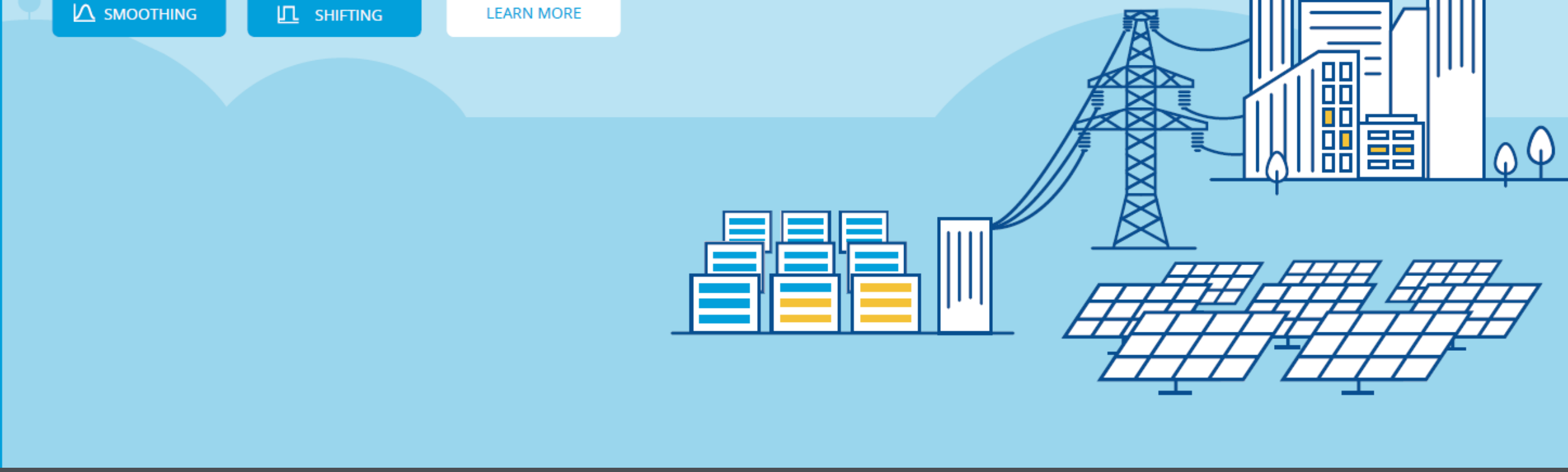


# SOLAR PV + STORAGE SIZING APP TUTORIAL

December 03, 2020

WORLD BANK GROUP
Energy & Extractives

ESMAP

# CONTENT

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# SOLAR PV + STORAGE SIZING TOOL

**Objective:**

- To provide a preliminary assessment of the energy storage sizing requirements (both in terms of energy and power), and the project cost of hybrid solar PV and energy storage systems, using energy storage for smoothing and shifting applications.

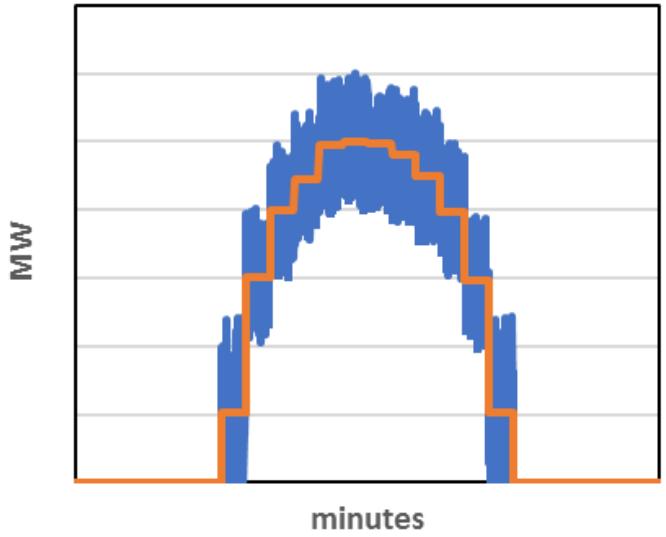
**Characteristics**:

- Direct linkage to the Global Solar Atlas where solar PV data is automatically retrieved by the app.
- User friendly interface and customizable for more sophisticated analysis.
- Real time results. Results adjusted as per the given input parameters ( location, load profile, storage cost assumptions, etc.).
- The sizing of this hybrid system is based on a high-level representation of the solar variability (twelve representative days). This analysis does not substitute a pre-feasibility or feasibility study for a hybrid solar PV and battery storage system.

# FOCUS ON TWO APPLICATIONS

## 1. Smoothing

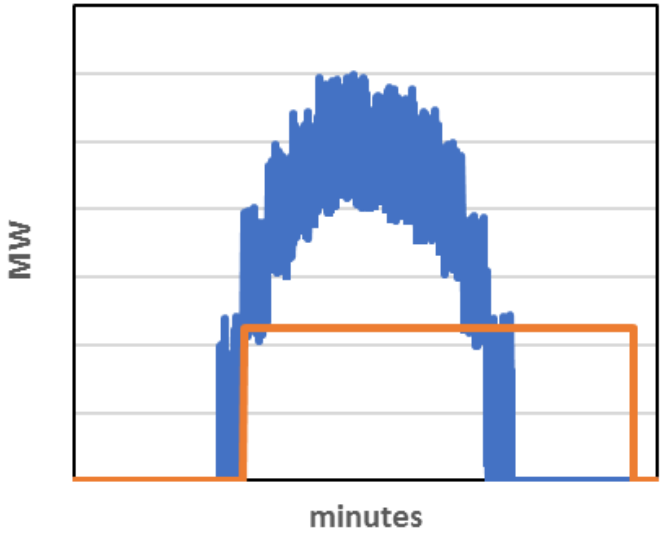
- Reduce short-run variability of solar PV.
- Allow sources of flexibility in the system to respond.
- Equivalent to providing reserves only to address the variability and uncertainty of the PV plant.




Optimal energy **storage capacity** to provide a "smooth" profile over a given time step (e.g. 2 hours)

## 2. Shifting

- Guarantee a given output profile during a certain time duration.
- Involves dimensioning solar field and battery.




Optimal amount of **solar PV and energy storage** to meet a load profile defined by the user (provide firm capacity)

# FORMULATION

The solution is a **total cost minimization of the CAPEX**. The objective function:

*Total Cost = Annual Solar Plant Cost + Annual BESS Energy Cost + Annual BESS Power Cost + Unserved Energy Cost*

The solution is constrained by a set of linear constraints that describe the bounds of the solution over time steps corresponding:

- Solar profile
- Solar generation
- Battery state of charge (including efficiency)
- Demand
- Unserved energy

# TEAM

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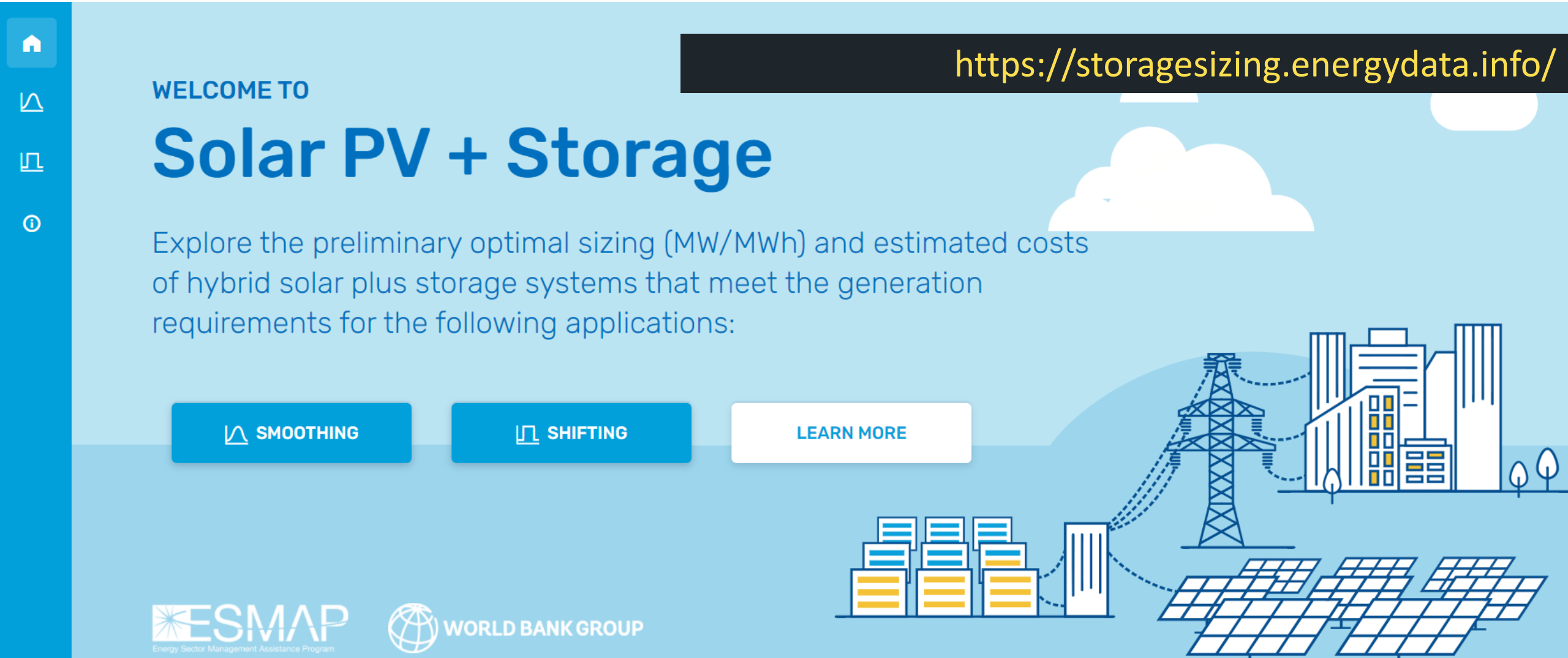
Derilinx

DRIVE DECISION-MAKING. INSPIRE CHANGE

# THE SESSION TODAY

**Learning objectives**: Understanding the basic functionalities of the solar plus storage sizing tool for two applications: (i) capacity smoothing or (ii) delivering a user-defined demand profile.

https://storagesizing.energydata.info/



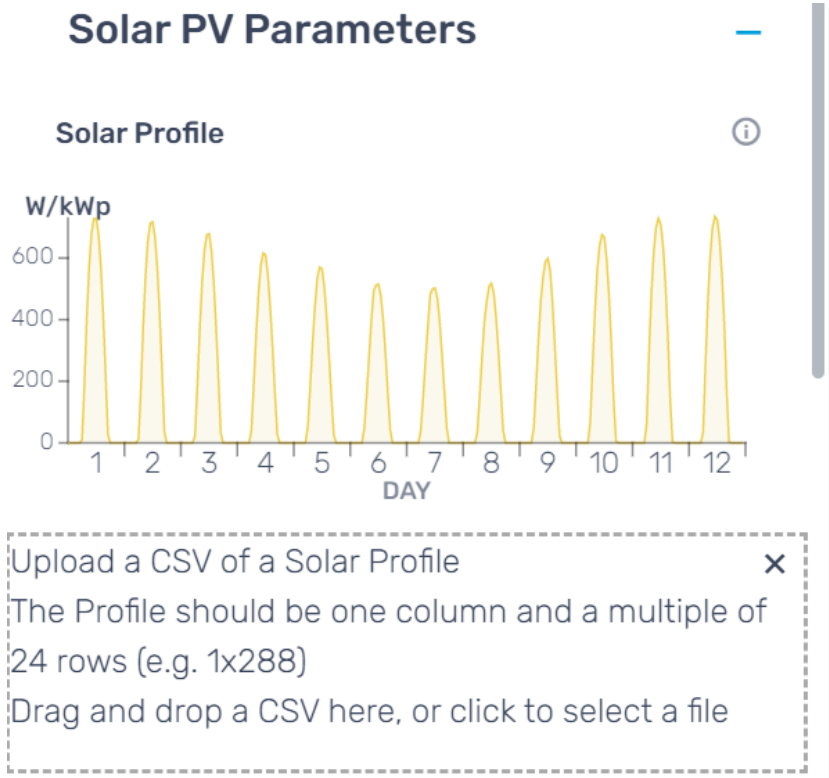
# SOLAR PV + STORAGE SIZING EXERCISES

1. **Smoothing application**
   a. Different countries
   b. Different step size 2 hours to 3 hours
   c. Different battery type

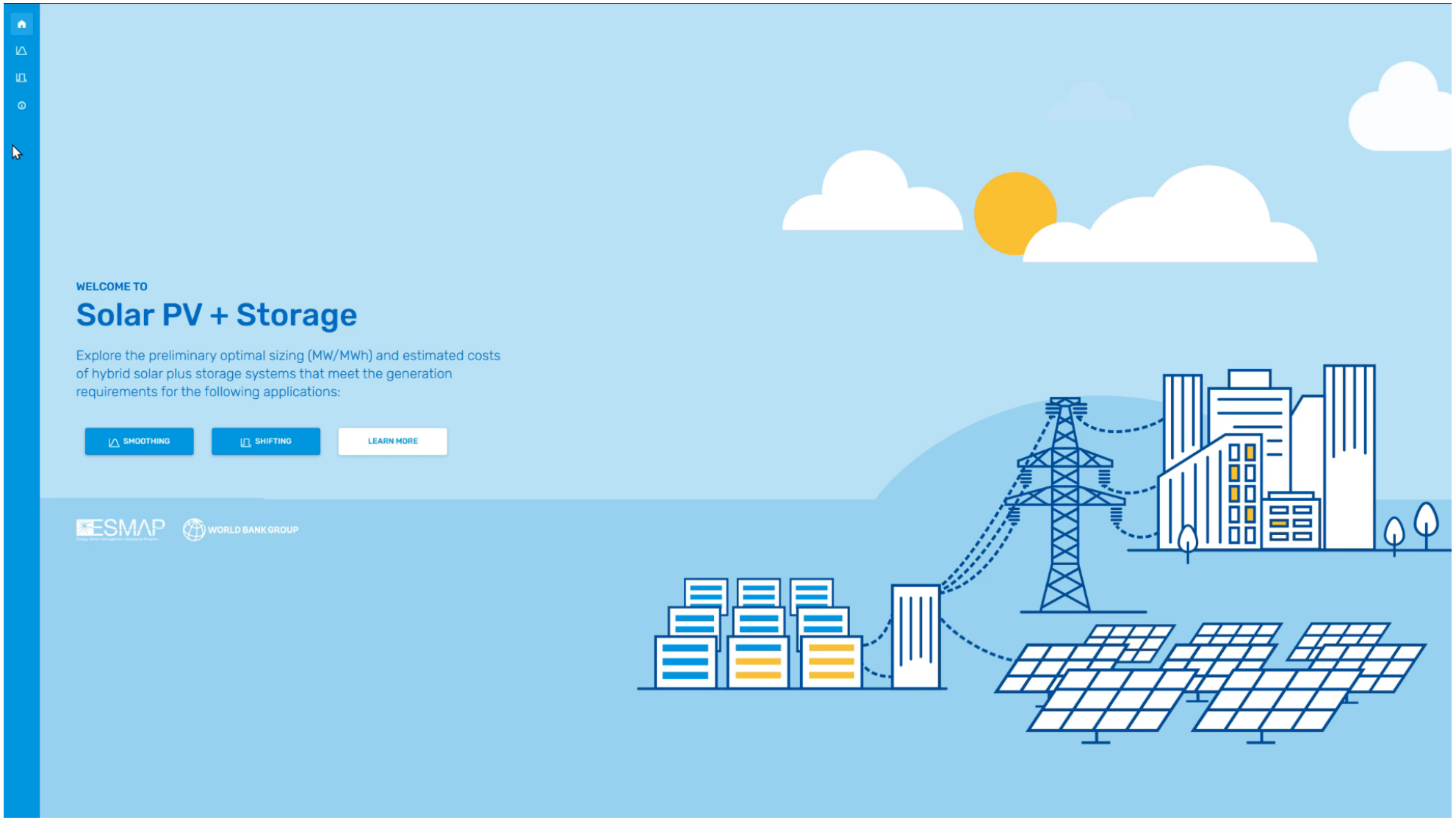
2. **Shifting application**:
   a. Default profile, showing the full solar profile (8760 hours)
   b. Square profile from 8am-10pm
   c. Flat profile, showing analogy with mini grid design

Upload file provided ***CAR_P50.csv***:

- Solar profile with full variability, upload a .csv file



# QUICK GUIDE AND TOOL TUTORIAL



# KEY TAKEAWAYS

- Solar sizing is complex because of the number of variables at play
- For an accurate estimation of solar and storage, it is important to use a full year of solar profile data
- This tool allows a quick assessment of solar and storage
- This analysis does not substitute a pre-feasibility or feasibility study for a hybrid solar PV and battery storage system.

# THANK YOU

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# INPUT/OUTPUTS

| Application | Inputs | Output |
| --- | --- | --- |
| • Smoothing<br>  • Optimize BESS<br>• User Defined Demand Profile (firming)<br>  • Optimize BESS and solar | • Solar data<br>• BESS data<br>• General data<br>  • Location<br>  • Demand profile<br>  • Unserved energy cost | • PV Size (MW)<br>• BESS Size (MW / MWh)<br>• Unserved energy %<br>• Total cost<br>• LCOE<br>• Graph |