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PEOPLE

PLANET

OPTIMUS
BRIGHTER TOMORROW

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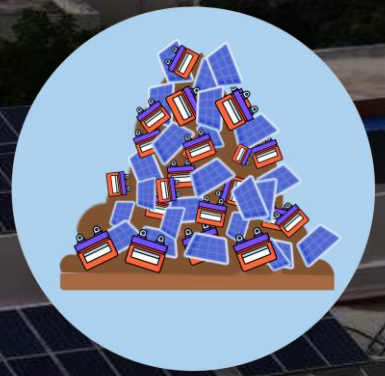
THREE PROBLEMS

OVERFLOWING LANDFILLS



UNRELIABLE AND EXPENSIVE GRID SUPPLY

HIGH CAPEX FOR SOLAR ENERGY

ONE SOLUTION

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POCKET-FRIENDLY & PLANET-FRIENDLY
ROOFTOP SOLAR SOLUTION

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How do we do it?

Battery Pack

Application

Landfill

REPURPOSE

REFURBISH

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On-Grid

Off-Grid

Solar panels

Application

Landfill

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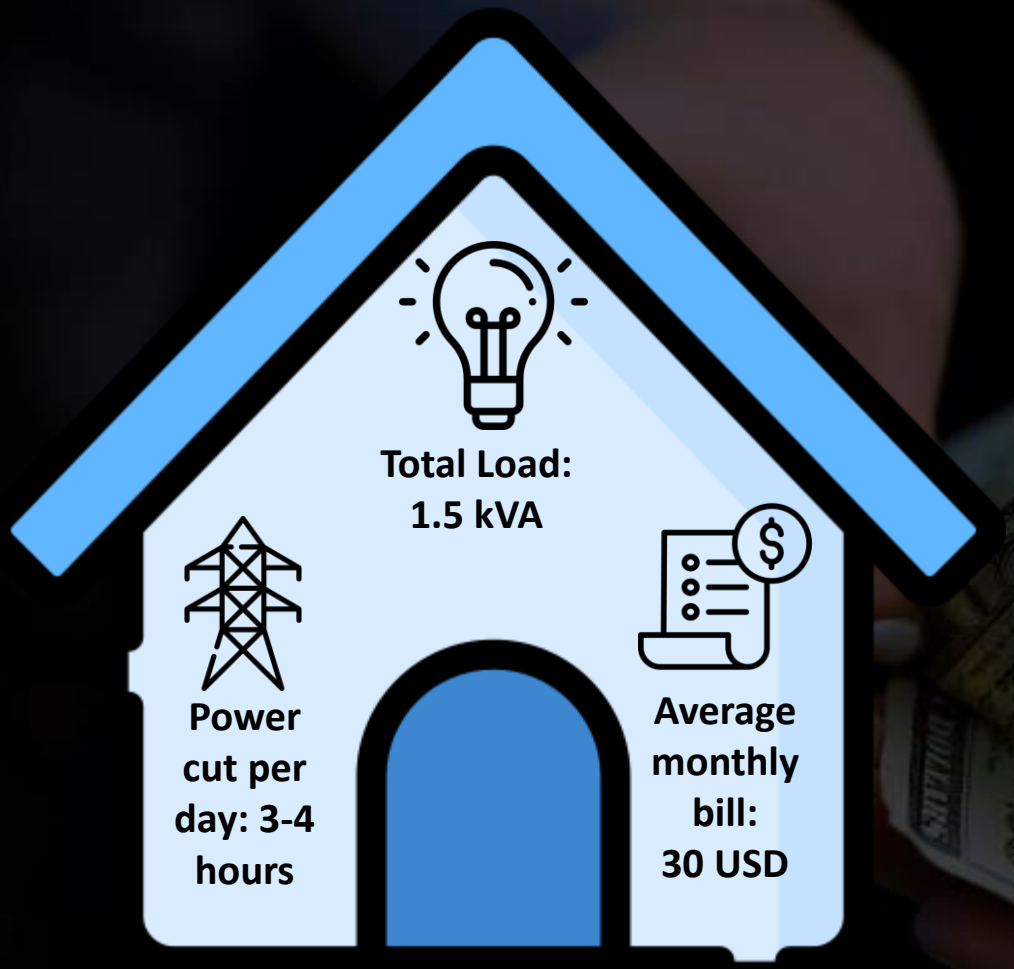
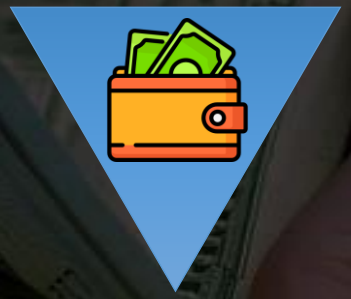
Why OPTIMUS?

HASSAN's Home

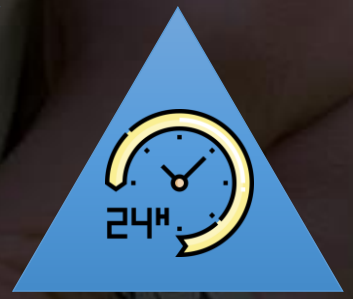


Solar UPS

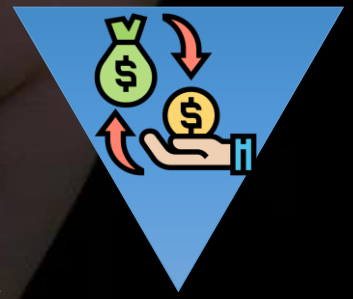
	MARKET PRICE	OPTIMUS
CAPEX (USD)	1500	1200



Upto 25% less CAPEX



24/7 reliable power supply



Decreased payback period

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AFFORDABLE

Upto 30% Low Capex
Savings Intimation
Time to profit

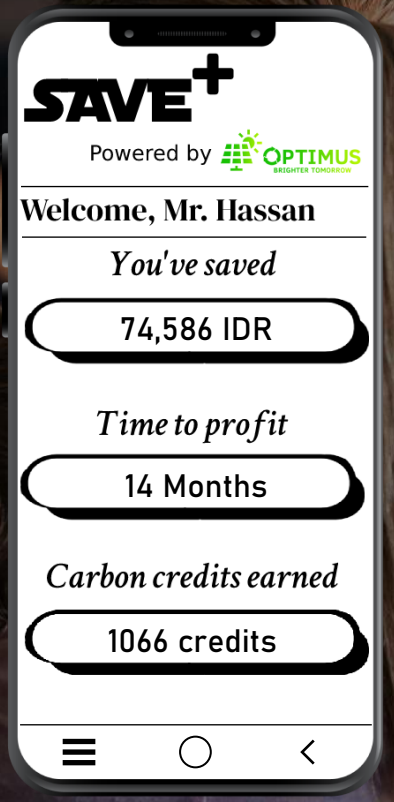
CERTIFIED

SE Brand
Multipoint quality checks

GREENER

Circular usage
Carbon credits

Advantage OPTIMUS



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OPTIMUS Market

TARGET ENERGY

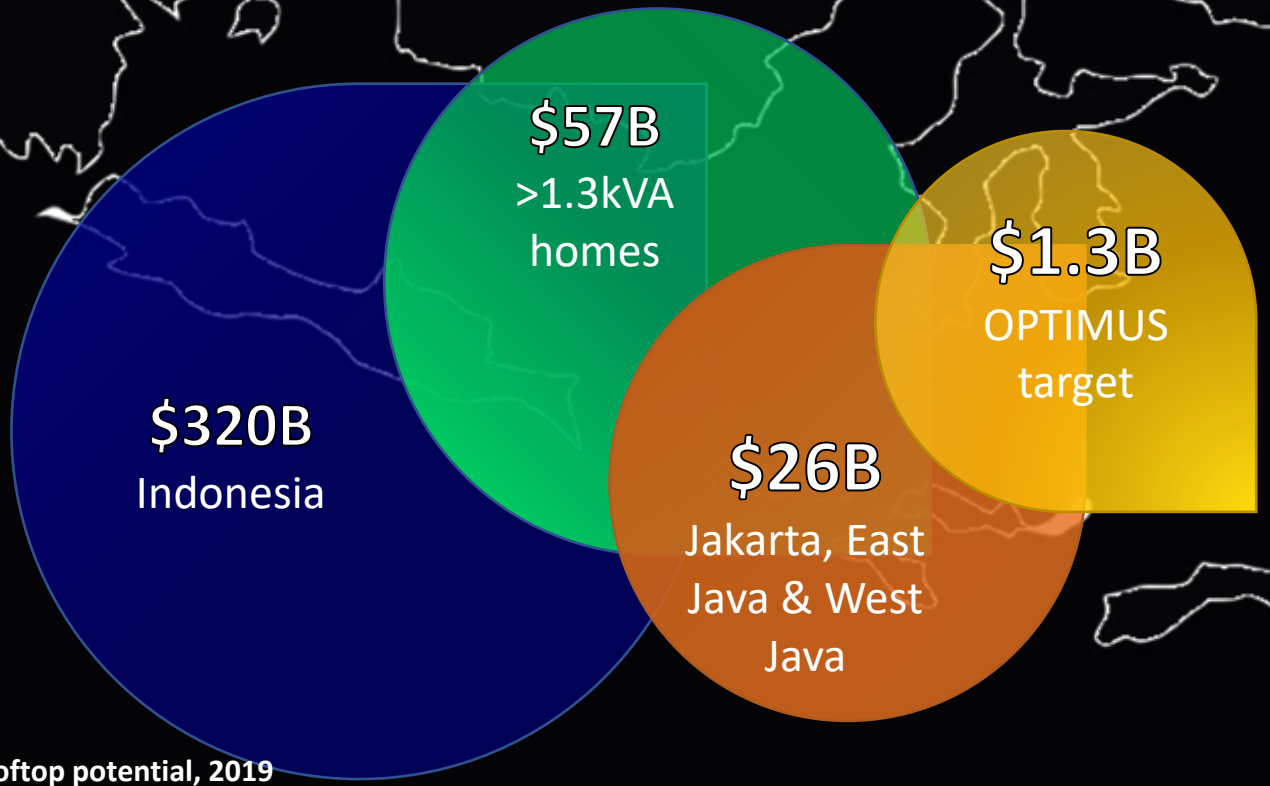
1.1 GWp

TARGET HOUSEHOLDS

0.9-1.2 million

TARGET CUSTOMER

Annual income:
6000-7000 USD
Installed capacity
> 1.3kVA



Market source: IESR-Residential rooftop potential, 2019

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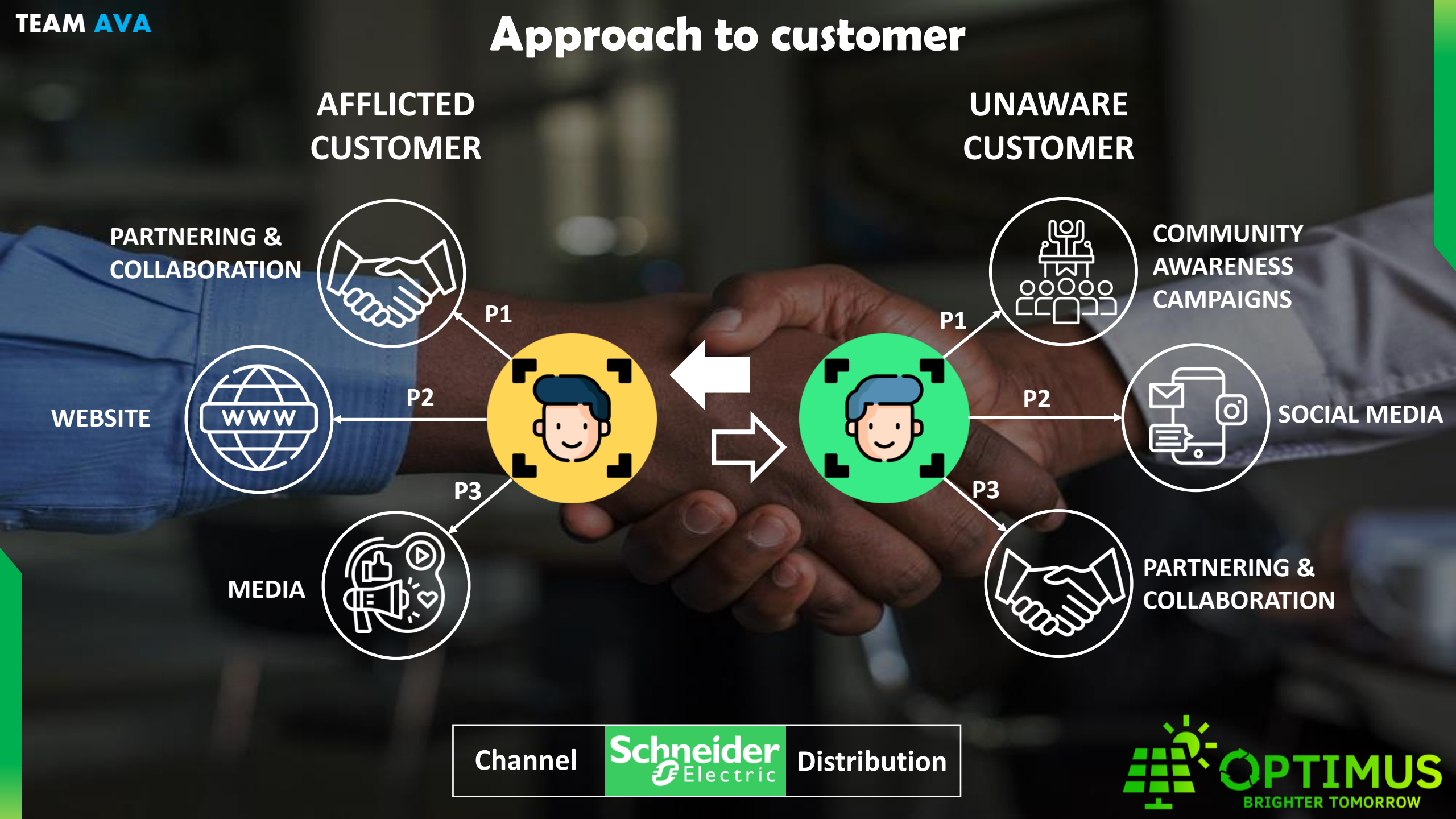
Approach to customer



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EXPAND OPTIMUS

First Prototype
- Connect with refurbishers
- Technical requirement
- App ready

MONTH 6

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- Observe quality aspects
- Improve app and analytics

25 Homes

MONTH 12

500 Homes
- Improve on solution
- Aggressive sales

MONTH 18

YEAR 2

- Islands, DG consumers group

Expand Segment

YEAR 3

Expand Geography
- India
- In-house refurbishing

YEAR 5

Indonesia+India

0.5 million Homes

YEAR 10

1 million Homes

Consume 5-7 million panels & 1-2 million batteries

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For a Brighter Tomorrow....

Future is HERE!

PLANET & PEOPLE

Solar is now AFFORDABLE

Energy INDEPENDENCE

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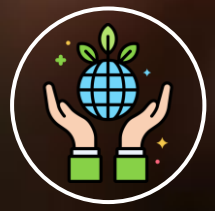

SE Purpose ALIGNMENT

LOCAL and GLOBAL

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To **maximize resource utilization** with **circular economy practices** for sustainability and thereby bringing prosperity by providing **affordable energy independence**

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Reuse 1 million ton waste
&
Brighten 10 million homes by 2050

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Market related


Why Indonesia?


Market sizing


Present Indonesia DPV


Customer profiling


Competitors

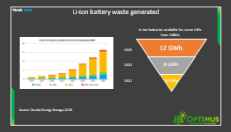

Indonesia Policy

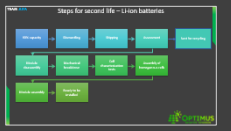

Future trends

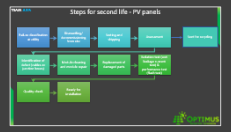

Global Outlook

Supply Chain


PV panel waste


Li-ion waste generated

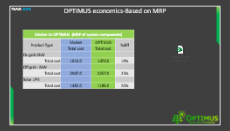

Steps for 2nd life-PV

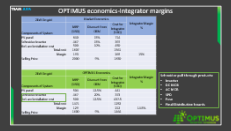

Steps for 2nd life-Batteries


Shipment/landing costs


Data on used vs new panels

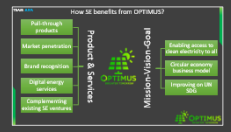
Product economics


MRP based


Sales price based


Payback period

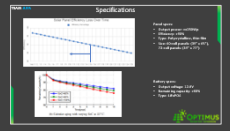

Potential partners

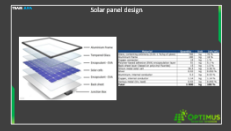

SE-OPTIMUS alignment

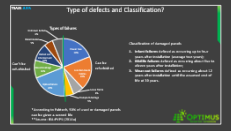

Resources required

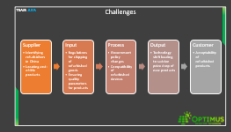

SDG Goals alignment

Technical


Future trends


PV Panel design


Defects & classification


Challenges


Testing for PV panels


Testing for Li-ion batteries

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Why Indonesia?

Why Indonesia?

- Cost of Electricity
  - Indonesia:10-12 cents/unit ; US (average): 10.7 cents/unit
  - India:7-8 cents/unit
- Energy Landscape in Indonesia
  - High dependency on Coal and Diesel power for electricity
  - Poor quality of grid, even in mainland
- Present Capex for solar rooftop in Indonesia
  - Higher than other developing countries- $1100-1400/kW in Indonesia
    - In India it is around $900-1100/kW
  - Higher %share of module cost(40-45%) to total cost
    - In US, %share of module cost is only 15% to total cost
- Topography
  - Archipelago-High T&D cost

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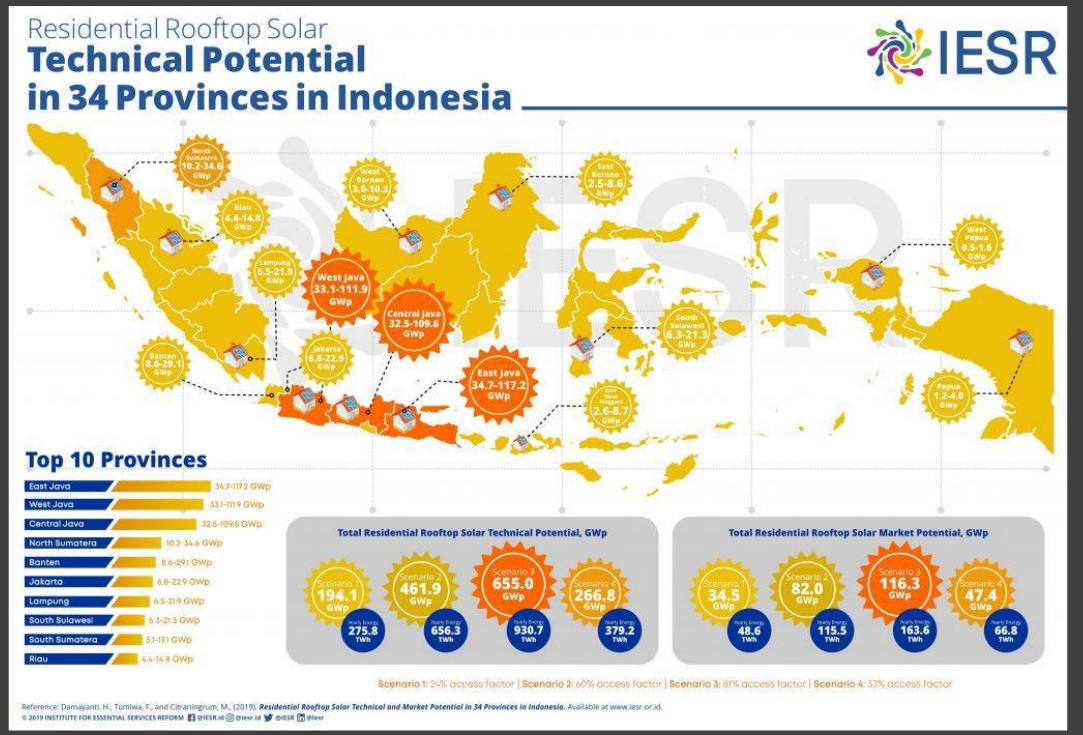
Why Jakarta, East Java & West Java?

IESR Report

- 3 provinces have both high technical and market potential
- High number of users like Hassan, with >1.3kVA installed capacity
- High number of homes with min 10 sq.m space for solar rooftop

Residential Rooftop solar PV	GWp	USD in billions	Million homes
Technical potential in Indonesia	266.8	320	66
Market potential Indonesia	47.49	57	26
Market potenttial in 3 Provinces	21.6	26	5
OPTIMUS Target in 3 Provinces	1.1	1.3	1



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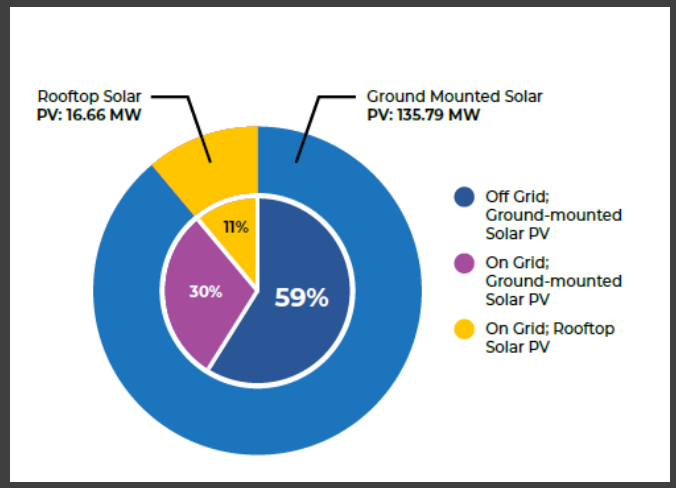
Present Indonesia DPV status

- Solar capacity is 152MW (Nov. 2019)
  - 89% is ground-mounted and 11% rooftop
  - Rooftop solar is 16.66MW
  - CAGR for residential: >100%
- 90% of rooftops are residential users



Source: IESR_DEC_2019

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Customer Profile

- 3 segments and customer profiles
  - Urban -Middle class -Mainland
  - Remote areas/Islands-Villa Type Resorts-DG dependent
  - Rural Islands-Poor-No access to electricity

Customer Profile

Customer Profile			
	Hasan Prasetyo & family in Kebayoran Lama, Jakarta city	Pondok Santi Estate Luxury Beachside Accommodation, Lombak Island, Indonesia	Banyu Muhammed & family in Maluku and papu Islands, Indonesia
Case Example			
Customer profile	A family of 4, middle class home	Luxury resorts in remote part of the islands, multiple Villa type property	A family of 5-6 members, agriculture and fishing are the sources of income, and are living in a small hut/thatched house

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Competitors

Firm Name	Location	Type	Components	Expertise	Customer segment	Digital support	Finance
Inecosolar	Bali	Integrator	Sourcing	S,D,P, I & C	Residential	No digital service	Capex
Solar Power Indonesia	Bali	Integrator	Sourcing	S,D,P, I & C	Resort	No digital service	Capex
Solardex energy	Central java		Sourcing	S,D,P, I & C		No digital service	Capex/ Pay as you go
PT solarpanel Indonesia	Java	integrator	Sourcing	S,D,P, I & C	Residential/ resort	No digital service	Capex
Canopy Power	Bali	integrator	Sourcing	S,D,P, I & C	Resorts/ Commercial	Digital Monitoring	Capex
Sunterra	Jakarta	integrator	Sourcing	S,D,P, I & C	Resorts/Commercial/residential	No digital service	Capex/ EMI option
Lein Power	Jakarta	integrator	Sourcing	S,D,P, I & C	Residential	Digital Monitoring-ABB	Capex
Solar Warrior	Jakarta/ Java	integrator	Sourcing	S,D,P, I & C	Resedential	Digital Monitoring	Capex/ EMI option
OPTIMUS	Jakarta, Java	integrator	Self/ Sourcing	S,D,P, I & C	Residential	Digital monitoring app	Capex

Survey, design, procure, install & commission

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Indonesia Policy

- No subsidy on Capex for solar rooftop
- Net metering scheme for on-grid- 1:0.65
- Encouraging adoption for solar rooftops for Govt Sector buildings
- Green Building codes

Green Building Codes: huge potential of cost savings, the codes are only adopted in a small number of cities

- Efforts to push for energy efficient buildings were first initiated by Jakarta through Governor Reg. No. 38/2012 on Green Building Code which focuses on large commercial and residential buildings for new and existing buildings. This was later followed by the Minister of Public Works and Public Housing (PUPR) Reg. No. 2/2015 on national guidance for green buildings which marked the first green building code at the national level.
- To date, there are three cities (Jakarta, Bandung, and Semarang) that have local green building codes while other three cities (Surabaya, Manado and Makassar) are still preparing their codes. By 2018, there were 339 new buildings in Jakarta certified as green buildings with cost saving may reach USD 90 million (ICED, 2019).
- The main barriers to the adoption of green buildings in Indonesia are the high investment costs, lack of funding scheme for the energy efficient building projects, and relatively low awareness of cost saving potential brought

2012 — **Jakarta Governor Reg. No. 38/2012 First Green Building Code**
Enactment of first green building code in Indonesia. Focuses on large commercial and residential buildings

2015 — **PUPR Reg. No. 2/2015 First National Green Building Code**
First National green building code acting as a guidance for the developers of green buildings in Indonesia

2016 — **Bandung City Mayor Reg. No. 1023/2016-Green Building**

2019 — **Semarang City Mayor Reg. No. 24/2019**

ROOFTOP SOLAR

Local governments to take the lead in rooftop solar PV adoption

		Realization (in 2019)	Target (in 2020)
JAKARTA	In response to public outcry over Jakarta's status as the most polluted city in the world, the governor of Jakarta issued the Governor Instruction No. 66/2019 which mandates the use of rooftop solar PV on public schools, sport facilities, and medical facility from 2019-2022.	• <10 government buildings (>50 kWp each) • 80 schools	• <20 government buildings (10-50 kWp each) • 234 schools
CENTRAL JAVA	Central Java was the first province to finalize the Provincial Energy Plan (RUED) in 2018. The RUED mandates all SKPD (Local Government Agencies) and encourage commercial and industrial complexes to install rooftop solar PV. In September 2019, the government of Central Java declared its intention to be the first solar province in Indonesia.	• 3 government buildings (30-35 kWp each) • 80 kWp in industrial complexes	• 17 government (SKPD) buildings
BALI	With Governor Reg. No 45/2019, Bali becomes the first province that has a local regulation on clean energy. Some of its mandatory clauses are rooftop PV use at minimum 20% of government buildings and buildings with area >500 m2. The regulation also stipulates land and building tax (PBB) reduction and ease of financing as incentives for solar PV. More details, however, are expected to be issued shortly.	• 1 government building (158 kWp) • 2 schools	

Source: IESR_DEC_2019

IESR Institute for Essential Services Reform

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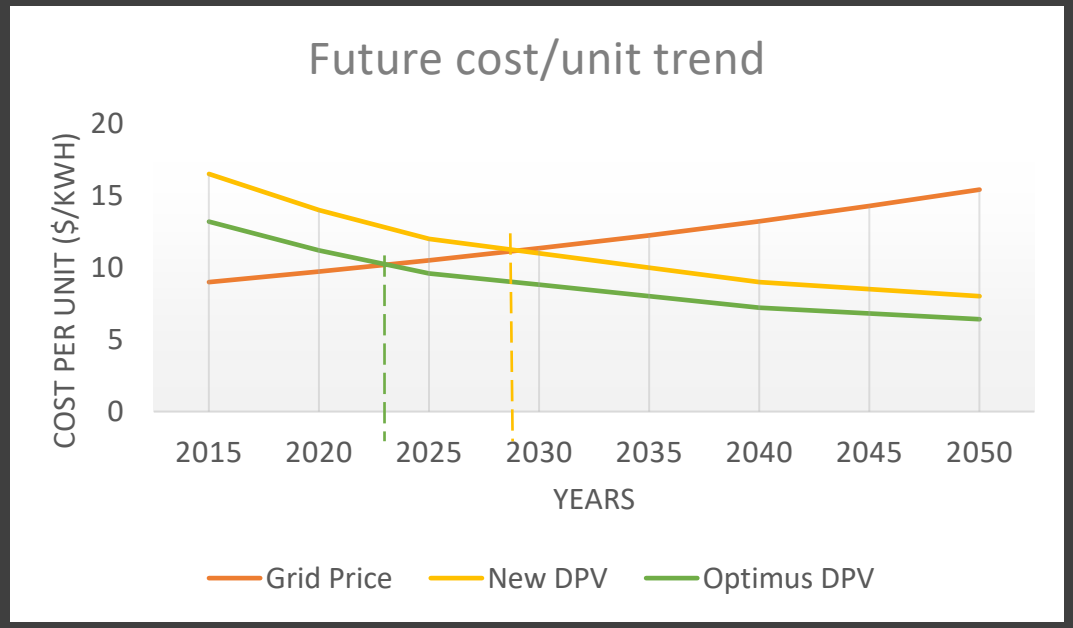
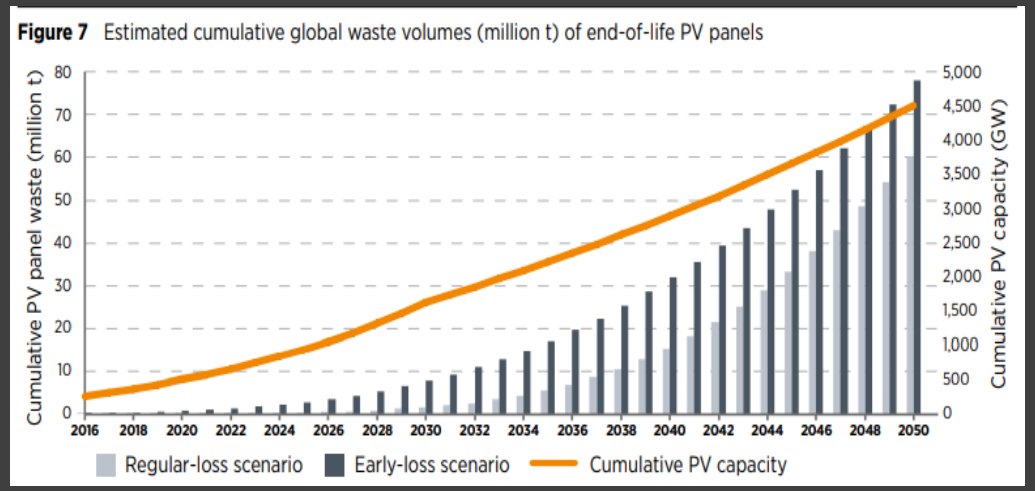
Future trends

Cost dynamics

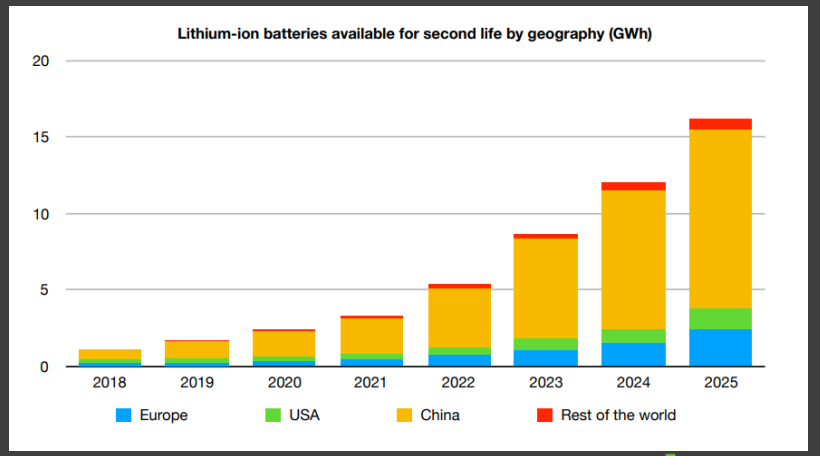


Source: PLN, 2016

Waste dynamics



Source: IRENA_IEAPVPS, 2016



Source: Circular energy storage,2020

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Global DPV outlook

Global Distributed Solar Rooftop Market

- Residential
- Commercial & Industries
- Off-grid market

Distributed PV categorisation by size

Segment	Size	Explanation
Residential	0-10 kW	Rooftop systems connected to the grid
Commercial and industrial	10 kW-1 000 kW	Rooftop and ground-mounted systems connected to the grid
Off-grid	8 W-100 kW	SHSs, small commercial installations and mini-grids

Adobe Acrobat Document

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OPTIMUS economics-Based on MRP

Market Vs OPTIMUS (MRP of system components)			
Product Type	Market	OPTIMUS	%diff
	Total cost	Total cost	
On grid-2kW			
Total cost	1810.0	1474.0	19%
Off grid - 2kW			
Total cost	2947.0	2257.0	23%
Solar UPS			
Total cost	1482.0	1186.0	20%

Microsoft Excel Worksheet

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OPTIMUS economics-Integrator margins

2kW On-grid	Market Economics			Integrator Margin %
Components of System	MRP (USD)	Discount from OEM	Cost for Integrator (USD)	
PV panel	840	15%	714	
Schneider Inverter	467	15%	397	
BoS and installation cost	500	10%	450	
Total cost	1807		1561	
Margin	193		269	15%
Selling Price	2000	9%	1830	

2kW On-grid	OPTIMUS Economics			Integrator Margin %
Components of System	MRP (USD)	Discount from OEM	Cost for Integrator (USD)	
PV panel	504	12.5%	441	
Schneider Inverter	467	20%	373	
BoS and installation cost	500	12.5%	437.5	
Total cost	1471		1252	
Margin	129		212	14.5%
Selling Price	1600	9%	1464	

Schneider pull through products:

- Inverter
- DC MCB
- AC MCB
- SPD
- Fuse
- Final Distribution boards

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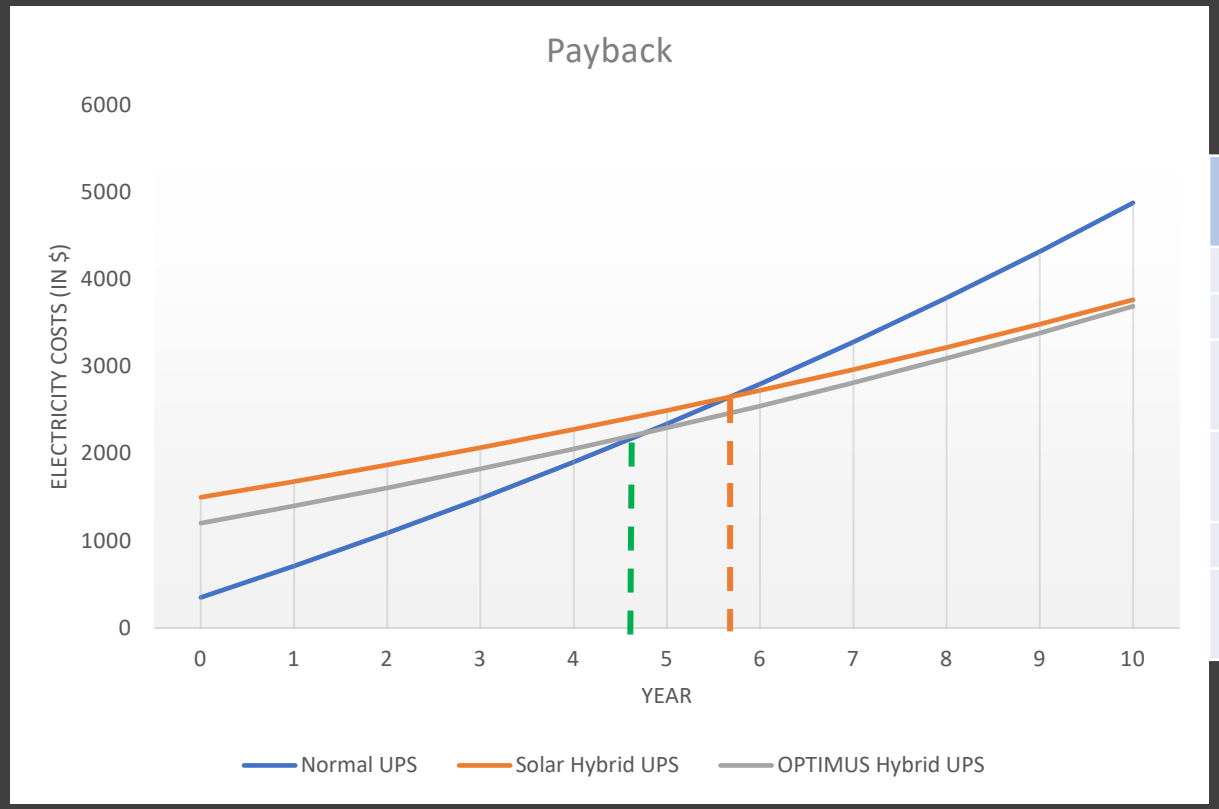
Hassan's Options & Payback

Microsoft Excel Worksheet



Features	Normal UPS	Solar Hybrid UPS	OPTIMUS UPS	OPTIMUS Advantage
Saves Electricity	No	Yes	Yes	
Battery charging	Grid	Grid+ Solar	Grid+ Solar	
Battery Type	Lead Acid	Lead Acid	Li-ion	Fast-charging cycle and zero maintenance
Battery Replacement	5 years	5 years	10 years	
Capex	350	1500	1200	20% low capex
Power saved/day	0 units	upto 4 units	upto 3.5 units	Refurbished with Min. 90% efficiency

80% of IESR's market survey respondents, expected a payback period of <7 years

Source: IESR_DEC_2019

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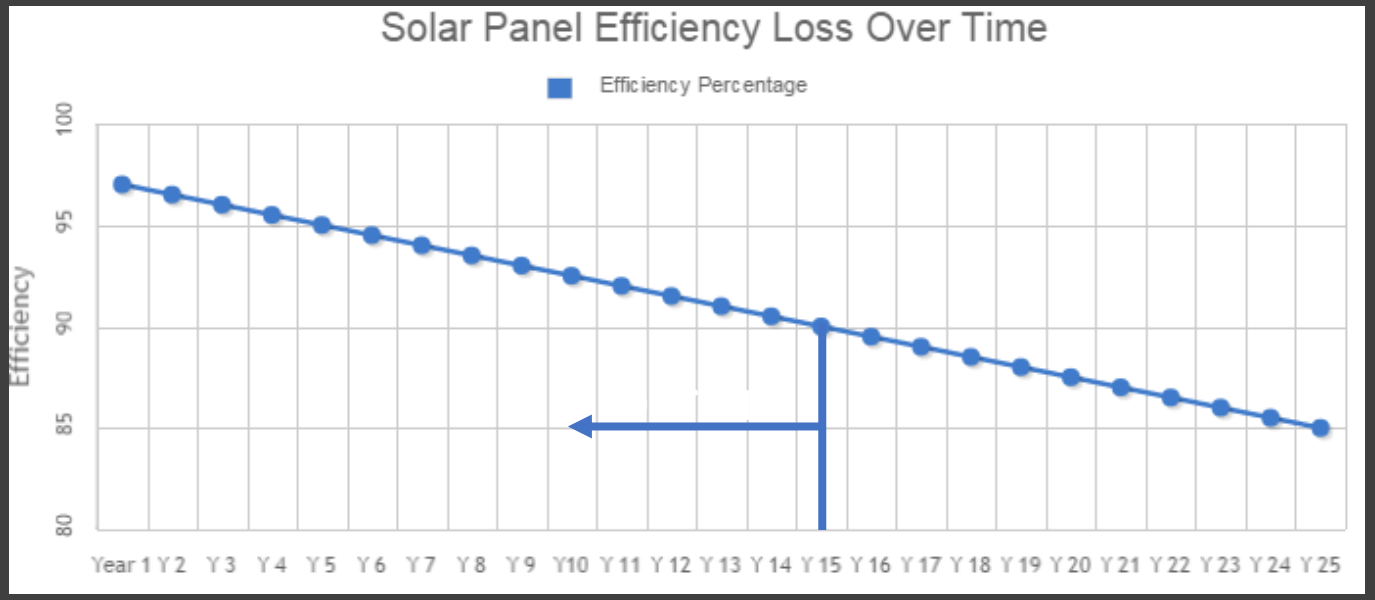
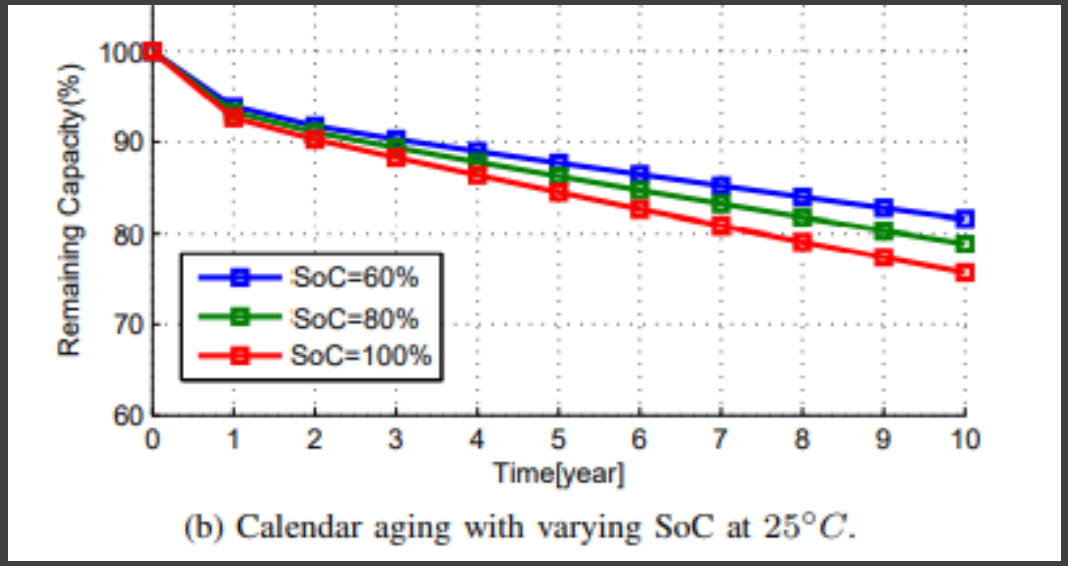
Specifications



Panel specs:

- Output power: >=250Wp
- Efficiency: >90%
- Type: Polycrystalline, thin-film
- Size: 60-cell panels: (39” x 65”), 72-cell panels: (39” x 77”)



(b) Calendar aging with varying SoC at $25°C$.

Battery specs:

- Output voltage: 12.8V
- Remaining capacity: >80%
- Type: LiFePO4

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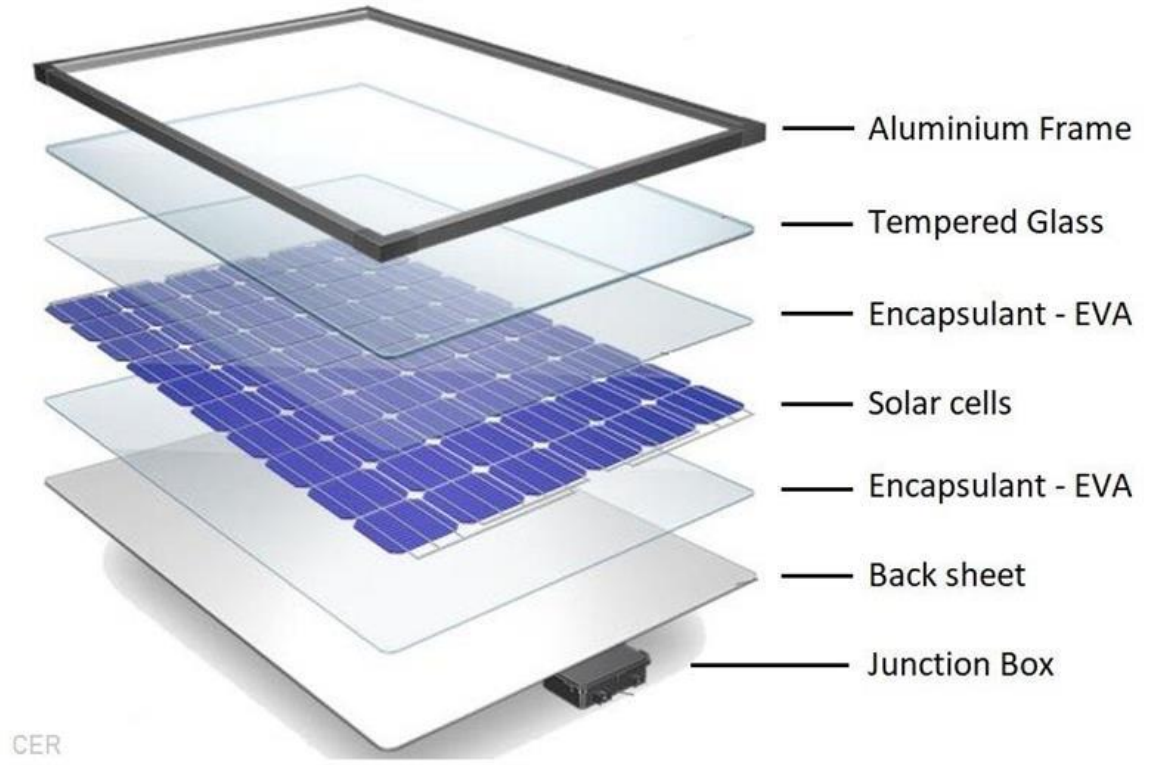
Solar panel design



Material	Quantity	Unit	(wt/wt)
Glass, containing antimony (0.01-1 %/kg of glass)	700	kg	70 %
Aluminium frame	180	kg	18 %
Copper connector	10	kg	1 %
Polymer-based adhesive (EVA) encapsulation layer	51	kg	5.1 %
Back-sheet layer (based on polyvinyl fluoride)	15	kg	1.5 %
Silicon metal solar cell	36.5	kg	3.56 %
Silver	0.53	kg	0.053 %
Aluminium, internal conductor	5.3	kg	0.53 %
Copper, internal conductor	1.14	kg	1.14 %
Various metal (tin, lead)	0.53	kg	0.053 %
Total	**1 000**	**kg**	**100 %**

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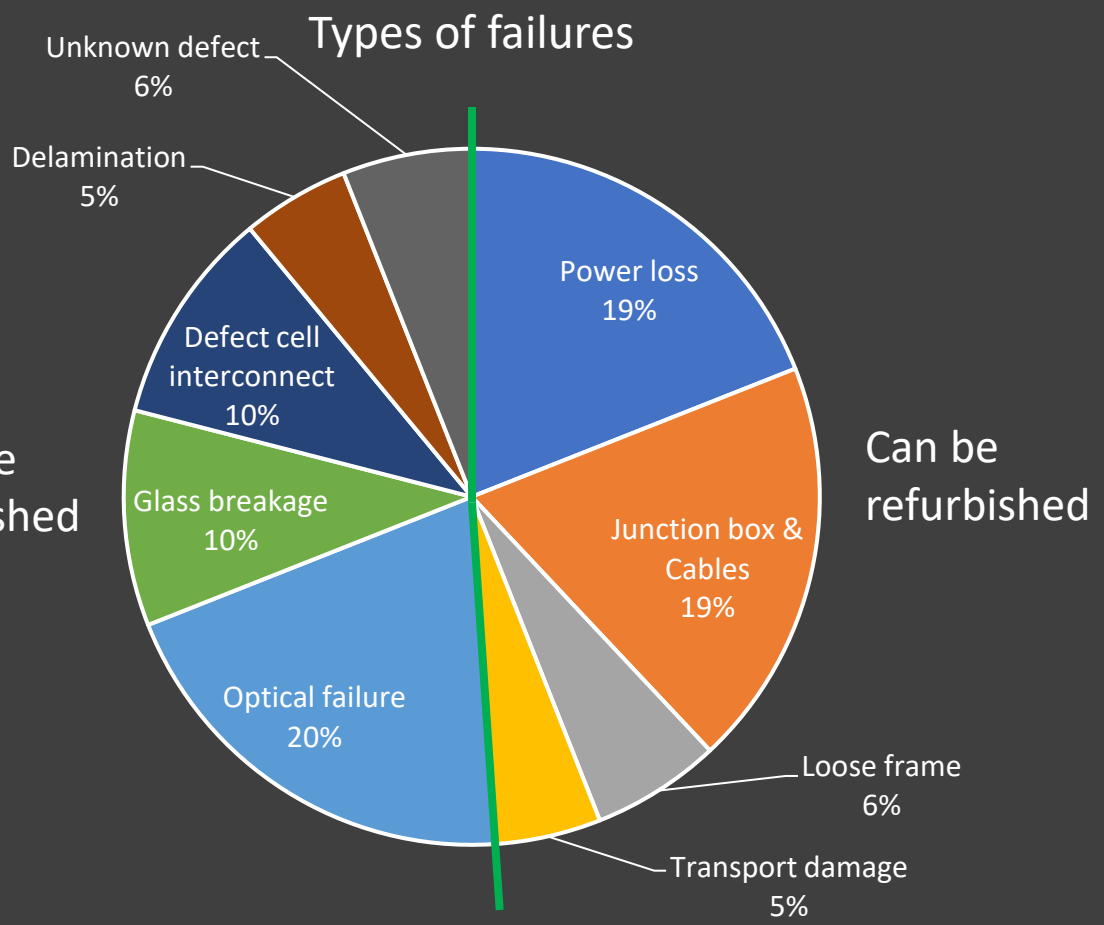
Type of defects and Classification?



Classification of damaged panels

1. **Infant failures** defined as occurring up to four years after installation (average two years);
2. **Midlife failures** defined as occurring about five to eleven years after installation;
3. **Wear-out failures** defined as occurring about 12 years after installation until the assumed end-of life at 30 years.

*According to Fabtech, 50% of used or damaged panels can be given a second life

**Source: IEA-PVPS (2014a)

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Tests on solar panels

Tests	Band required	Method
Hotspots check -	Tol > 75%	thermography
Bubble formation	To be worked out	NIR cameras
Shading or faded cells	>25% lower yield	Yield check of single array
Diode check	Leakage current <	Reverse bias
Flash test	Ref PV module > 90%	Flash spectrum test
Flash Test – Temperature dependency	Ref PV module > 90%	Flash spectrum test
Micro cracks	Allowance to be worked out	NIR cameras
IV curve check – dark and Night	> 10% loss in efficiency	

Tests on Li-ion batteries

Table 1. Generic tests to reuse the battery.

Inspection/Test Categories	Type of Inspections/Tests	Influence on Safety	Risk Impact [1]
Visual	Swelling of modules or cells	Medium	Medium/Low
	Corrosion of connectors	Medium/Low	Low
	Intrusion of water and dust	High	Medium
	Loose cables and connections	Medium	Medium/Low
	Production date is available	Low	Not Applicable (N/A)
Electrical and Mechanical	Internal resistance	Low	High/Medium
	Measured discharge capacity	Low	High
	Insulation resistance	High	Medium
	Potential equalisation	Medium	Medium/Low
	State of Charge (SOC) range as per datasheet	High	High
Battery Management System (BMS)	Remaining useful capacity	Low	High
	Direct Current (DC) resistance	Low	High/Medium
	On board State of Health (SOH)	Low	High

[1] Evaluation factor for battery reuse (High to Low = impact on battery reuse).

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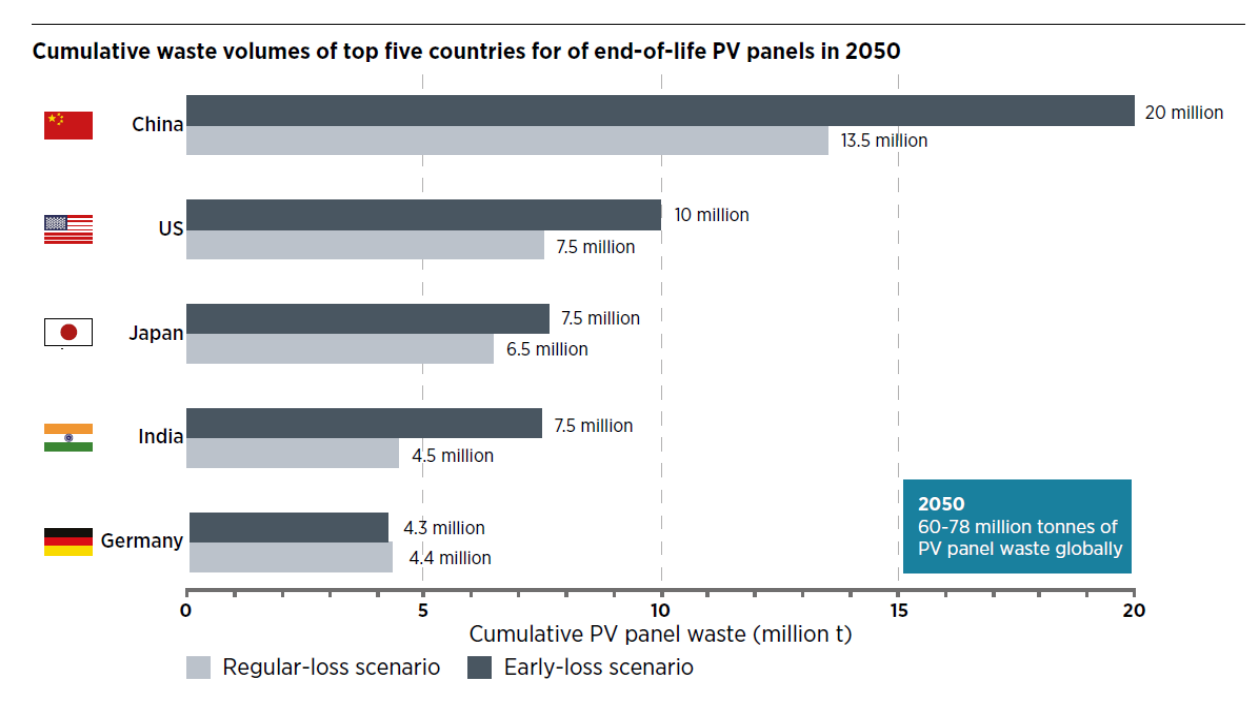
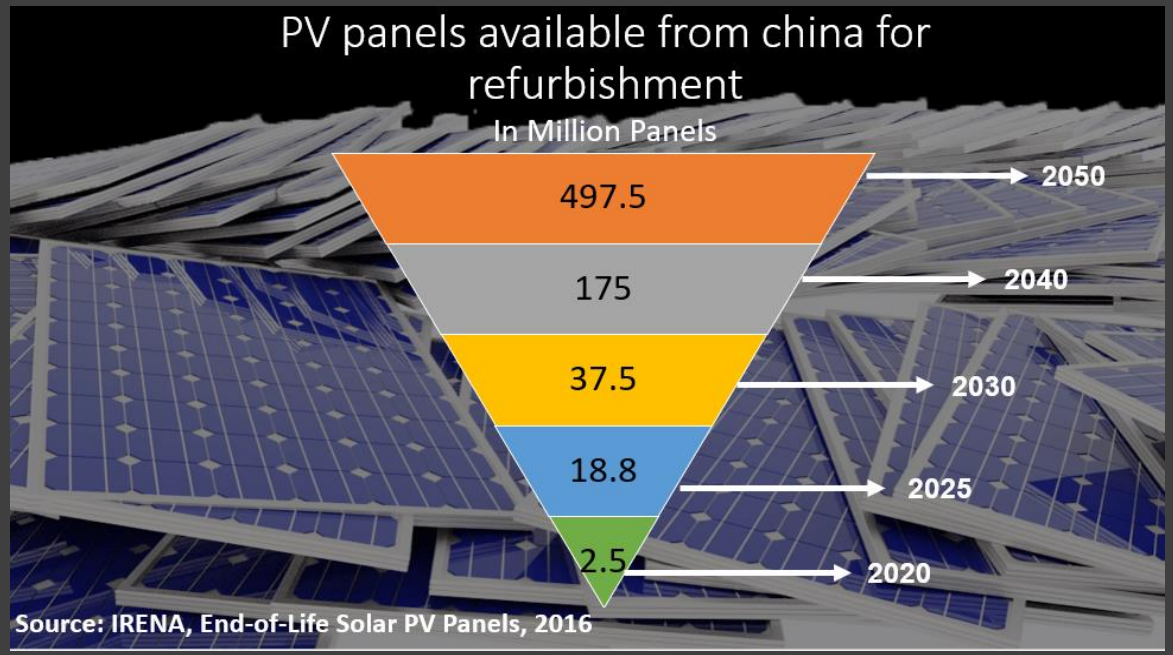
PV panels waste generated

Microsoft Excel Worksheet





Source: IRENA_IEAPVPS, 2016

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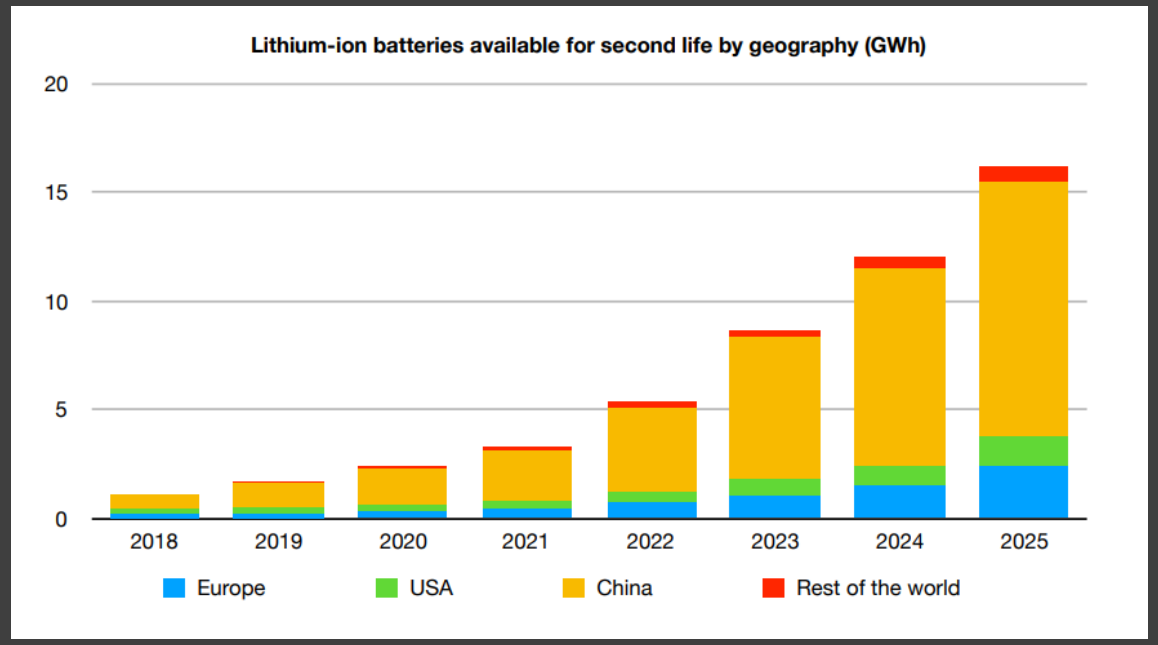
Li-ion battery waste generated



Li-ion batteries available for second life from CHINA

Source: Circular Energy Storage, 2020

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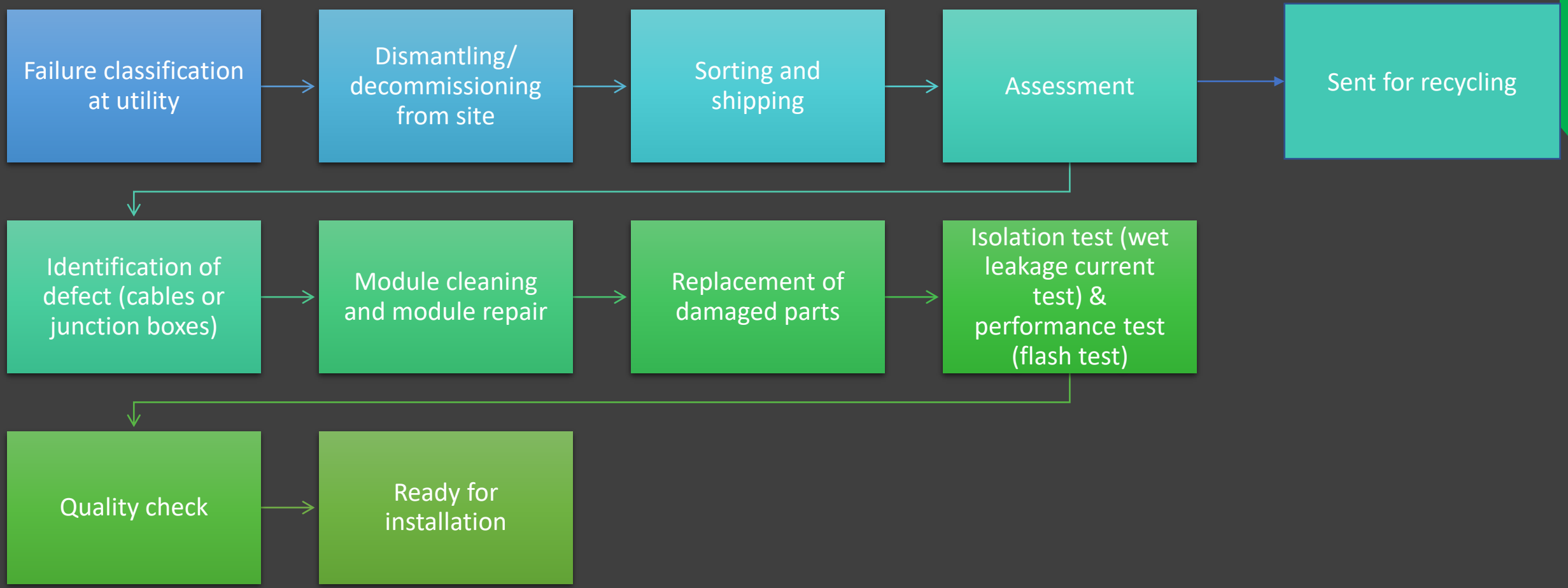
Steps for second life - PV panels



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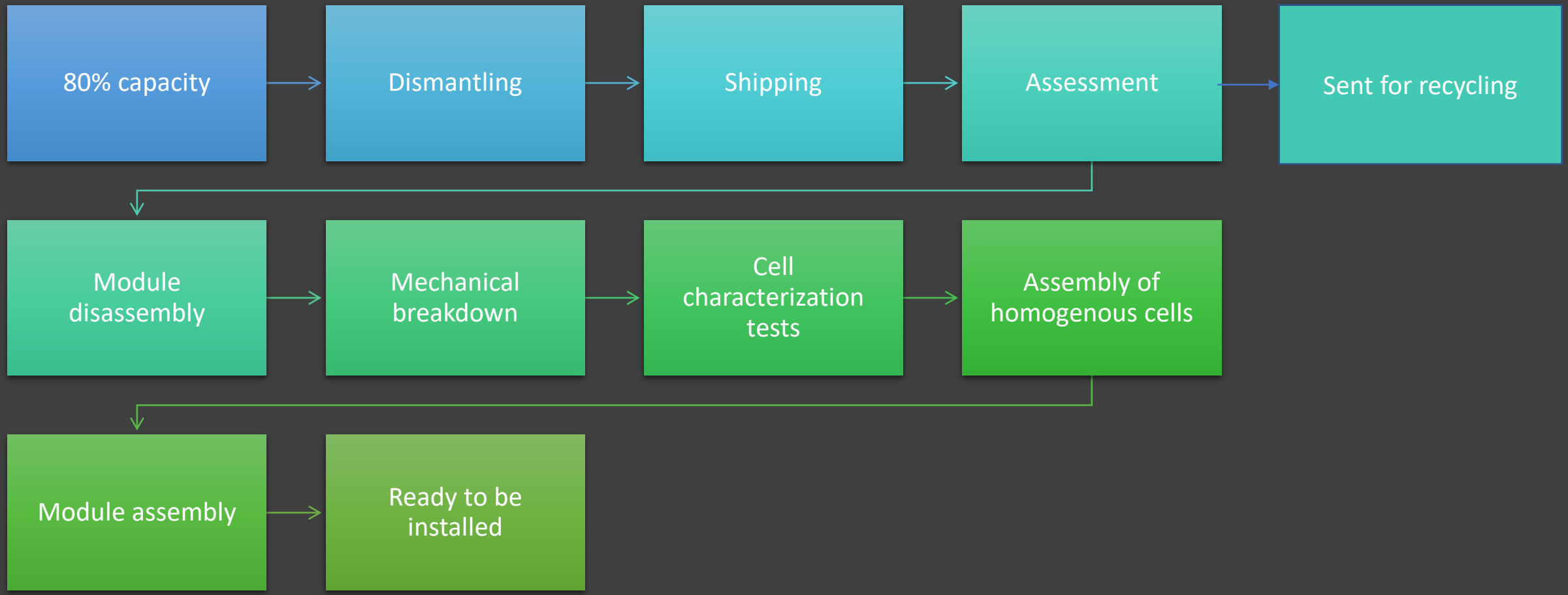
Steps for second life – Li-ion batteries



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Shipping/landing cost

Input supply

Arrangements to obtain used panels
Manufacturers & Solar panel farms

Microsoft Excel Worksheet

Refurbishers

Refurbishment completed
Around 55% cost in retail market

Shipping

3% extra per panel *

Port to facility

2% extra per panel *

Landed cost=60% of new panel cost

* **Reference – Malaysia to India Copper shipping**

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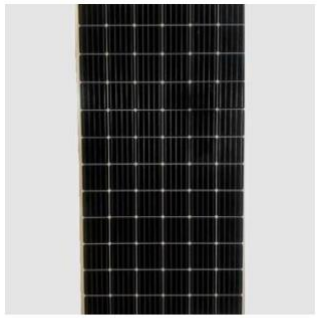
Refurbished panel cost

Refurbished Panel Costing		
	1kW	
	 ALL PRODUCTS $130.00 Mission Solar 335W MSE335BBBSO6J	 ALL PRODUCTS $58.00 SanTan Solar T Series 250W Snail Trails
	New Panel 330Wp x 3	Refurbished 250 Wp x 4
Panel Price	$390.00	$232.00
Shipping cost	$9.00	$12.00
Landed cost	$399.00	$244.00
	Difference	61%

$/Wp (New)	$/Wp (Used)
0.35-0.4	0.2-0.25

Source: Santan Solar

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Potential partners

Companies	Category	Location	Remarks
FabTech Solar Solutions	PV panel refurbisher/recycler	Arizona, USA	Refurbished 600,000 panels over the last two years
RINOVASOL©	PV panel refurbisher/recycler	Weiden, Germany	Refurbished & recycled 1 million panels
fortum	Battery refurbisher	Espoo, Finland	EV autorickshaws in India
LOHUM	Battery manufacturer & refurbisher	India	Partnered with MG Motors for end-of-life batteries
ENERGYBIN	Refurbished marketplace	Minnesota, USA	Community of 1000 solar companies for equipment resale
SECONDSOL™ THE PHOTOVOLTAIC MARKETPLACE	Refurbished marketplace	Meiningen, Germany	Online marketplace for used PV products and services
SanTan Solar	Refurbished marketplace	Arizona, USA	Online marketplace for used solar products

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How SE benefits from OPTIMUS?

- Pull-through products
- Market penetration
- Brand recognition
- Digital energy services
- Complementing existing SE ventures

Product & Services

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Mission-Vision-Goal

- Enabling access to clean electricity to all
- Circular economy business model
- Improving on UN SDG

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What resources are required?

- Support in developing relations with local suppliers, distribution partners, SE Ecoxperts
- Guidance on supply chain
- Digital expertise for developing Save+ app
- Networking with existing SE Ventures like Clipsal solar, Dash energy, Sense
- Technical expertise in testing, validation and certification

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Challenges

Supplier

- Identifying refurbishers in China
- Locating end-of-life products

Input

- Regulations for shipping of refurbished goods
- Ensuring quality parameters for products

Process

- Government policy changes
- Compatibility of refurbished devices

Output

- Technology shift leading to sudden price drop of new products

Customer

- Acceptability of refurbished products

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