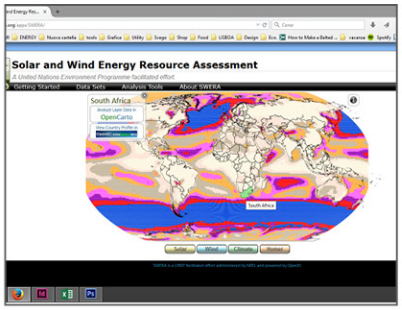
SYSTEM CONCEPT DESIGN

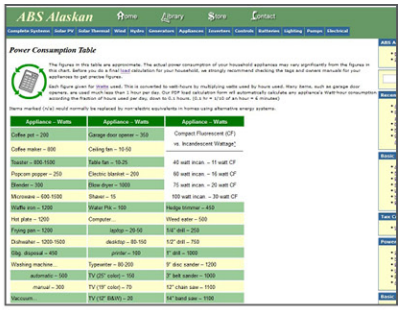
SYSTEM ENGINEERING

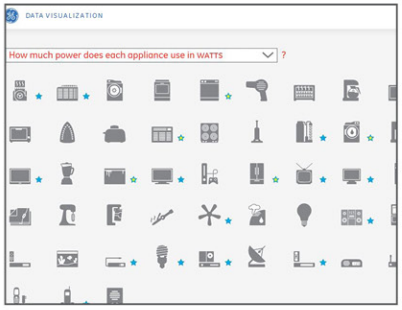
COMMUNICATION

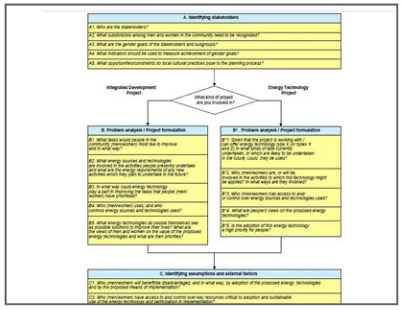
Research & study

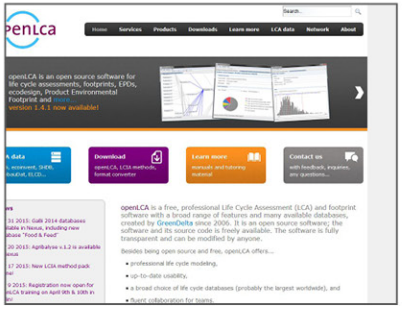


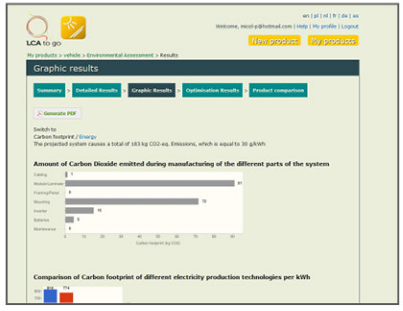


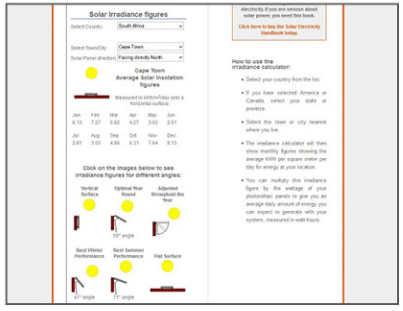




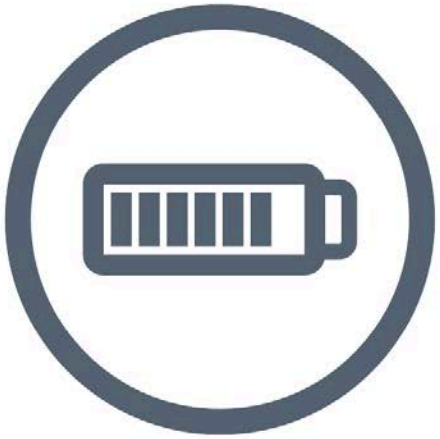




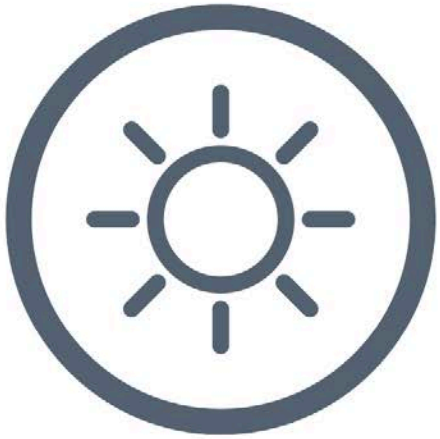




Design



1. determine the energy user need/load



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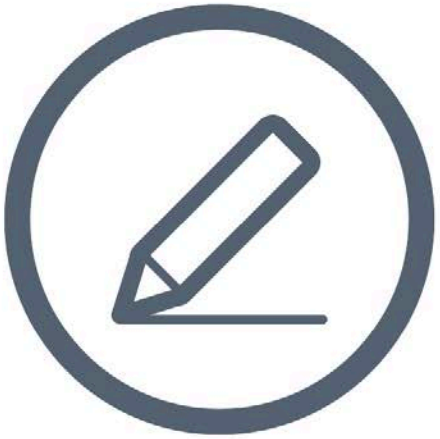


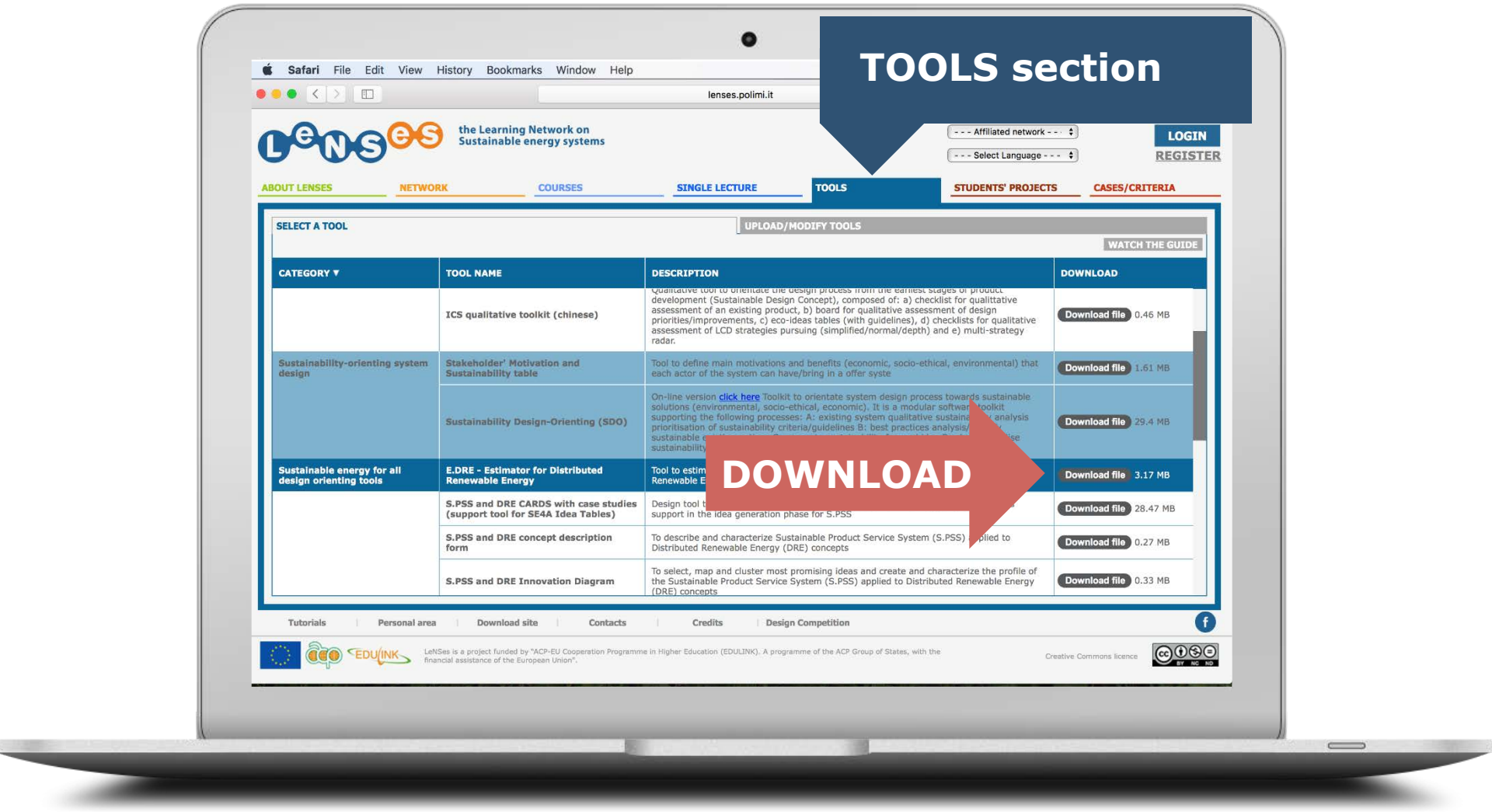
3. design and sizing of the system

Test and refinement

Test with Students +
Technical review in Nairobi

Test with Students +
Technical review in Milan

Available on lenses.polimi.it



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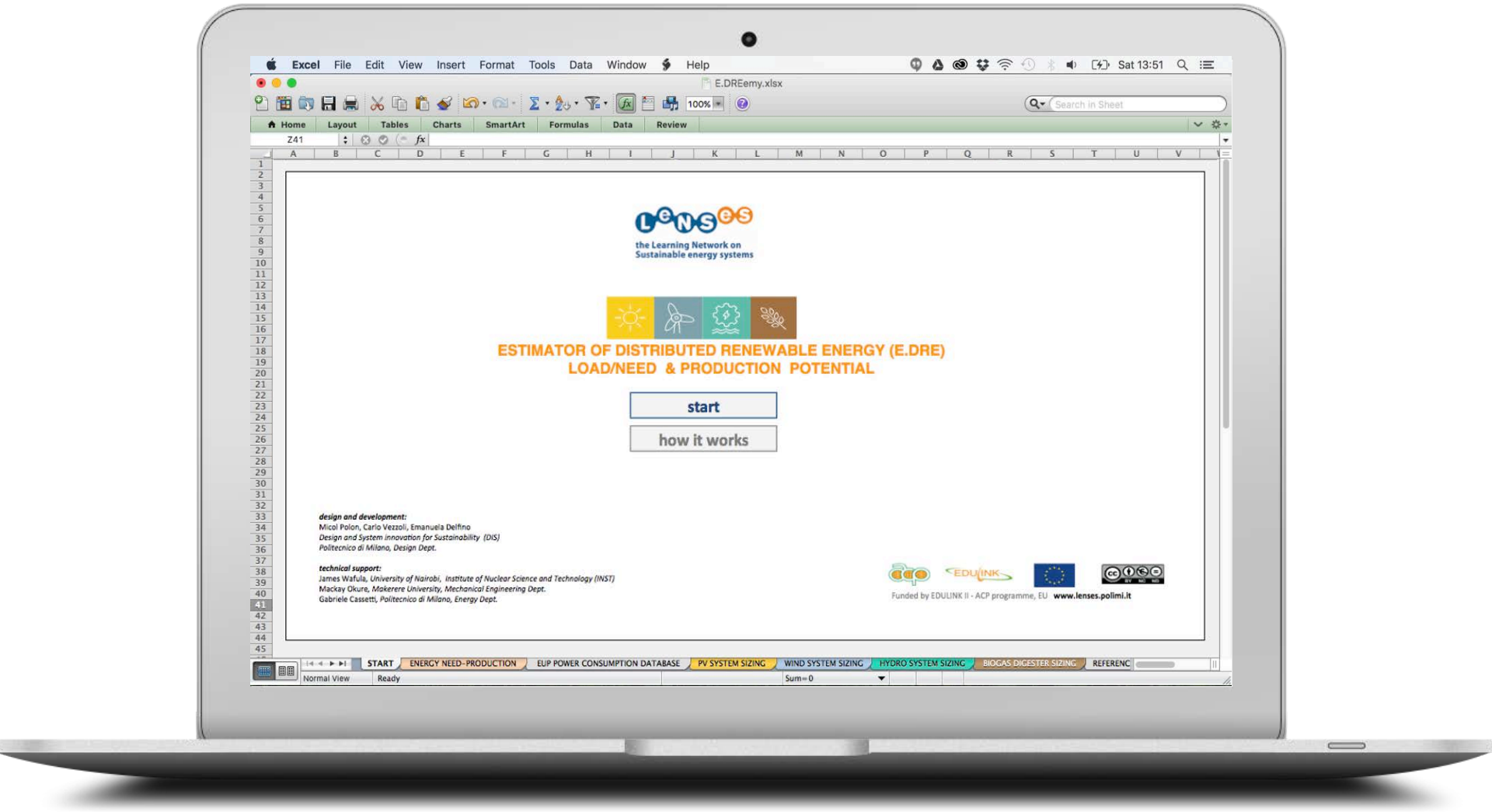
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the Learning Network on Sustainable energy systems
ESTIMATOR OF DISTRIBUTED RENEWABLE ENERGY (E.DRE)
LOAD/NEED & PRODUCTION POTENTIAL
start
how it works
design and development:
Micol Polon, Carlo Vezzoli, Emanuela Delfino
Design and System innovation for Sustainability (DIS)
Politecnico di Milano, Design Dept.
technical support:
James Wafula, University of Nairobi, Institute of Nuclear Science and Technology (INST)
Mackay Okure, Makerere University, Mechanical Engineering Dept.
Gabriele Cassetti, Politecnico di Milano, Energy Dept.
Funded by EDULINK II - ACP programme, EU www.lenses.polimi.it
START ENERGY NEED-PRODUCTION EUP POWER CONSUMPTION DATABASE PV SYSTEM SIZING WIND SYSTEM SIZING HYDRO SYSTEM SIZING BIOGAS DIGESTER SIZING REFERENC
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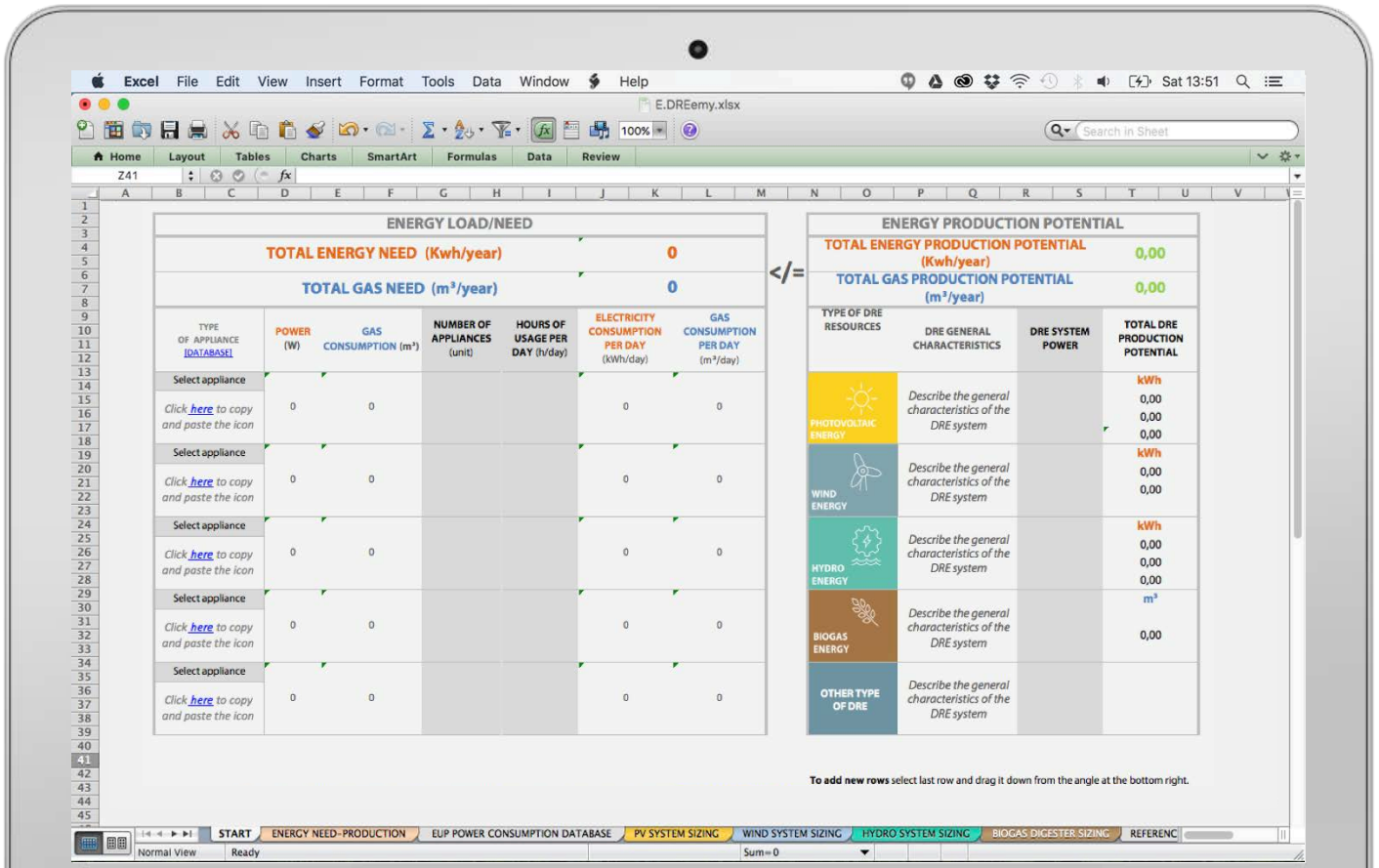
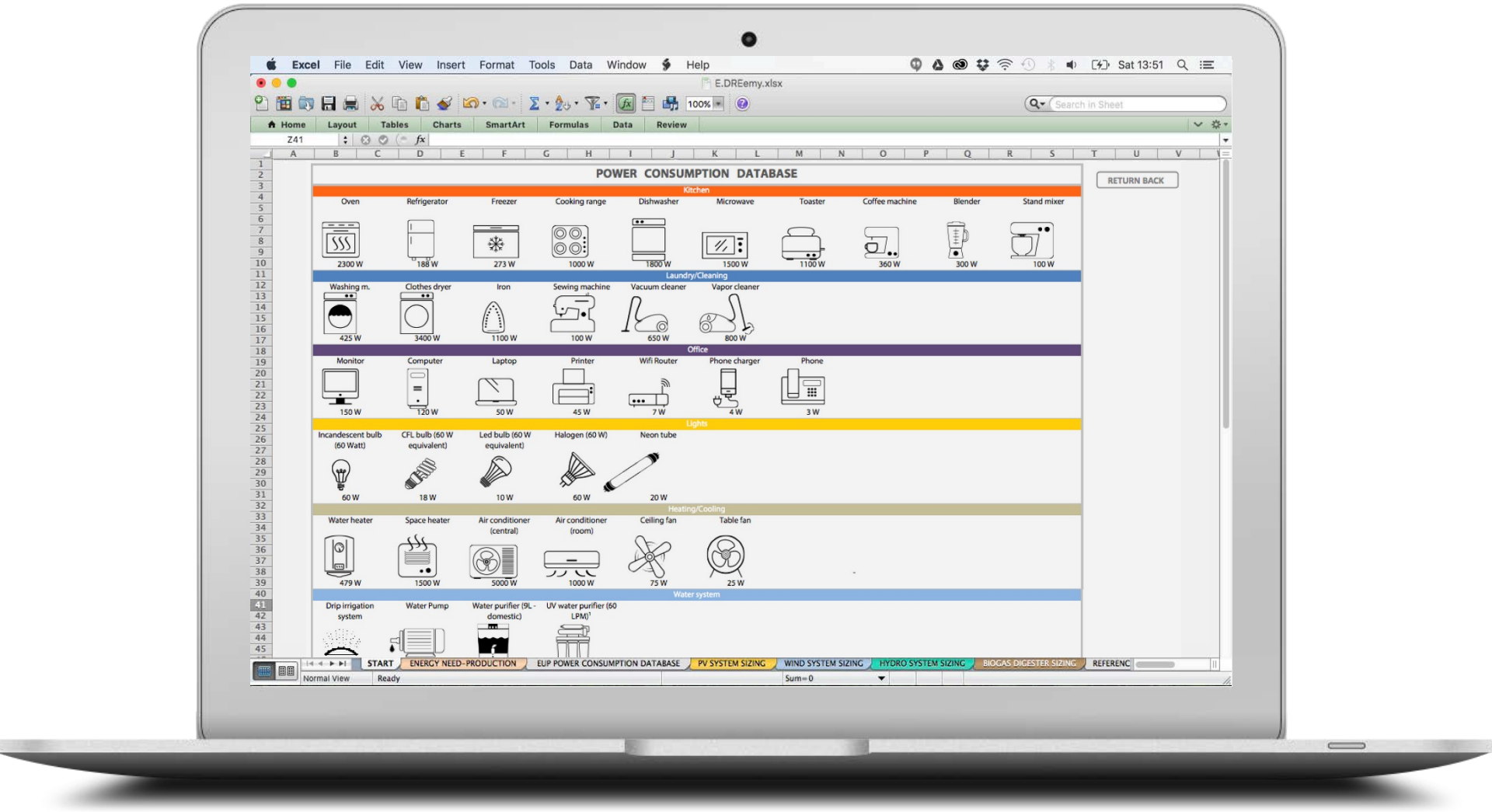
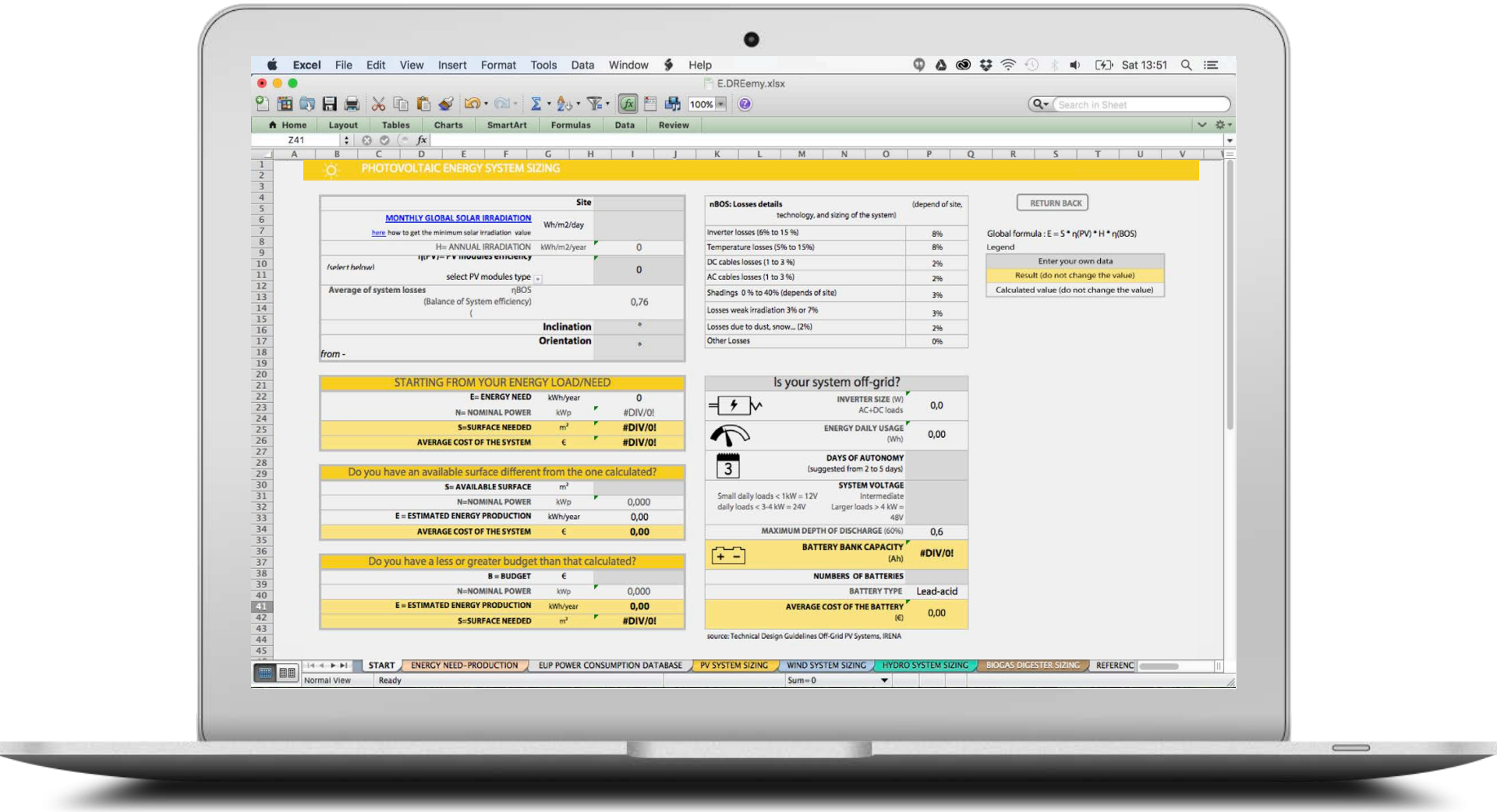
1. Energy need and production



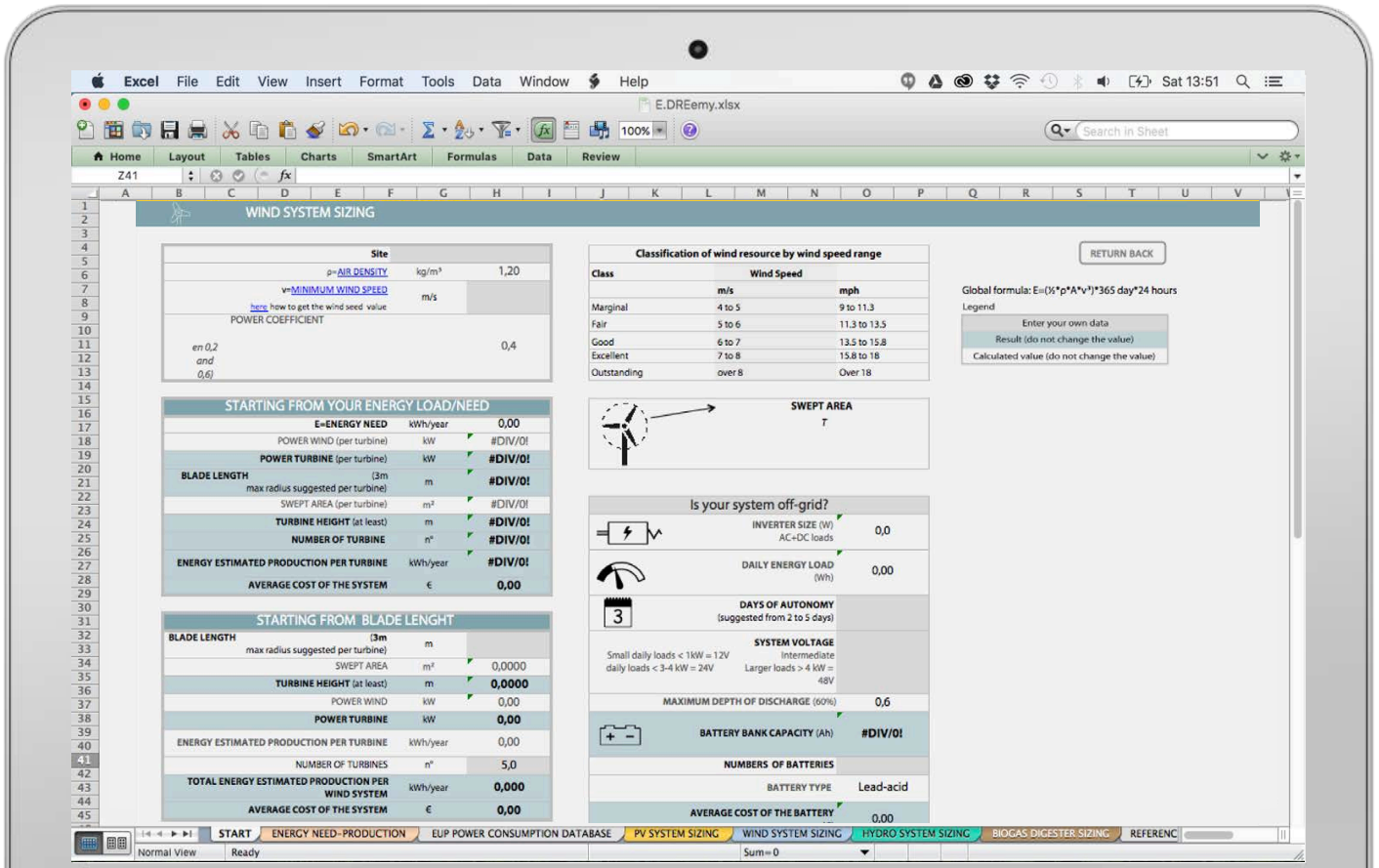
2. Energy using product (EUP) consumption database



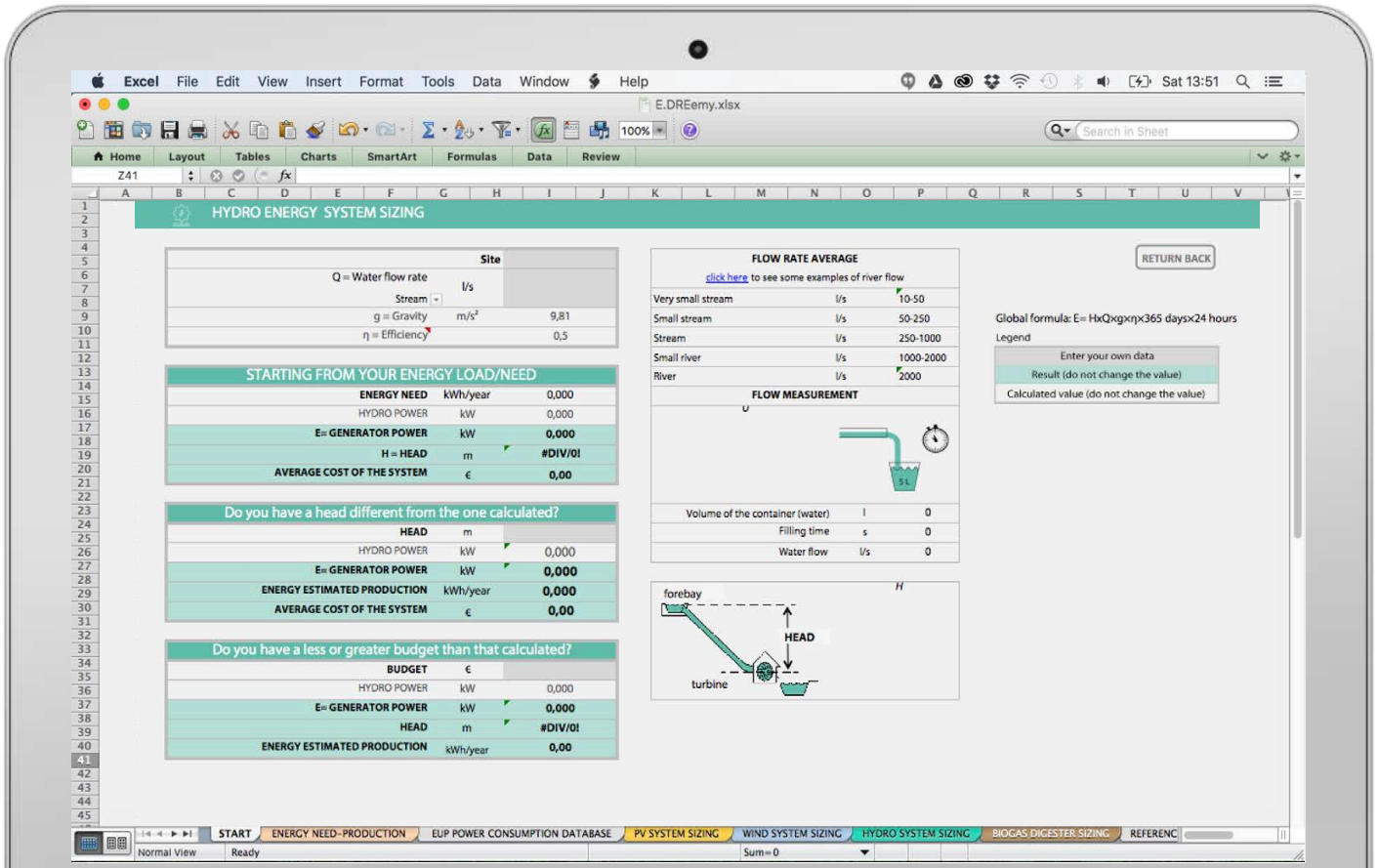
3. Photovoltaic system sizing



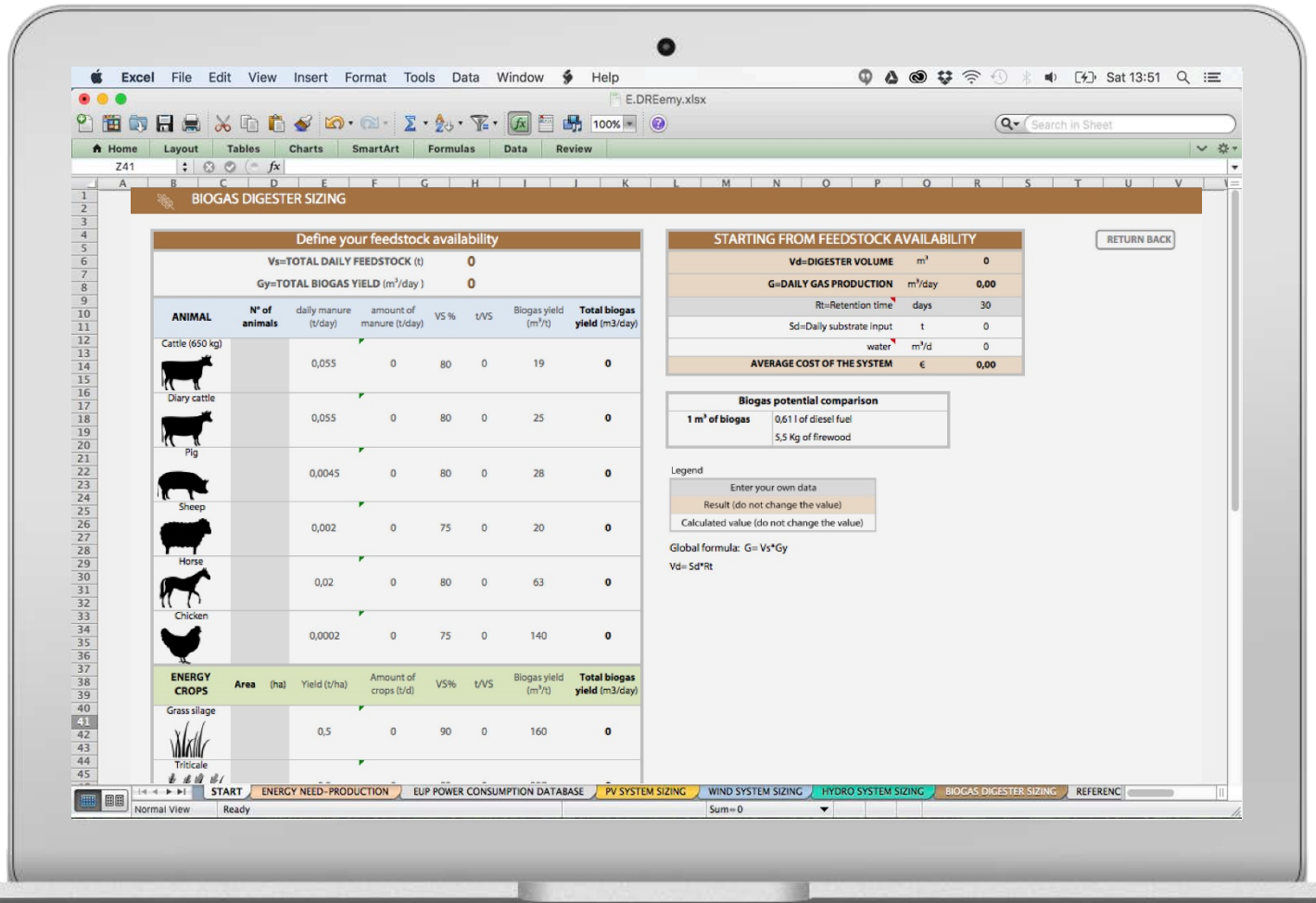
4. Wind system sizing



5. Hydro system sizing



6. Biomass digester sizing



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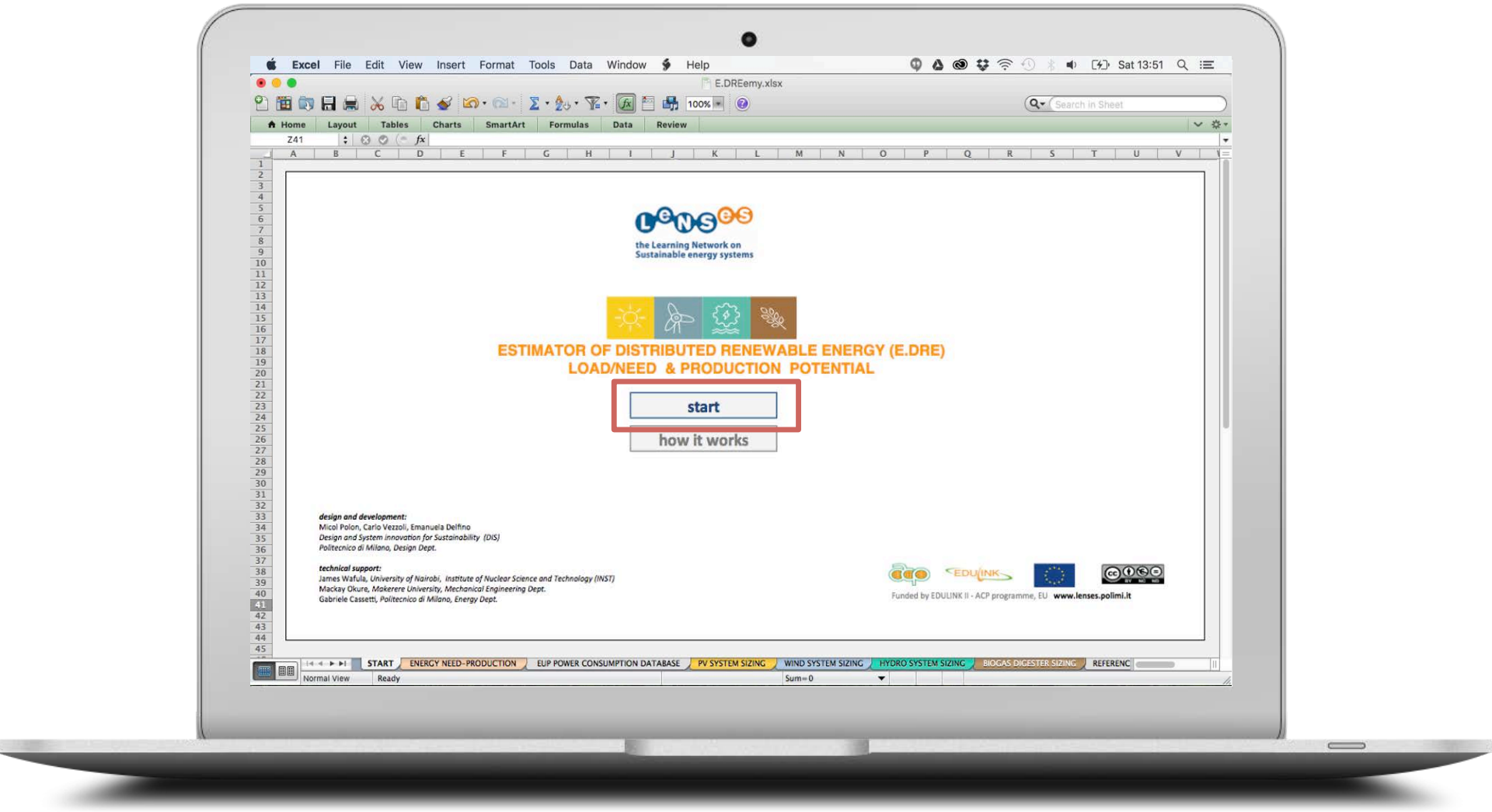
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START ENERGY NEED-PRODUCTION EUP POWER CONSUMPTION DATABASE PV SYSTEM SIZING WIND SYSTEM SIZING HYDRO SYSTEM SIZING BIOGAS DIGESTER SIZING REFERENC
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To calculate/visualize the energy need of the system/user

ENERGY LOAD/NEED

TOTAL ENERGY NEED (Kwh/year)	0
TOTAL GAS NEED (m³/year)	0

TYPE OF APPLIANCE [DATABASE]	POWER (W)	GAS CONSUMPTION (m³)	NUMBER OF APPLIANCES (unit)	HOURS OF USAGE PER DAY (h/day)	ELECTRICITY CONSUMPTION PER DAY (kWh/day)	GAS CONSUMPTION PER DAY (m³/day)
Select appliance						
Click here to copy and paste the icon	0	0			0	0
Select appliance						
Click here to copy and paste the icon	0	0			0	0
Select appliance						
Click here to copy and paste the icon	0	0			0	0
Select appliance						
Click here to copy and paste the icon	0	0			0	0
Select appliance						
Click here to copy and paste the icon	0	0			0	0

</=

ENERGY PRODUCTION POTENTIAL

TOTAL ENERGY PRODUCTION POTENTIAL (Kwh/year)	0,00
TOTAL GAS PRODUCTION POTENTIAL (m³/year)	0,00

TYPE OF DRE RESOURCES	DRE GENERAL CHARACTERISTICS	DRE SYSTEM POWER	TOTAL DRE PRODUCTION POTENTIAL
PHOTOVOLTAIC ENERGY	Describe the general characteristics of the DRE system		kWh 0,00 0,00 0,00
WIND ENERGY	Describe the general characteristics of the DRE system		kWh 0,00 0,00
HYDRO ENERGY	Describe the general characteristics of the DRE system		kWh 0,00 0,00 0,00
BIOGAS ENERGY	Describe the general characteristics of the DRE system		m³ 0,00
OTHER TYPE OF DRE	Describe the general characteristics of the DRE system		

To add new rows select last row and drag it down from the angle at the bottom right.

Details of the system production potential

ENERGY LOAD/NEED

TOTAL ENERGY NEED (Kwh/year)	0
TOTAL GAS NEED (m³/year)	0

TYPE OF APPLIANCE [DATABASE]	POWER (W)	GAS CONSUMPTION (m³)	NUMBER OF APPLIANCES (unit)	HOURS OF USAGE PER DAY (h/day)	ELECTRICITY CONSUMPTION PER DAY (kWh/day)	GAS CONSUMPTION PER DAY (m³/day)
Select appliance						
Click here to copy and paste the icon	0	0			0	0
Select appliance						
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Select appliance						
Click here to copy and paste the icon	0	0			0	0
Select appliance						
Click here to copy and paste the icon	0	0			0	0
Select appliance						
Click here to copy and paste the icon	0	0			0	0

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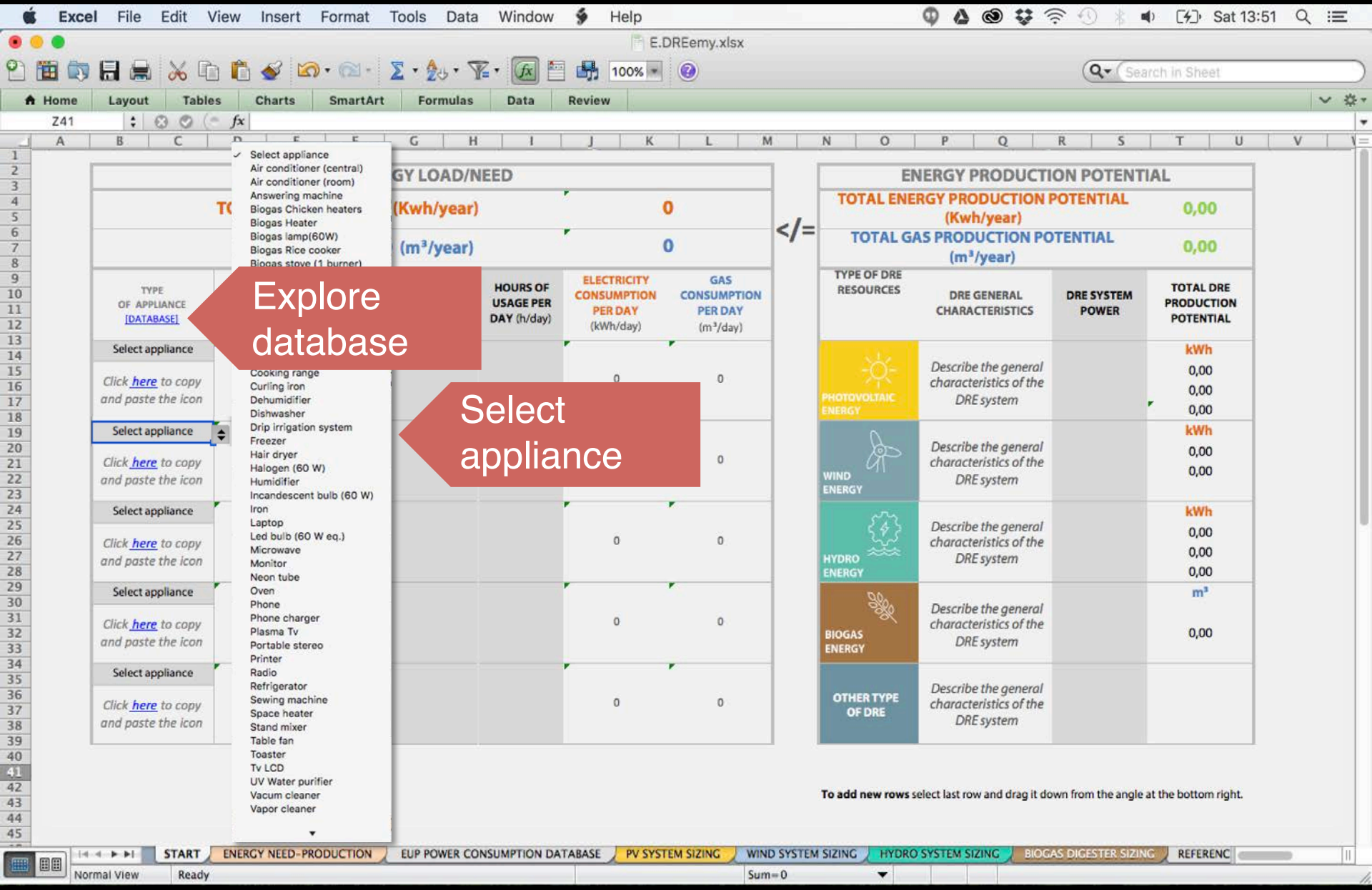
ENERGY PRODUCTION POTENTIAL

TOTAL ENERGY PRODUCTION POTENTIAL (Kwh/year)	0,00
TOTAL GAS PRODUCTION POTENTIAL (m³/year)	0,00

TYPE OF DRE RESOURCES	DRE GENERAL CHARACTERISTICS	DRE SYSTEM POWER	TOTAL DRE PRODUCTION POTENTIAL
PHOTOVOLTAIC ENERGY	Describe the general characteristics of the DRE system		kWh 0,00 0,00 0,00
WIND ENERGY	Describe the general characteristics of the DRE system		kWh 0,00 0,00
HYDRO ENERGY	Describe the general characteristics of the DRE system		kWh 0,00 0,00 0,00
BIOGAS ENERGY	Describe the general characteristics of the DRE system		m³ 0,00
OTHER TYPE OF DRE	Describe the general characteristics of the DRE system		

To add new rows select last row and drag it down from the angle at the bottom right.

1. Type of appliances



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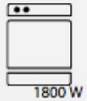
POWER CONSUMPTION DATABASE

RETURN BACK

Kitchen

Oven	Refrigerator	Freezer	Cooking range	Dishwasher	Microwave	Toaster	Coffee machine	Blender	Stand mixer
									
2300 W	188 W	273 W	1000 W	1800 W	1500 W	1100 W	360 W	300 W	100 W

Laundry/Cleaning

Washing m.	Clothes dryer	Iron	Sewing machine	Vacuum cleaner	Vapor cleaner
					
425 W	3400 W	1100 W	100 W	650 W	800 W

Office

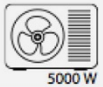
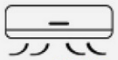
Monitor	Computer	Laptop	Pr…	Phone
				
150 W	120 W	50 W	4…	3 W

Copy and paste the icon

Lights

Incandescent bulb (60 Watt)	CFL bulb (60 W equivalent)	Led bulb (60 W equivalent)	Halogen (60 W)	Neon tube
				
60 W	18 W	10 W	60 W	20 W

Heating/Cooling

Water heater	Space heater	Air conditioner (central)	Air conditioner (room)	Ceiling fan	Table fan
					
479 W	1500 W	5000 W	1000 W	75 W	25 W

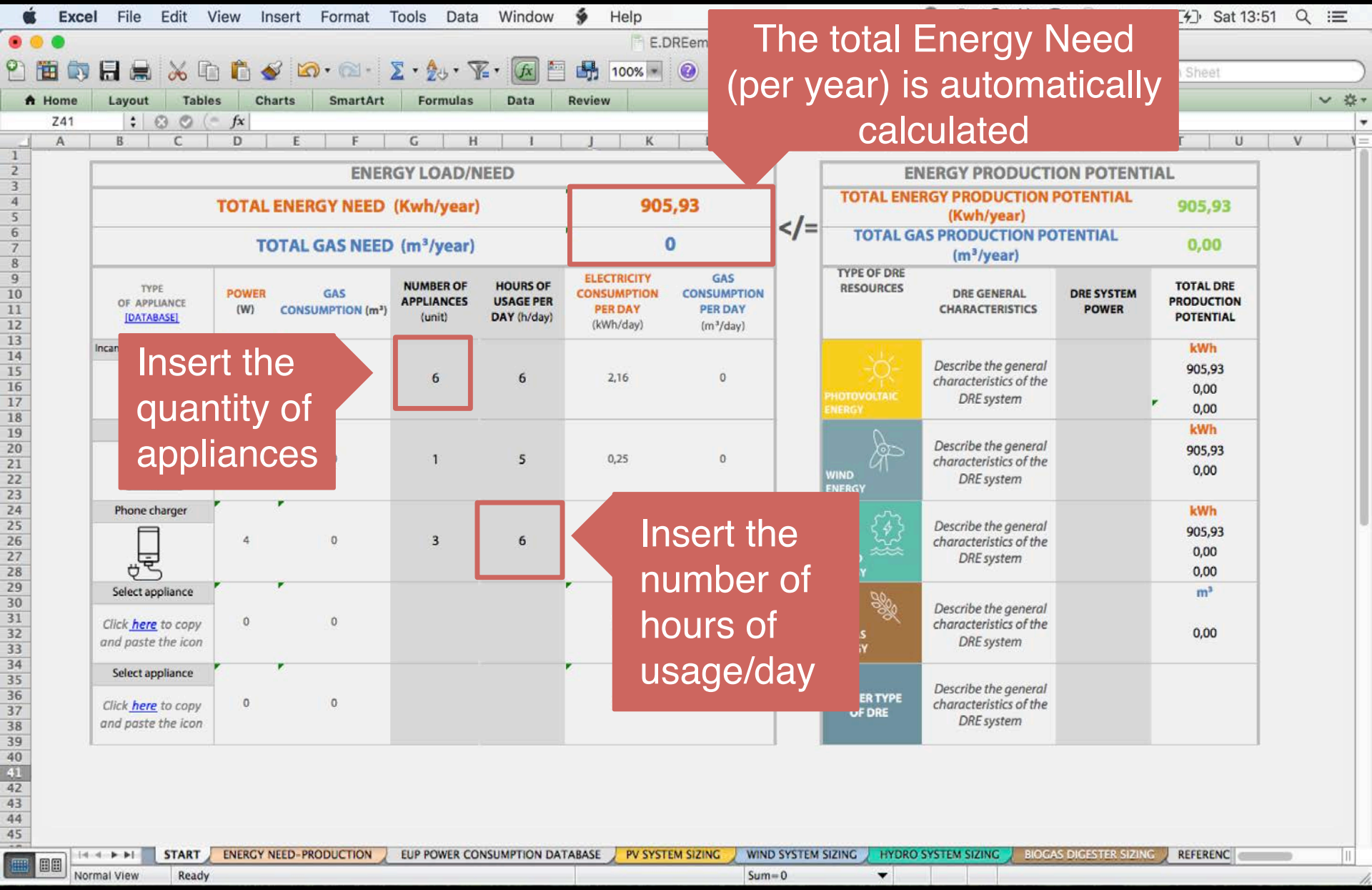
Water system

Drip irrigation system	Water Pump	Water purifier (9L - domestic)	UV water purifier (60 LPM)[1]
			

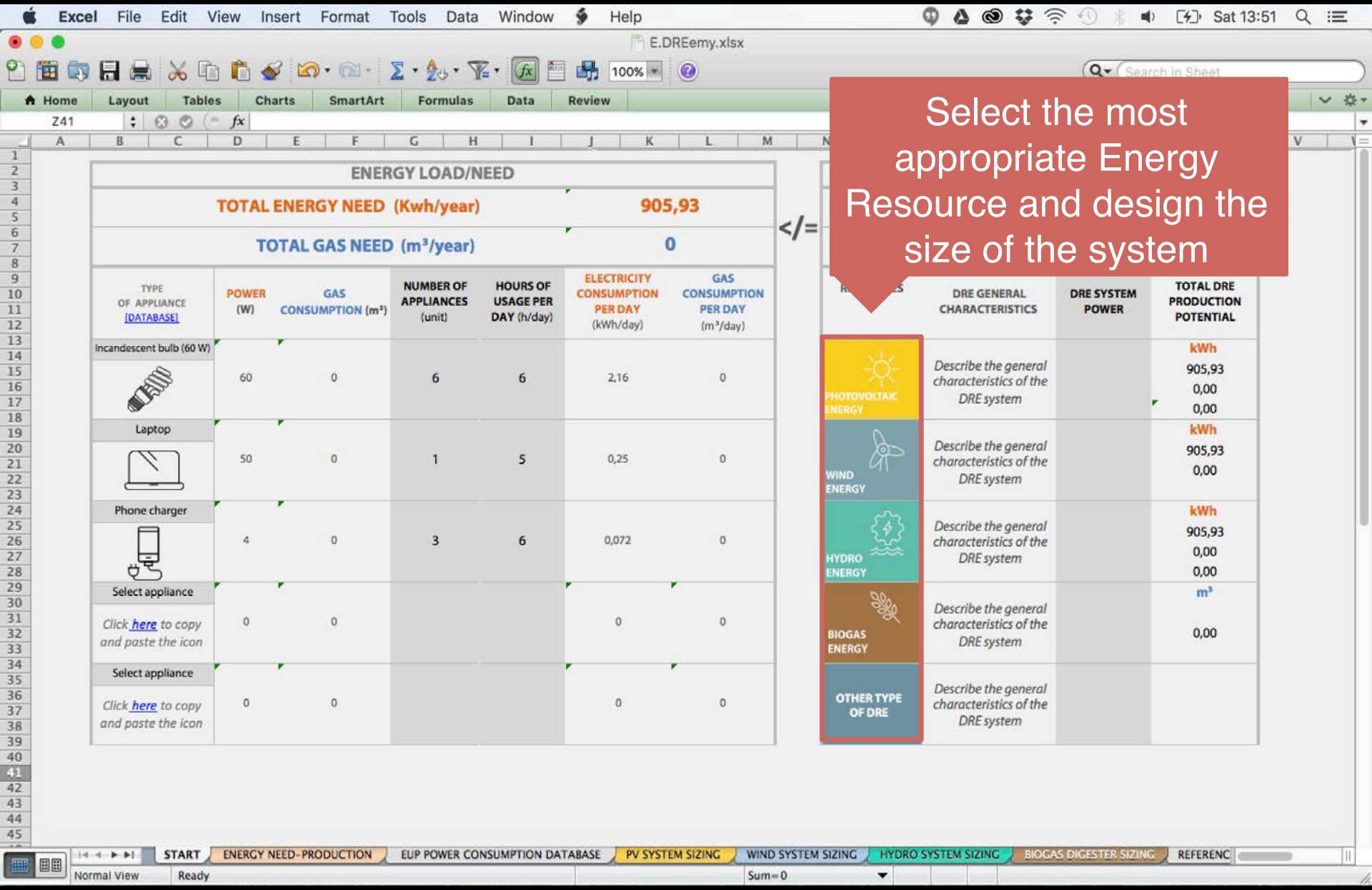
START | ENERGY NEED-PRODUCTION | EUP POWER CONSUMPTION DATABASE | PV SYSTEM SIZING | WIND SYSTEM SIZING | HYDRO SYSTEM SIZING | BIOGAS DIGESTER SIZING | REFERENC

Normal View | Ready | Sum=0

2. Calculate the energy need

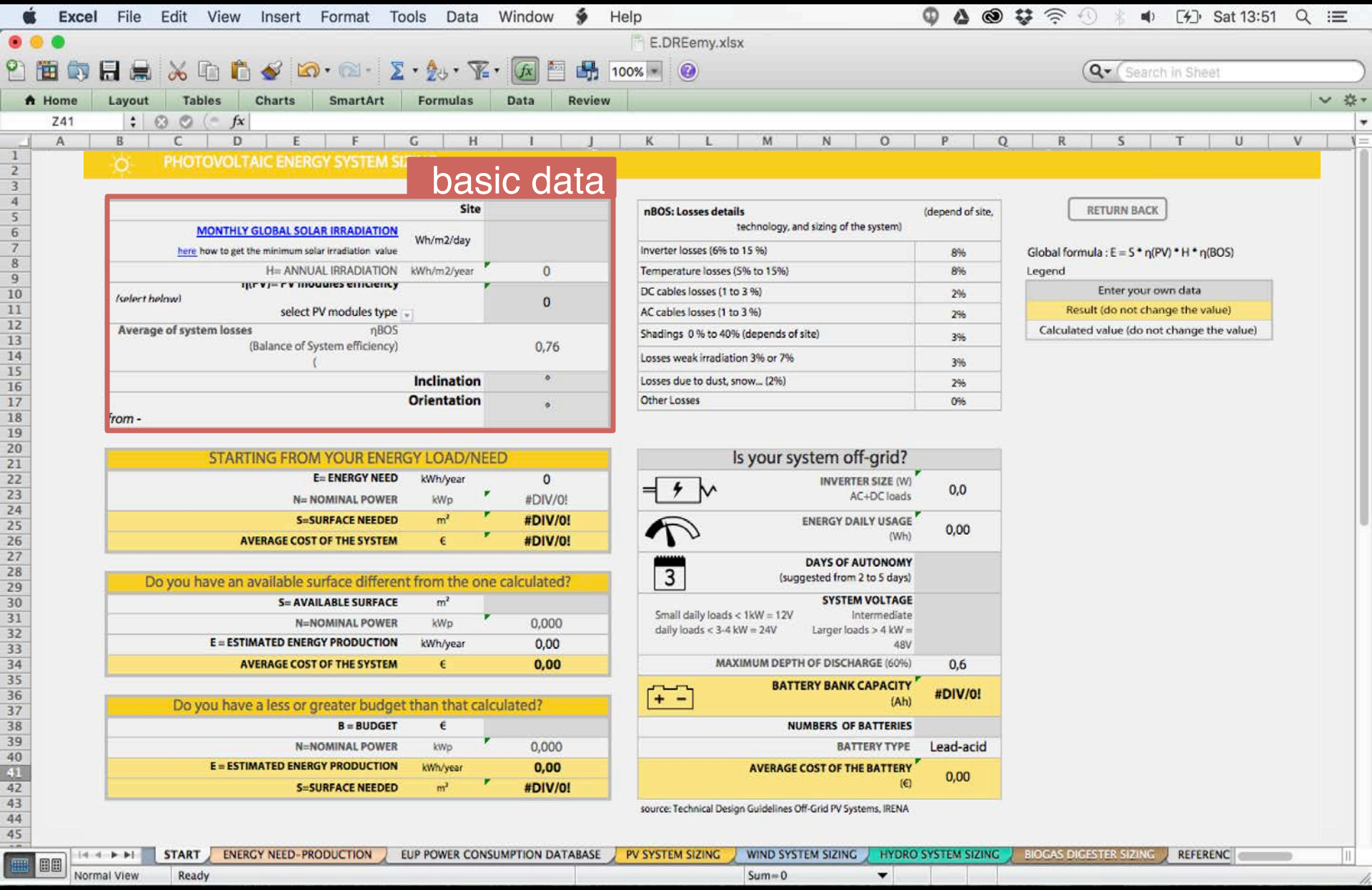


3. Browse the system sizing sheets

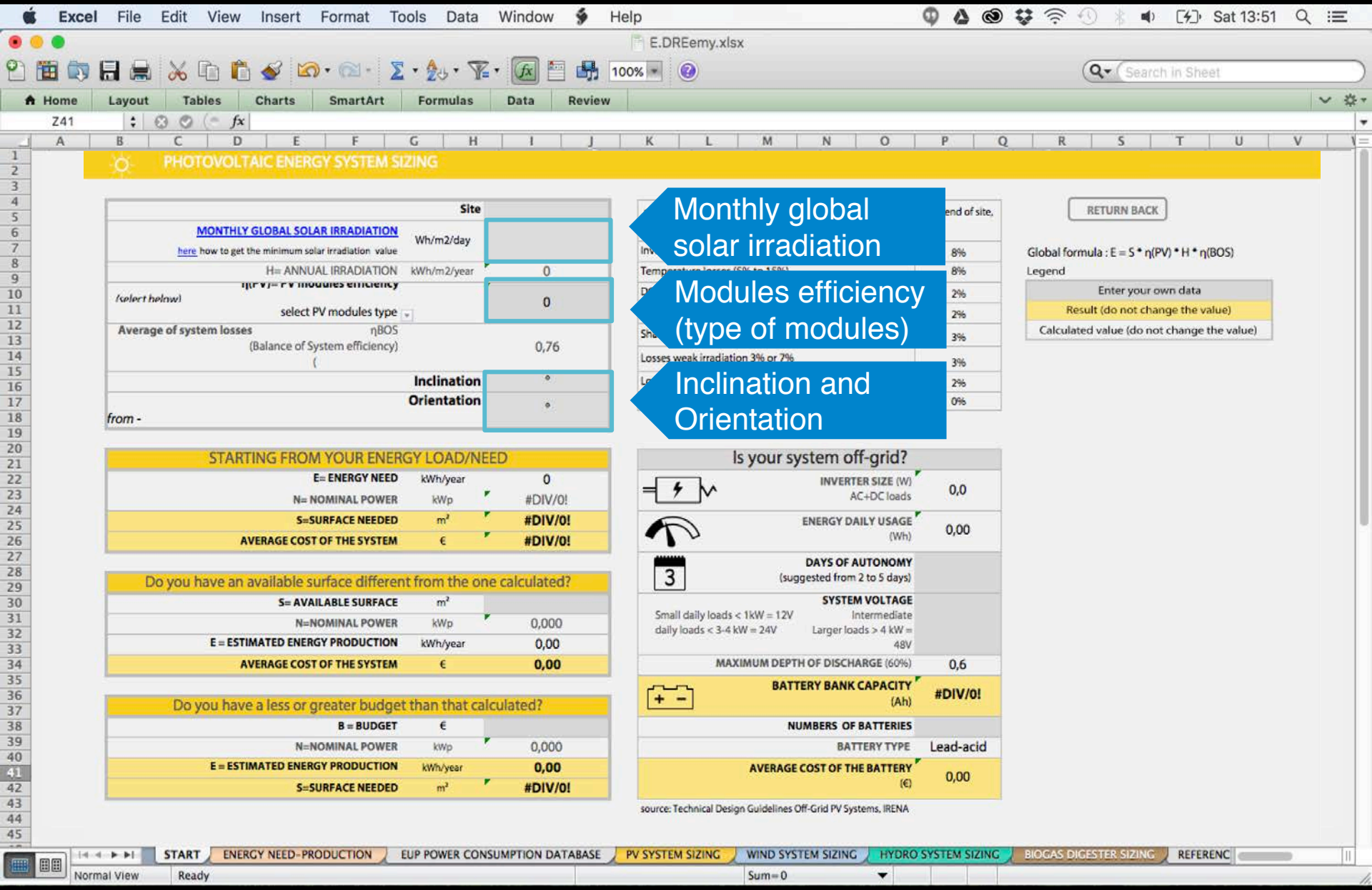


Select the most appropriate Energy Resource and design the size of the system

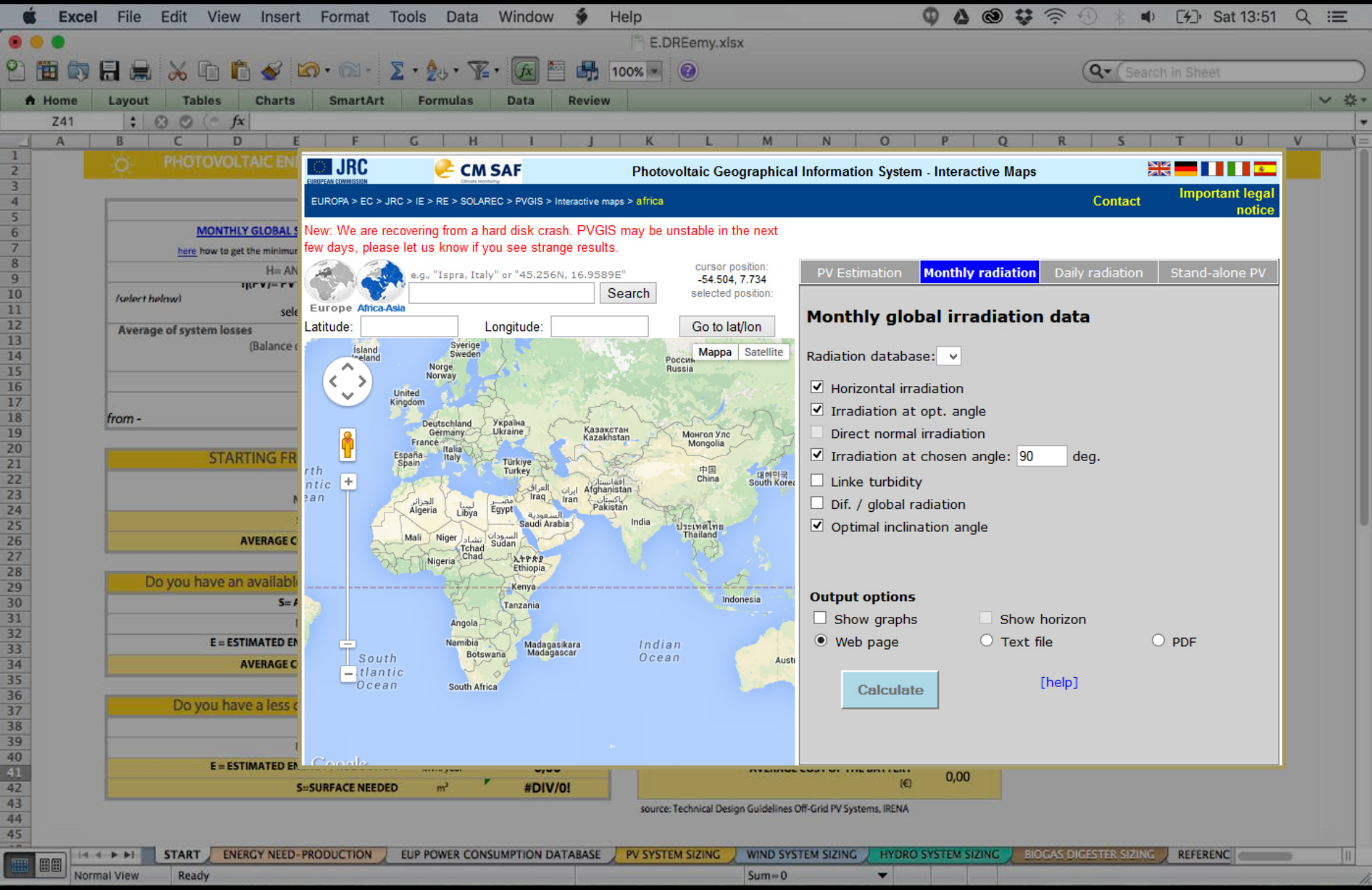
Photovoltaic Energy system sizing



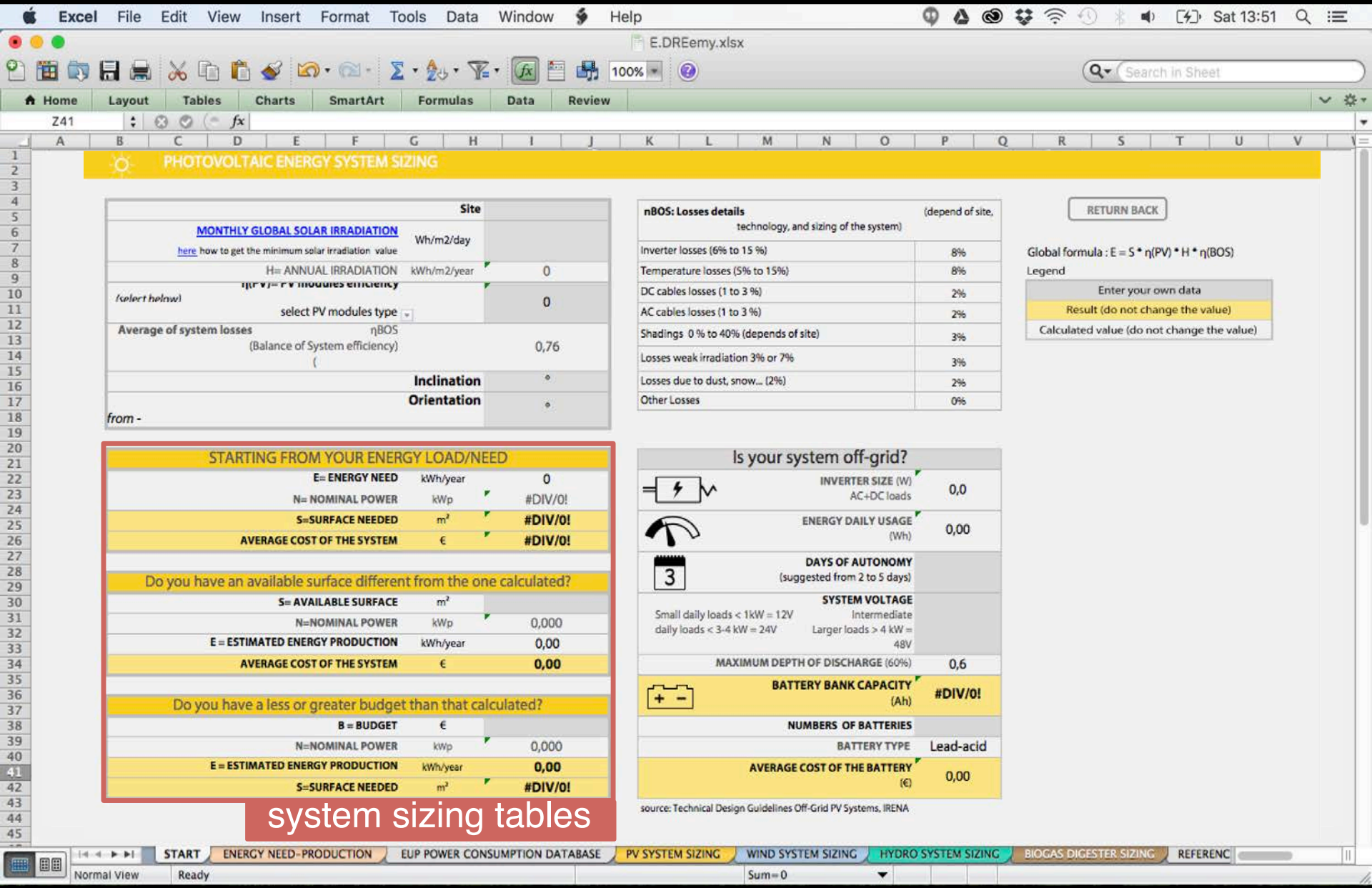
Photovoltaic Energy system sizing



Photovoltaic Energy system sizing

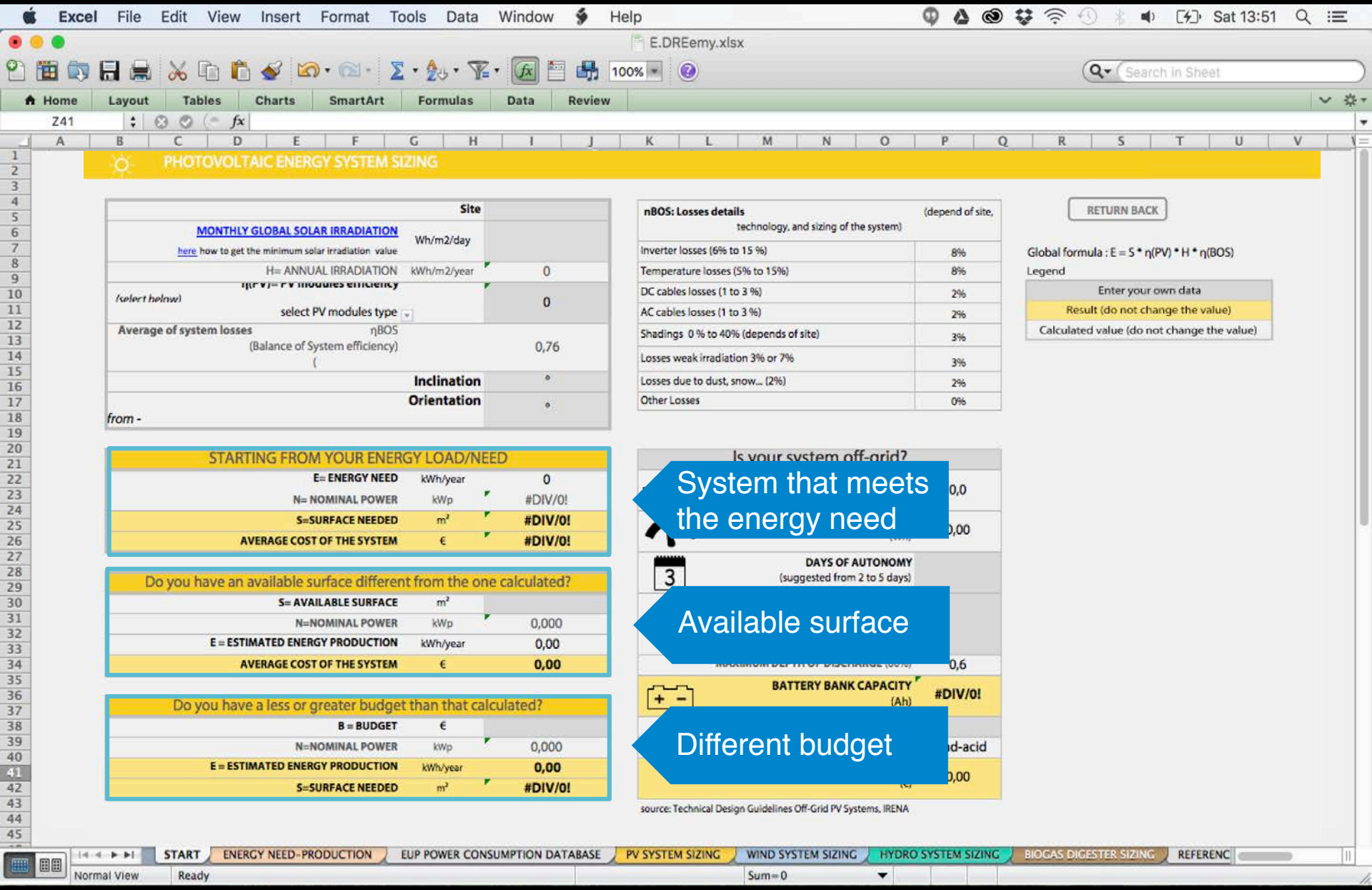


Photovoltaic Energy system sizing

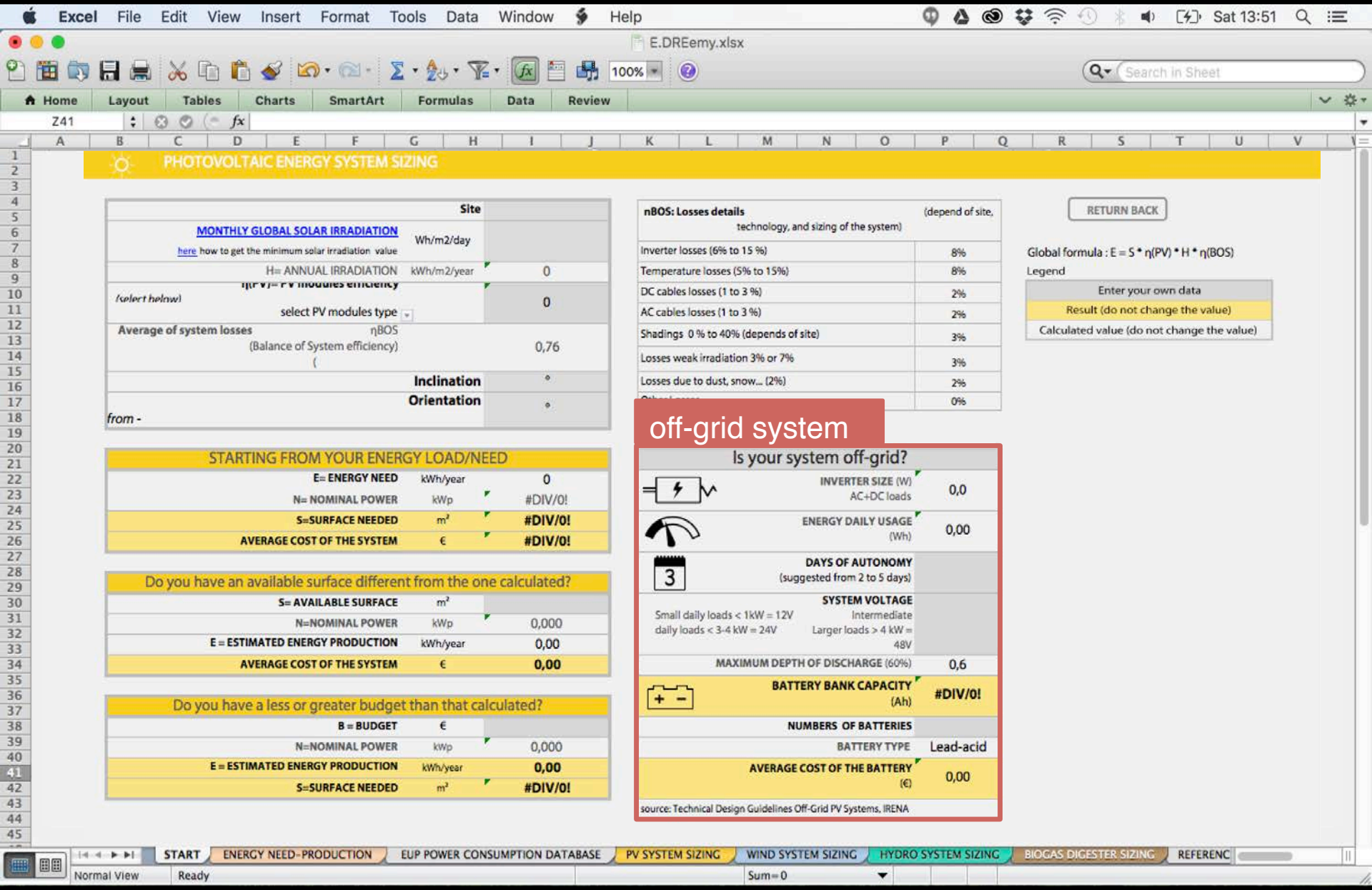


system sizing tables

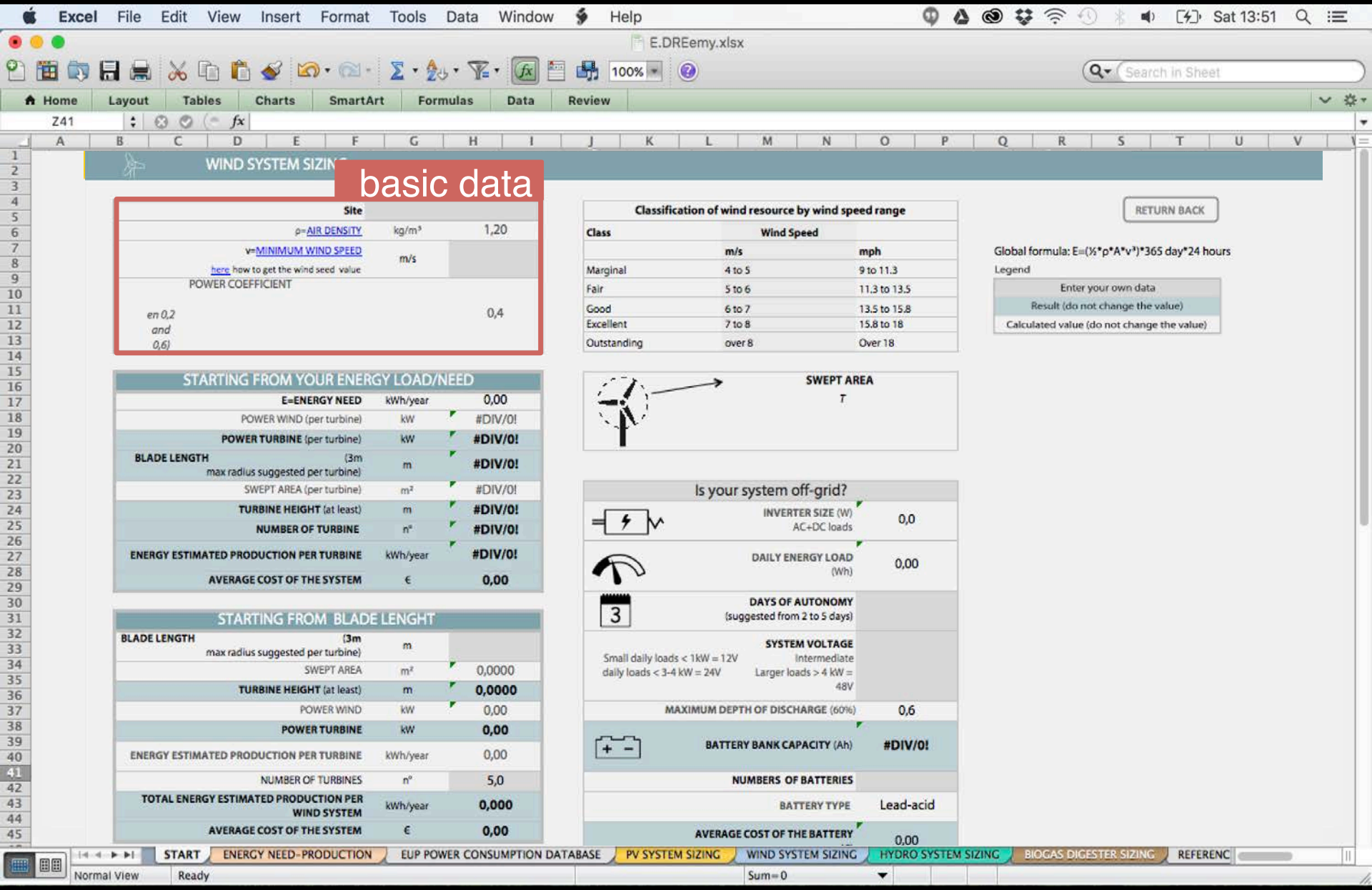
Photovoltaic Energy system sizing



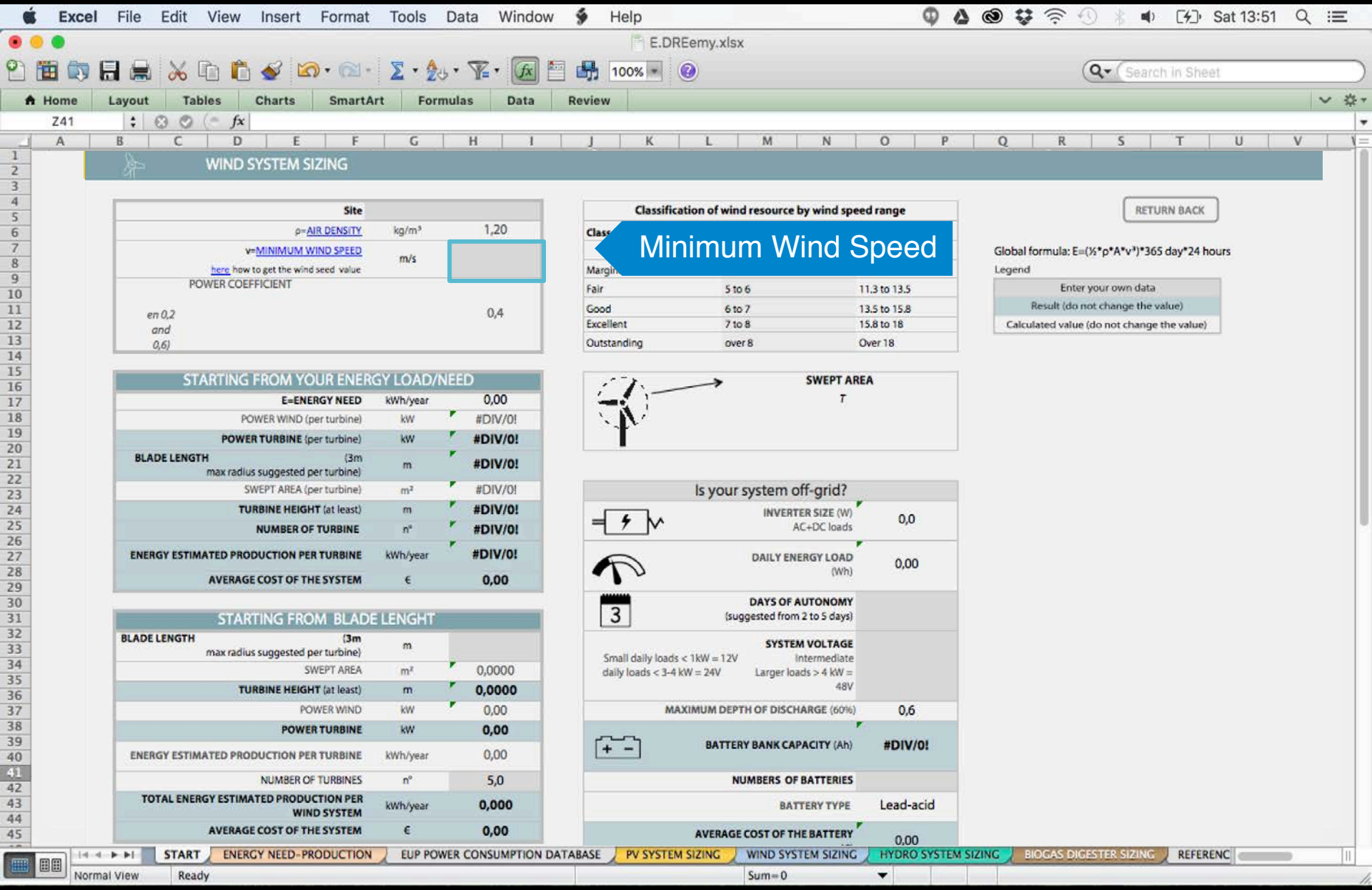
Photovoltaic Energy system sizing



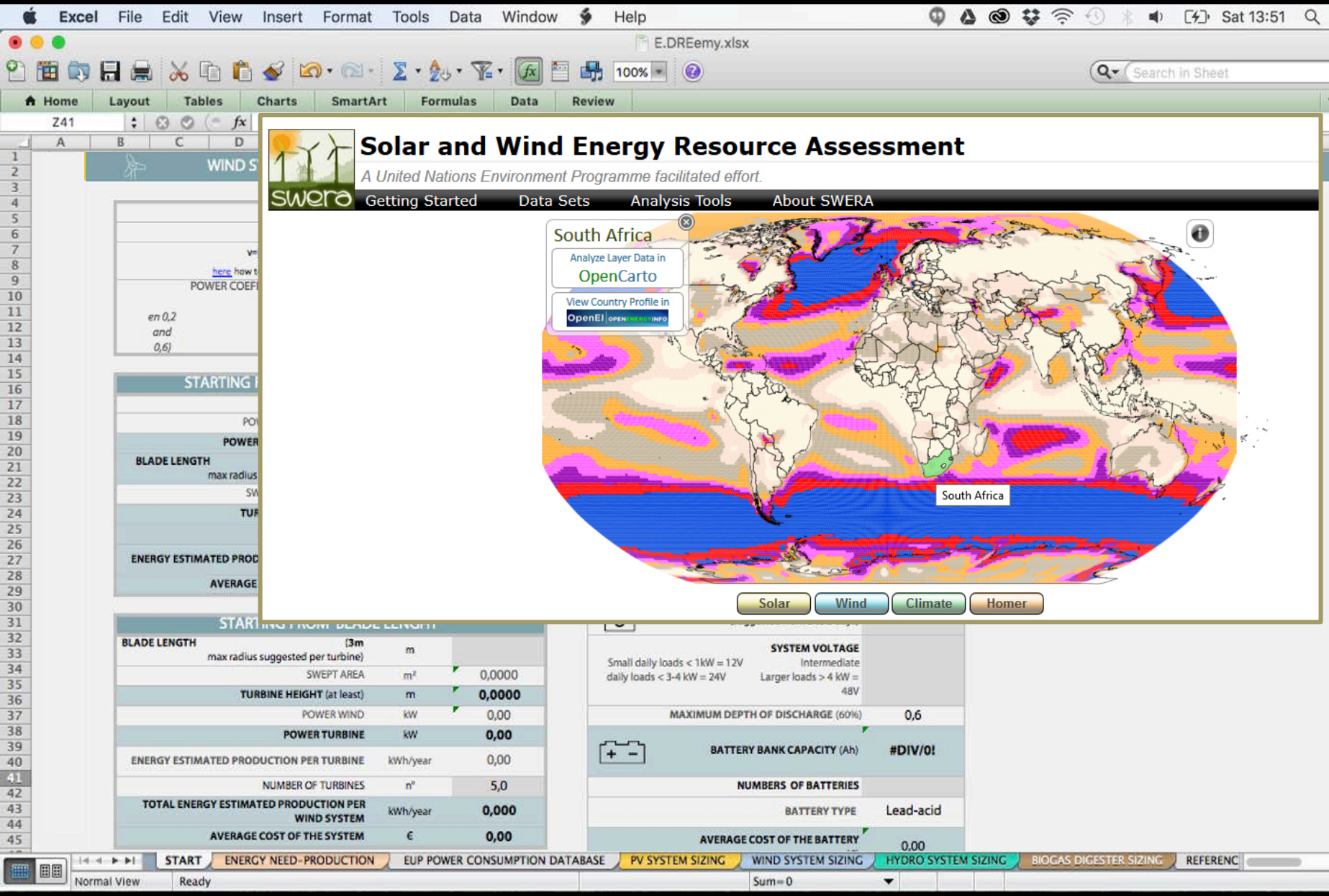
Wind system sizing



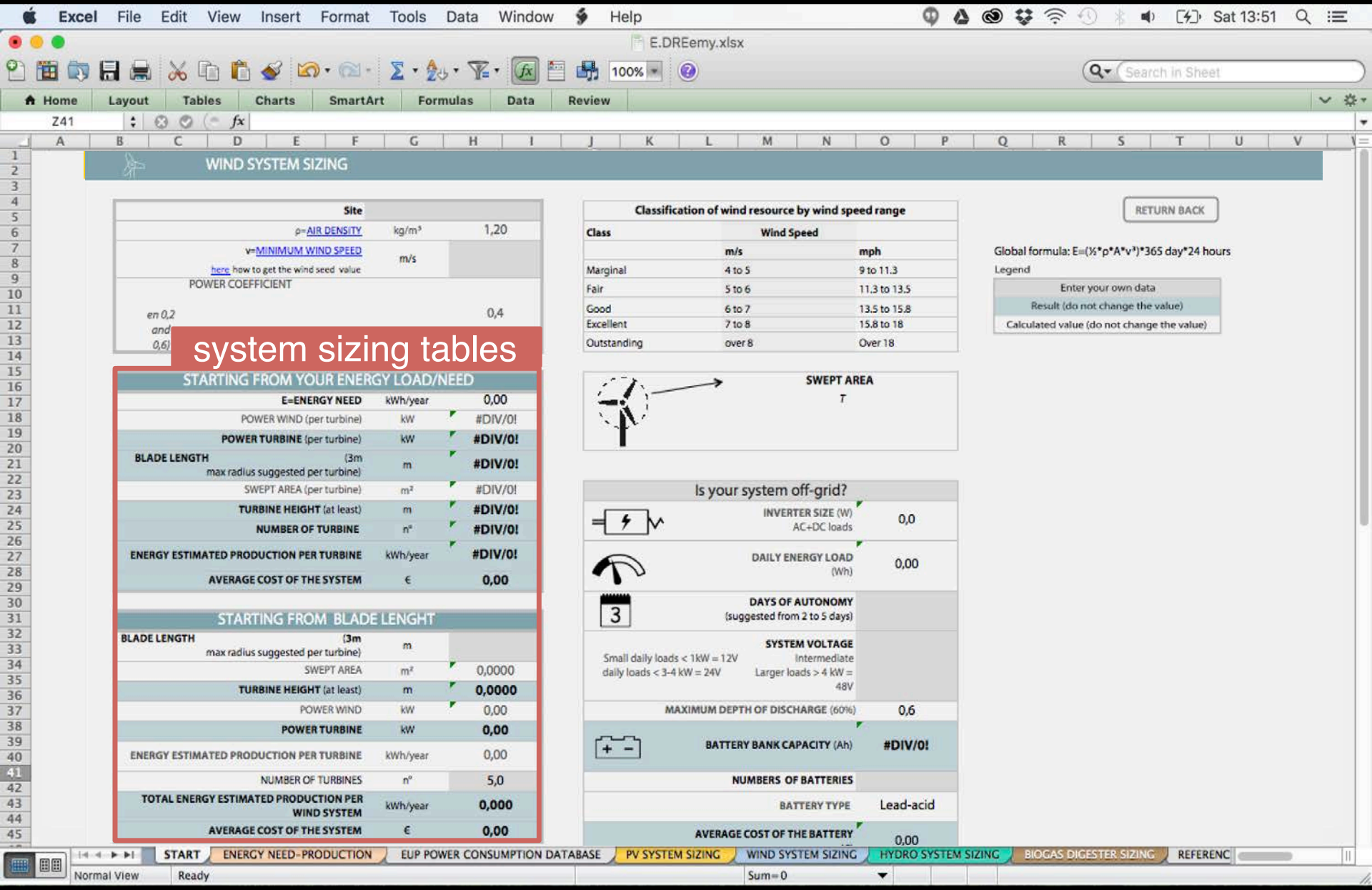
Wind system sizing



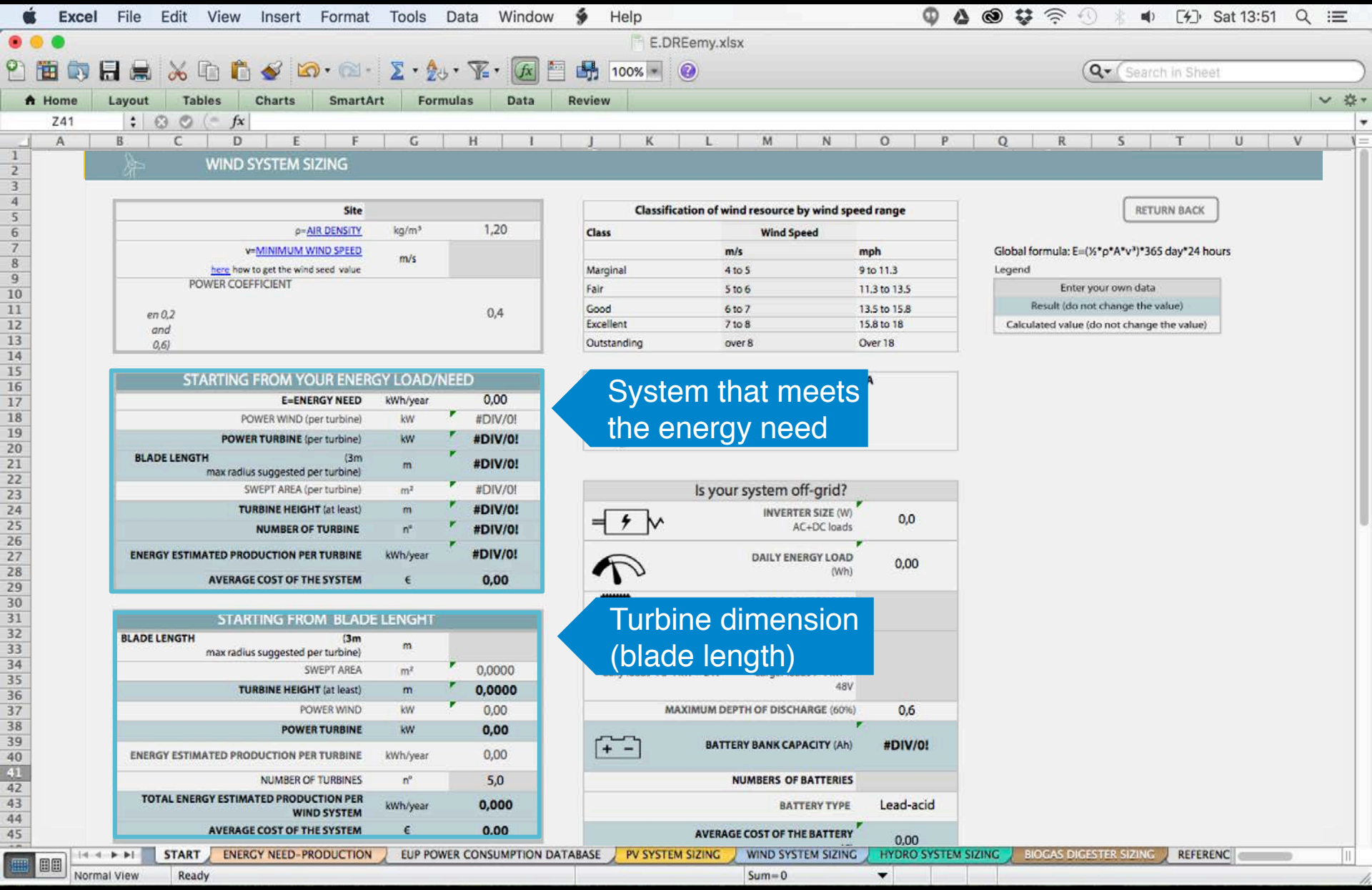
Wind system sizing



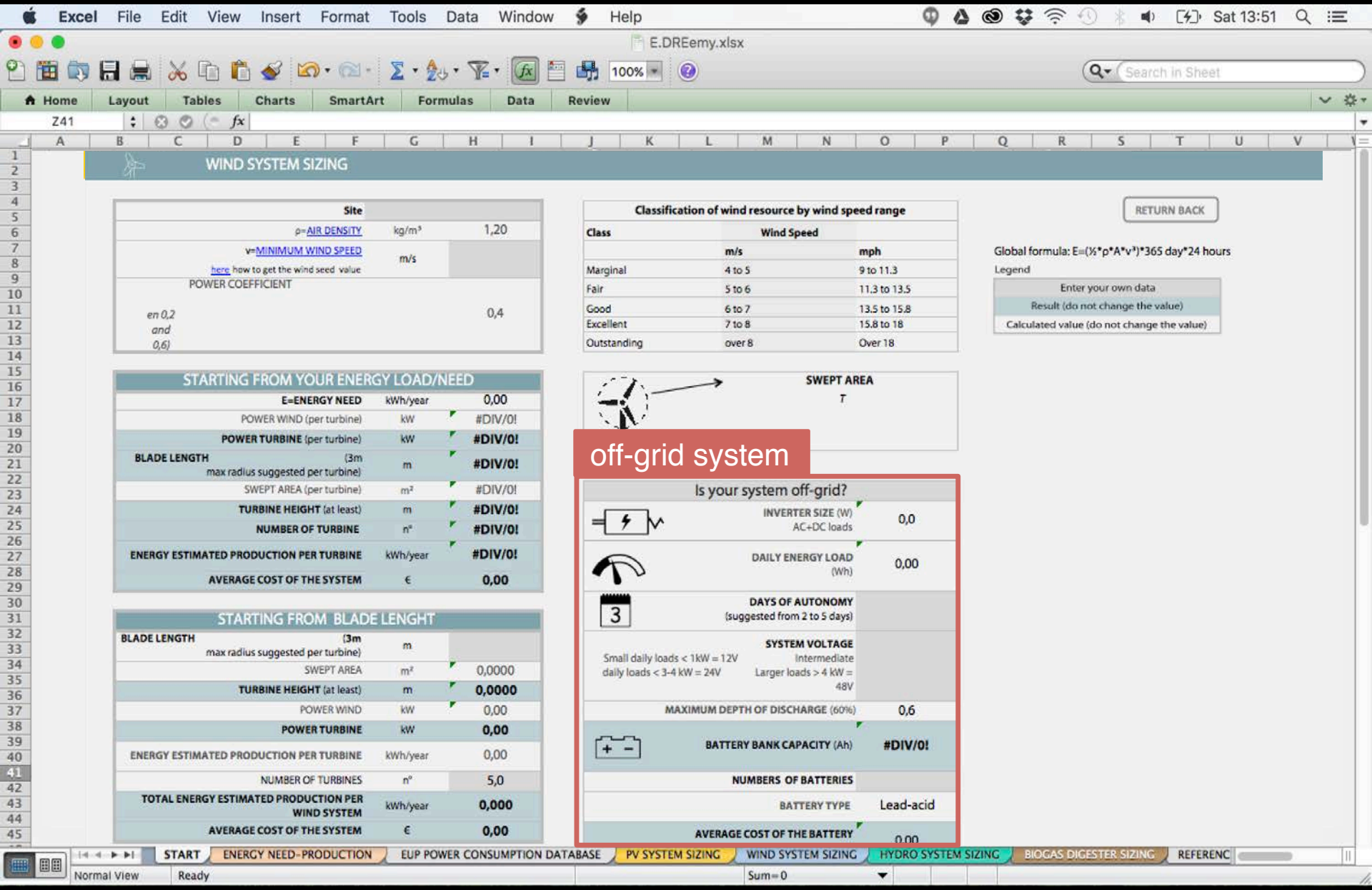
Wind system sizing



Wind system sizing



Wind system sizing



Hydro system sizing

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HYDRO ENERGY SYSTEM SIZING

basic data

		Site
Q = Water flow rate	l/s	
Stream		
g = Gravity	m/s²	9,81
η = Efficiency		0,5

STARTING FROM YOUR ENERGY LOAD/NEED

ENERGY NEED	kWh/year	0,000
HYDRO POWER	kW	0,000
E= GENERATOR POWER	kW	0,000
H = HEAD	m	#DIV/0!
AVERAGE COST OF THE SYSTEM	€	0,00

Do you have a head different from the one calculated?

HEAD	m	
HYDRO POWER	kW	0,000
E= GENERATOR POWER	kW	0,000
ENERGY ESTIMATED PRODUCTION	kWh/year	0,000
AVERAGE COST OF THE SYSTEM	€	0,00

Do you have a less or greater budget than that calculated?

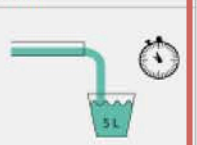
BUDGET	€	
HYDRO POWER	kW	0,000
E= GENERATOR POWER	kW	0,000
HEAD	m	#DIV/0!
ENERGY ESTIMATED PRODUCTION	kWh/year	0,00

FLOW RATE AVERAGE

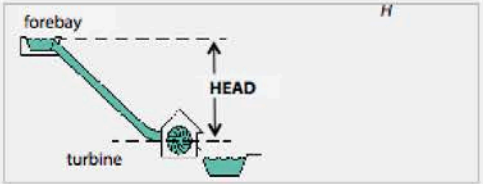
click here to see some examples of river flow

Very small stream	l/s	10-50
Small stream	l/s	50-250
Stream	l/s	250-1000
Small river	l/s	1000-2000
River	l/s	2000

FLOW MEASUREMENT



Volume of the container (water)	l	0
Filling time	s	0
Water flow	l/s	0



RETURN BACK

Global formula: E= HxQxgxηx365 days×24 hours

Legend

Enter your own data
Result (do not change the value)
Calculated value (do not change the value)

START | ENERGY NEED-PRODUCTION | EUP POWER CONSUMPTION DATABASE | PV SYSTEM SIZING | WIND SYSTEM SIZING | HYDRO SYSTEM SIZING | BIOGAS DIGESTER SIZING | REFERENC

Normal View | Ready | Sum=0

Hydro system sizing

HYDRO ENERGY SYSTEM SIZING

Site

Q = Water flow rate

FLOW RATE AVERAGE

click here to see some examples of river flow

RETURN BACK

STARTING

AVERAGE

Do you have a

ENERGY ES

AVERAGE

Do you have a le

ENERGY ES

Very small stream
10 to 50 l/s

Small stream
50 to 250 l/s

Stream
250 to 1000 l/s

Small river
1000 to 2000 l/s

River
2000 l/s and grater

source: http://www.micro-hydro-power.com/micro-hydro-power-Estimating-Head-and-Flow.htm

RETURN BACK

START | ENERGY NEED-PRODUCTION | EUP POWER CONSUMPTION DATABASE | PV SYSTEM SIZING | WIND SYSTEM SIZING | HYDRO SYSTEM SIZING | BIOG ...

START | ENERGY NEED-PRODUCTION | EUP POWER CONSUMPTION DATABASE | PV SYSTEM SIZING | WIND SYSTEM SIZING | HYDRO SYSTEM SIZING | BIOGAS DIGESTER SIZING | REFERENC

Normal View | Ready | Sum=0

Hydro system sizing

HYDRO ENERGY SYSTEM SIZING

Site		
Q = Water flow rate	l/s	
Stream		
g = Gravity	m/s²	9,81
η = Efficiency		0,5

STARTING FROM YOUR ENERGY LOAD/NEED		
ENERGY NEED	kWh/year	0,000
HYDRO POWER	kW	0,000
E= GENERATOR POWER	kW	0,000
H = HEAD	m	#DIV/0!
AVERAGE COST OF THE SYSTEM	€	0,00

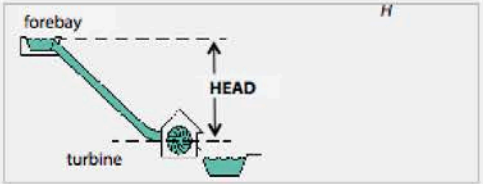
Do you have a head different from the one calculated?		
HEAD	m	
HYDRO POWER	kW	0,000
E= GENERATOR POWER	kW	0,000
ENERGY ESTIMATED PRODUCTION	kWh/year	0,000
AVERAGE COST OF THE SYSTEM	€	0,00

Do you have a less or greater budget than that calculated?		
BUDGET	€	
HYDRO POWER	kW	0,000
E= GENERATOR POWER	kW	0,000
HEAD	m	#DIV/0!
ENERGY ESTIMATED PRODUCTION	kWh/year	0,00

system sizing tables

FLOW RATE AVERAGE (click here to see some examples of river flow)		
Very small stream	l/s	10-50
Small stream	l/s	50-250
Stream	l/s	250-1000
Small river	l/s	1000-2000
River	l/s	2000

FLOW MEASUREMENT		
Volume of the container (water)	l	0
Filling time	s	0
Water flow	l/s	0



RETURN BACK

Global formula: E= HxQxgxηx365 days×24 hours

Legend

Enter your own data
Result (do not change the value)
Calculated value (do not change the value)

Hydro system sizing

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HYDRO ENERGY SYSTEM SIZING

	Site	
Q = Water flow rate	l/s	
Stream		
g = Gravity	m/s²	9,81
η = Efficiency		0,5

STARTING FROM YOUR ENERGY LOAD/NEED

ENERGY NEED	kWh/year	0,000
HYDRO POWER	kW	0,000
E= GENERATOR POWER	kW	0,000
H = HEAD	m	#DIV/0!
AVERAGE COST OF THE SYSTEM	€	0,00

Do you have a head different from the one calculated?

HEAD	m	
HYDRO POWER	kW	0,000
E= GENERATOR POWER	kW	0,000
ENERGY ESTIMATED PRODUCTION	kWh/year	0,000
AVERAGE COST OF THE SYSTEM	€	0,00

Do you have a less or greater budget than that calculated?

BUDGET	€	
HYDRO POWER	kW	0,000
E= GENERATOR POWER	kW	0,000
HEAD	m	#DIV/0!
ENERGY ESTIMATED PRODUCTION	kWh/year	0,00

FLOW RATE AVERAGE

click here to see some examples of river flow

Very small stream	l/s	10-50
Small stream	l/s	50-250
Stream	l/s	250-1000
Small river	l/s	1000-2000

System that meets the energy need

Different head

Different budget

RETURN BACK

Global formula: E= HxQxgxηx365 days×24 hours

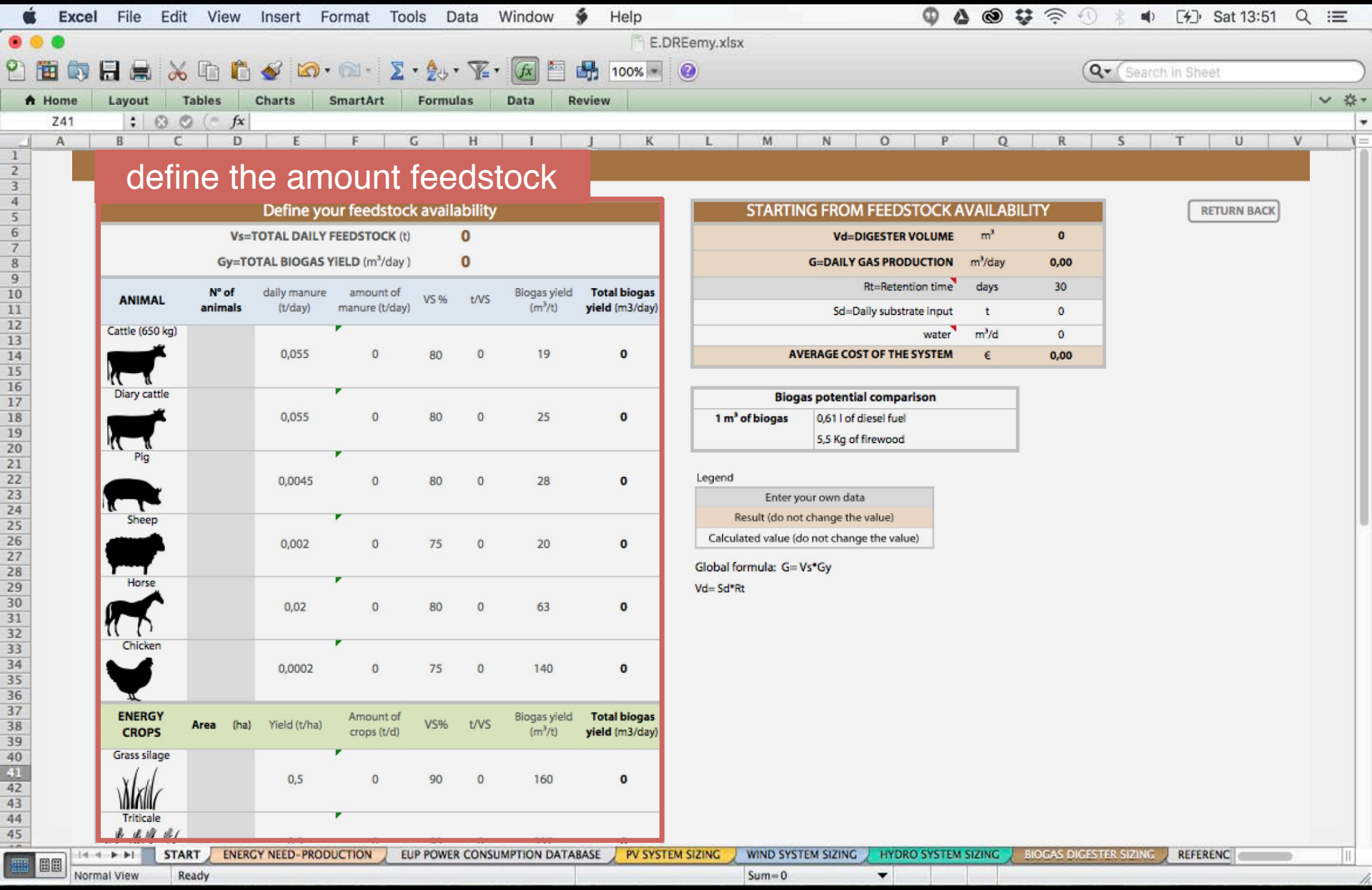
Legend

Enter your own data
Result (do not change the value)
Calculated value (do not change the value)

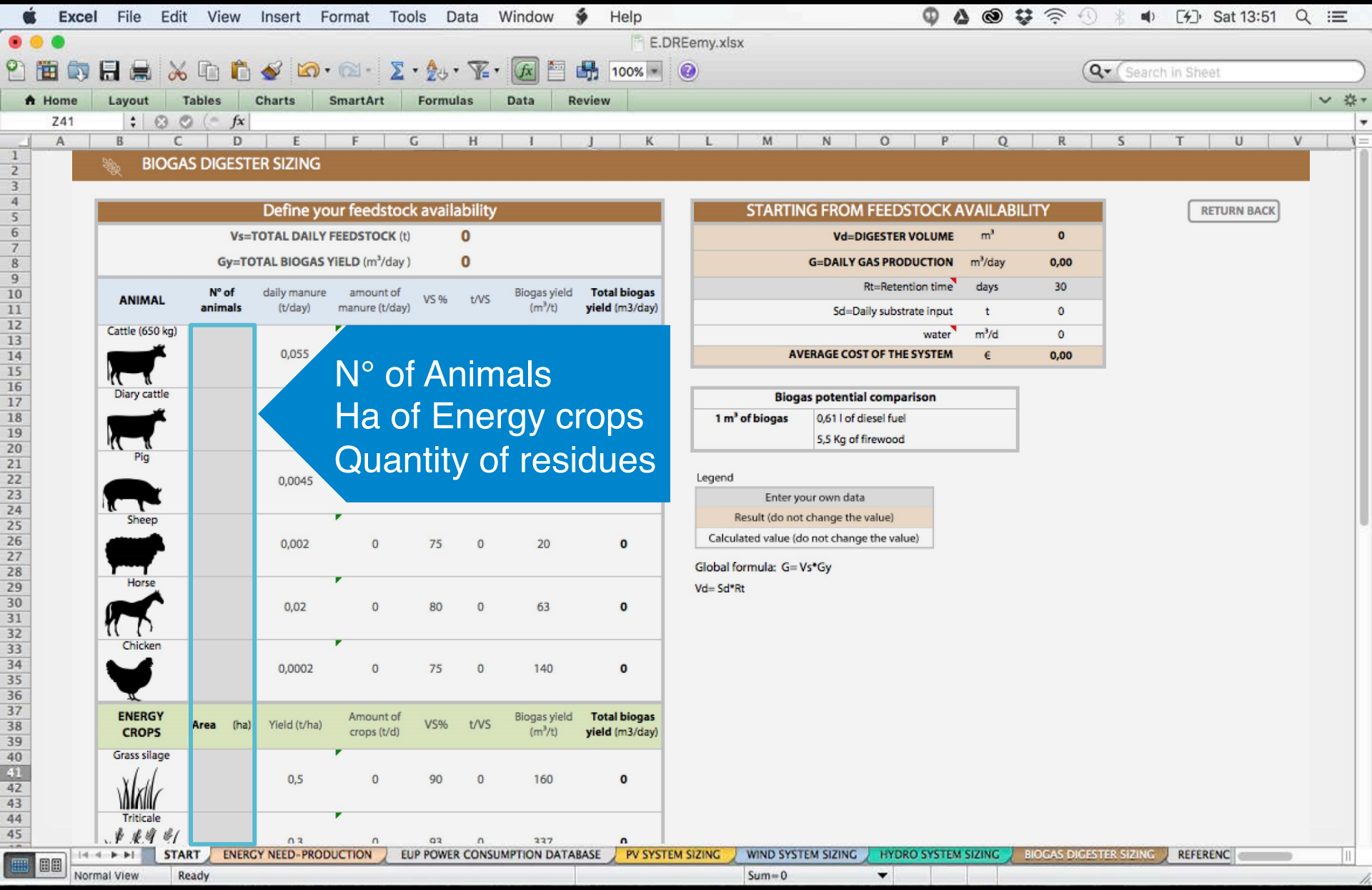
START | ENERGY NEED-PRODUCTION | EUP POWER CONSUMPTION DATABASE | PV SYSTEM SIZING | WIND SYSTEM SIZING | HYDRO SYSTEM SIZING | BIOGAS DIGESTER SIZING | REFERENC

Normal View | Ready | Sum=0

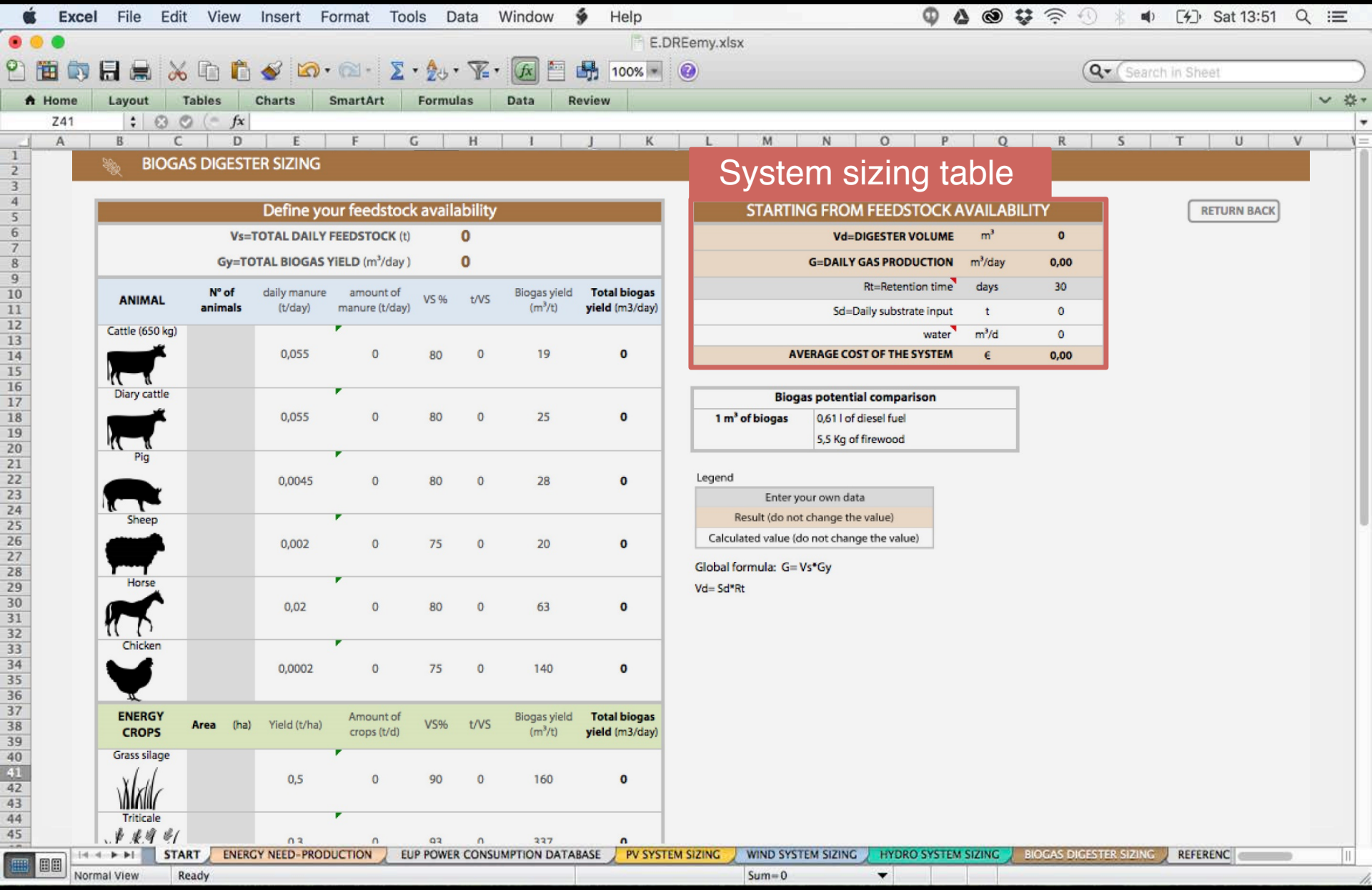
Biomass digester sizing



Biomass digester sizing



Biomass digester sizing



4. Verify if the system proposed satisfy the energy need

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ENERGY LOAD/NEED

TOTAL ENERGY NEED (Kwh/year)	905,93
TOTAL GAS NEED (m³/year)	0

TYPE OF APPLIANCE [DATABASE]	POWER (W)	GAS CONSUMPTION (m³)	NUMBER OF APPLIANCES (unit)	HOURS OF USAGE PER DAY (h/day)	ELECTRICITY CONSUMPTION PER DAY (kWh/day)	GAS CONSUMPTION PER DAY (m³/day)
Incandescent bulb (60 W)	60	0	6	6	2,16	0
Laptop	50	0	1	5	0,25	0
Phone charger	4	0	3	6	0,072	0
Select appliance	0	0			0	0
Select appliance	0	0			0	0

Click here to copy and paste the icon

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ENERGY PRODUCTION POTENTIAL

TOTAL ENERGY PRODUCTION POTENTIAL (Kwh/year)	905,93
TOTAL GAS PRODUCTION POTENTIAL (m³/year)	0,00

TYPE OF DRE RESOURCES	DRE GENERAL CHARACTERISTICS	DRE SYSTEM POWER	TOTAL DRE PRODUCTION POTENTIAL
PHOTOVOLTAIC ENERGY	Describe the general characteristics of the DRE system		kWh 905,93 0,00 0,00
WIND ENERGY	Describe the general characteristics of the DRE system		kWh 905,93 0,00
HYDRO ENERGY	Describe the general characteristics of the DRE system		kWh 905,93 0,00 0,00
BIOGAS ENERGY	Describe the general characteristics of the DRE system		m³ 0,00
OTHER TYPE OF DRE	Describe the general characteristics of the DRE system		

START | ENERGY NEED-PRODUCTION | EUP POWER CONSUMPTION DATABASE | PV SYSTEM SIZING | WIND SYSTEM SIZING | HYDRO SYSTEM SIZING | BIOGAS DIGESTER SIZING | REFERENC

Normal View | Ready | Sum=0

4. Verify if the system proposed satisfy the energy need

satisfying

ENERGY LOAD/NEED

TOTAL ENERGY NEED (Kwh/year)	905,93
TOTAL GAS NEED (m³/year)	0

TYPE OF APPLIANCE [DATABASE]	POWER (W)	GAS CONSUMPTION (m³)	NUMBER OF APPLIANCES (unit)	HOURS OF USAGE PER DAY (h/day)	ELECTRICITY CONSUMPTION PER DAY (kWh/day)	GAS CONSUMPTION PER DAY (m³/day)
Incandescent bulb (60 W) 	60	0	6	6	2,16	0
Laptop 	50	0	1	5	0,25	0
Phone charger 	4	0	3	6	0,072	0
Select appliance	0	0			0	0
Click here to copy and paste the icon						
Select appliance	0	0			0	0
Click here to copy and paste the icon						

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ENERGY PRODUCTION POTENTIAL

TOTAL ENERGY PRODUCTION POTENTIAL (Kwh/year)	905,93
TOTAL GAS PRODUCTION POTENTIAL (m³/year)	0,00

TYPE OF DRE RESOURCES	DRE GENERAL CHARACTERISTICS	DRE SYSTEM POWER	TOTAL DRE PRODUCTION POTENTIAL
PHOTOVOLTAIC ENERGY	*Describe the general characteristics of the DRE system*		kWh 905,93 0,00 0,00
WIND ENERGY	*Describe the general characteristics of the DRE system*		kWh 905,93 0,00
HYDRO ENERGY	*Describe the general characteristics of the DRE system*		kWh 905,93 0,00 0,00
BIOGAS ENERGY	*Describe the general characteristics of the DRE system*		m³ 0,00
OTHER TYPE OF DRE	*Describe the general characteristics of the DRE system*		

4. Verify if the system proposed satisfy the energy need

unsatisfying

ENERGY LOAD/NEED

TOTAL ENERGY NEED (Kwh/year)	905,93
TOTAL GAS NEED (m³/year)	0

TYPE OF APPLIANCE [DATABASE]	POWER (W)	GAS CONSUMPTION (m³)	NUMBER OF APPLIANCES (unit)	HOURS OF USAGE PER DAY (h/day)	ELECTRICITY CONSUMPTION PER DAY (kWh/day)	GAS CONSUMPTION PER DAY (m³/day)
Incandescent bulb (60 W) 	60	0	6	6	2,16	0
Laptop 	50	0	1	5	0,25	0
Phone charger 	4	0	3	6	0,072	0
Select appliance						
Click here to copy and paste the icon	0	0			0	0
Select appliance						
Click here to copy and paste the icon	0	0			0	0

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ENERGY PRODUCTION POTENTIAL

TOTAL ENERGY PRODUCTION POTENTIAL (Kwh/year)	834,15
TOTAL GAS PRODUCTION POTENTIAL (m³/year)	0,00

TYPE OF DRE RESOURCES	DRE GENERAL CHARACTERISTICS	DRE SYSTEM POWER	TOTAL DRE PRODUCTION POTENTIAL
PHOTOVOLTAIC ENERGY	*Describe the general characteristics of the DRE system*		kWh 905,93 834,15 0,00
WIND ENERGY	*Describe the general characteristics of the DRE system*		kWh 905,93 0,00
HYDRO ENERGY	*Describe the general characteristics of the DRE system*		kWh 905,93 0,00 0,00
BIOGAS ENERGY	*Describe the general characteristics of the DRE system*		m³ 0,00
OTHER TYPE OF DRE	*Describe the general characteristics of the DRE system*		

Conclusions

- Combine existing tools and information to design and dimension DRE system into one single tool accessible for designers
- Allow designers to have a basic knowledge on energy, and to integrate energy requirement into their design works
- Implemented with excel to make calculations
- It can be easily updated and integrated to be open to the fast evolution of the renewable energy technology