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CONSULTATION ON
SOLAR ENERGY



Naypyidaw Energy Consultations

I. SOLAR ENERGY



Japan
Fund for
Poverty
Reduction



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NEMC Group

August 13-14, 2014



Objective

- Assessment, Strategy, and Roadmap (ASR)
- **Renewable Energy Policy**
- RE part of long-term **Energy Master Plan**

Cooperation NEMC - ADB

- **Planning, Policy and Regulations**
- **Pilot installations** (1 MW PV grid connection)
- **Pilot development** (25 villages Energy4all)
- **Planning Security** needed by public Administration, private Enterprise, Investors, Developers, Donors
- **Develop progressive, simple, liberal support**



Solar Energy

- Direct Radiation > PV - Heat Radiation > Thermal
- Drives Weather > Wind
- Drives Weather > Hydro

Hot Water



Home Power



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Three Generations Renewable Energy

1st Generation - **established**

Hydropower, Biomass Burning, Geothermal

2nd Generation - **mature**

Small Hydro

Solar-Power (thermal, CSP, PV) > Solar-Offgrid

Wind-Power

Biogas

3rd Generation - **developing**

Wind-Offgrid, Biomass Gasification, Biorefinery, Marinepower

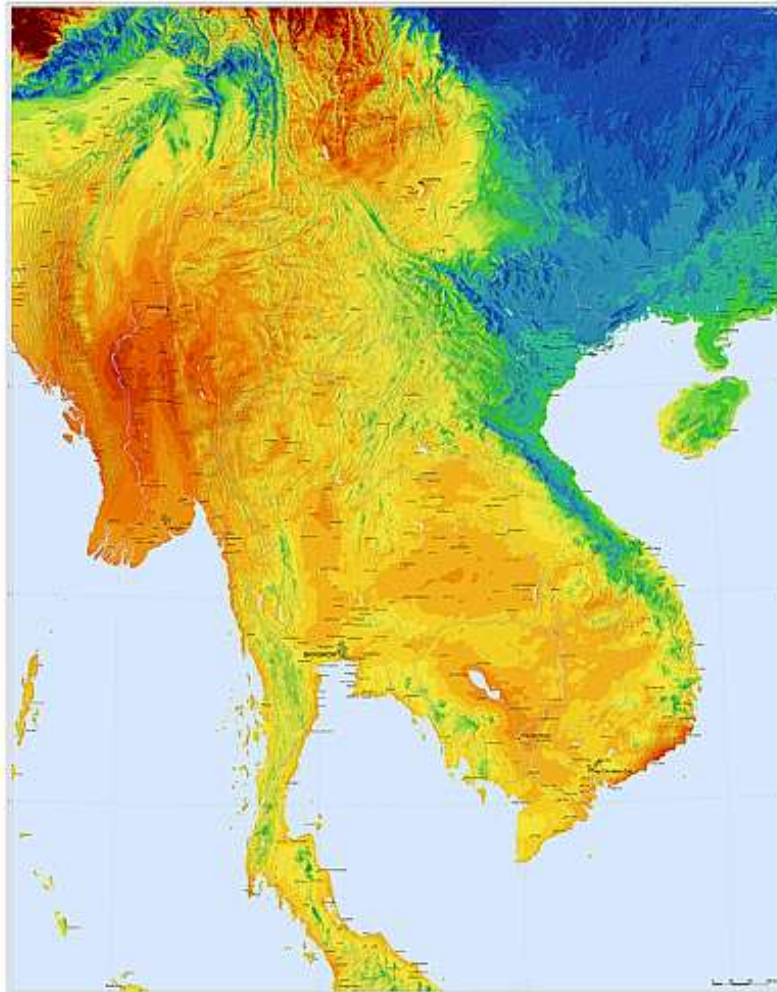


IRENA Roadmap 2030: **Double** Renewable Energy



SOUTH EAST ASIA MAINLANDS

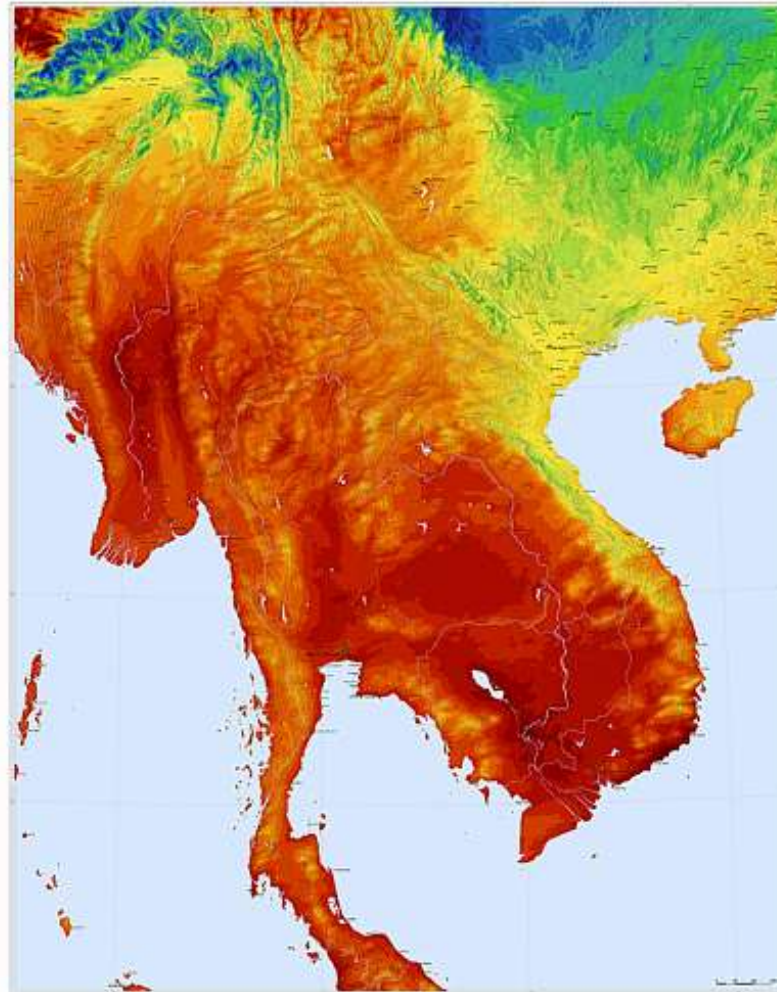
Direct Normal Irradiation



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SOUTH EAST ASIA MAINLANDS

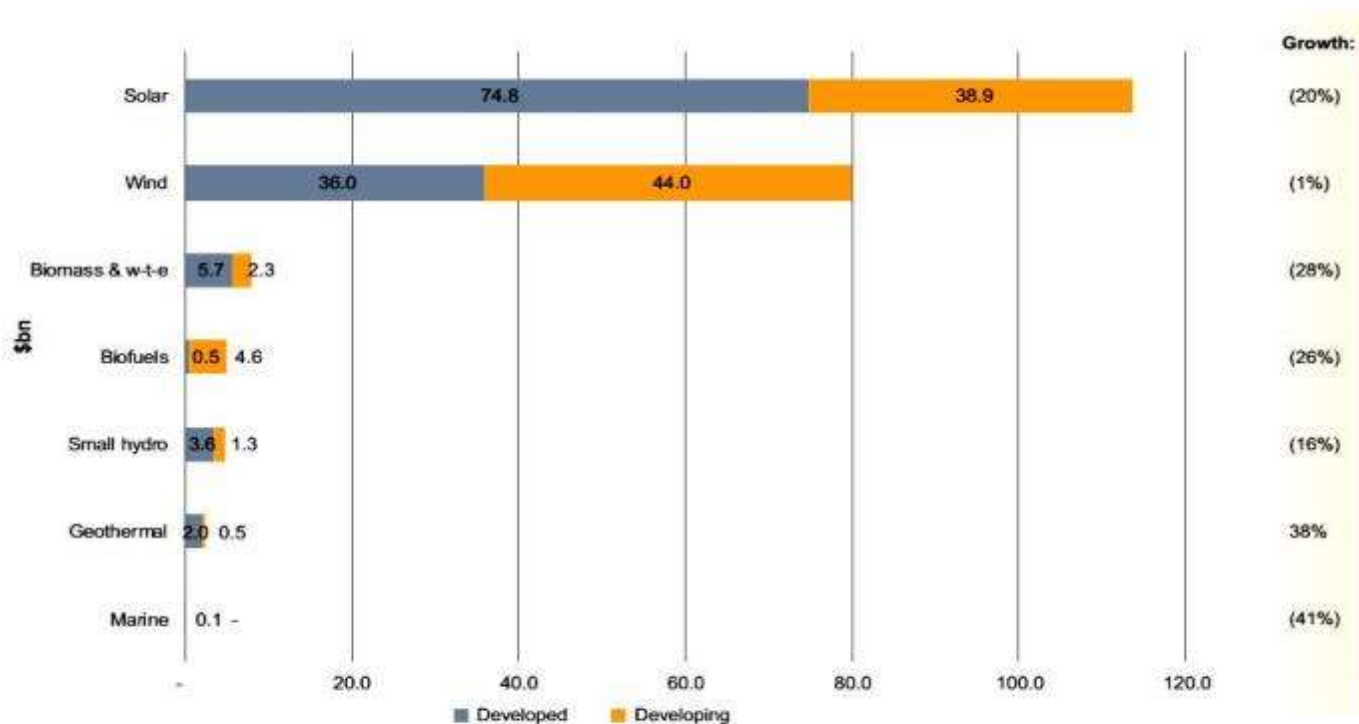
Global Horizontal Irradiation



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Global new investment in renewable energy: Developed vs. developing countries 2013



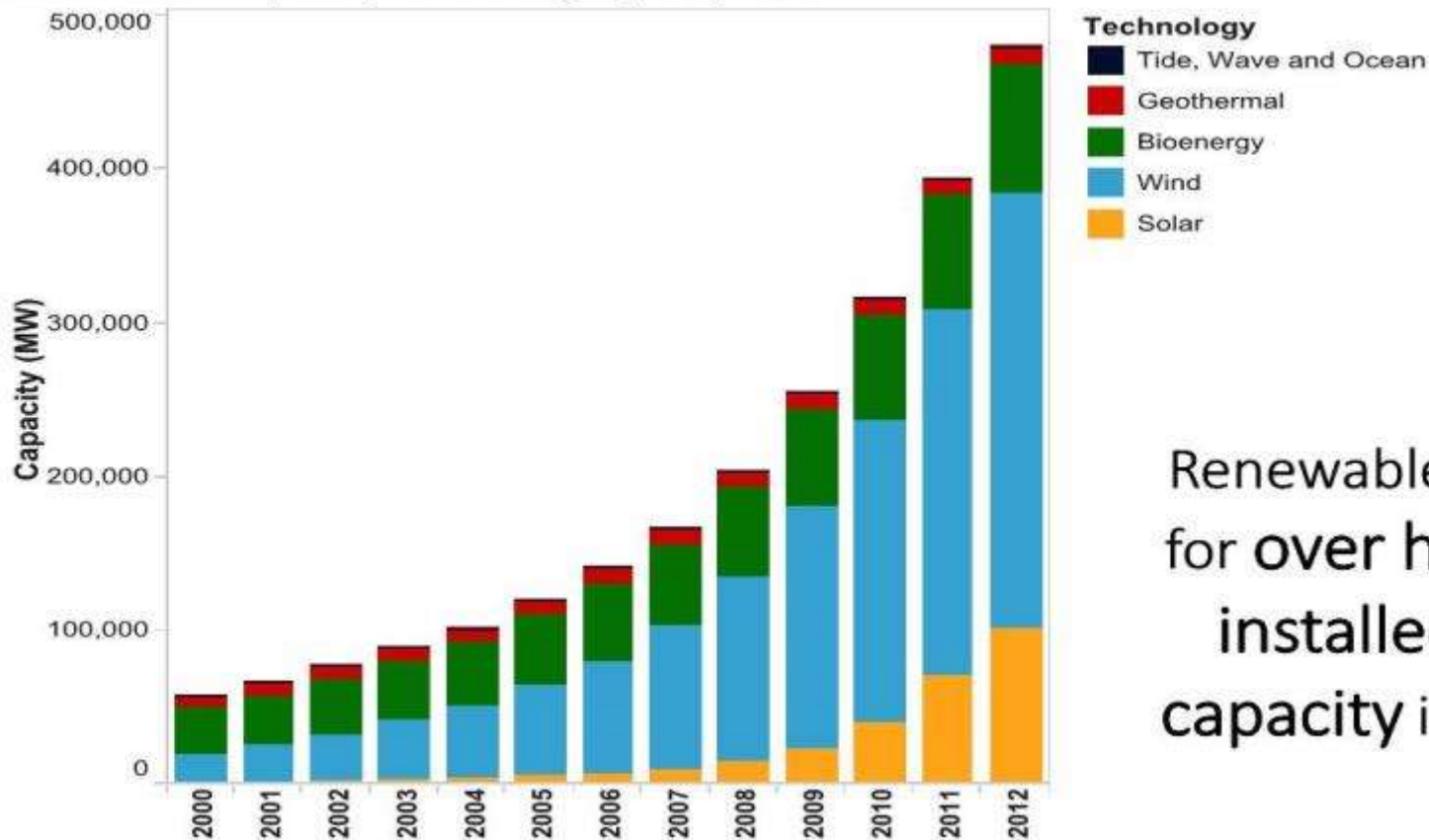
Note

Total values include estimates for undisclosed deals. New investment volume adjusts for reinvested equity. Includes estimates for small distributed capacity, corporate and government R&D. Developed volumes are based on OECD countries excluding Mexico, Chile, and Turkey.



Strong development of RE projects over the recent years

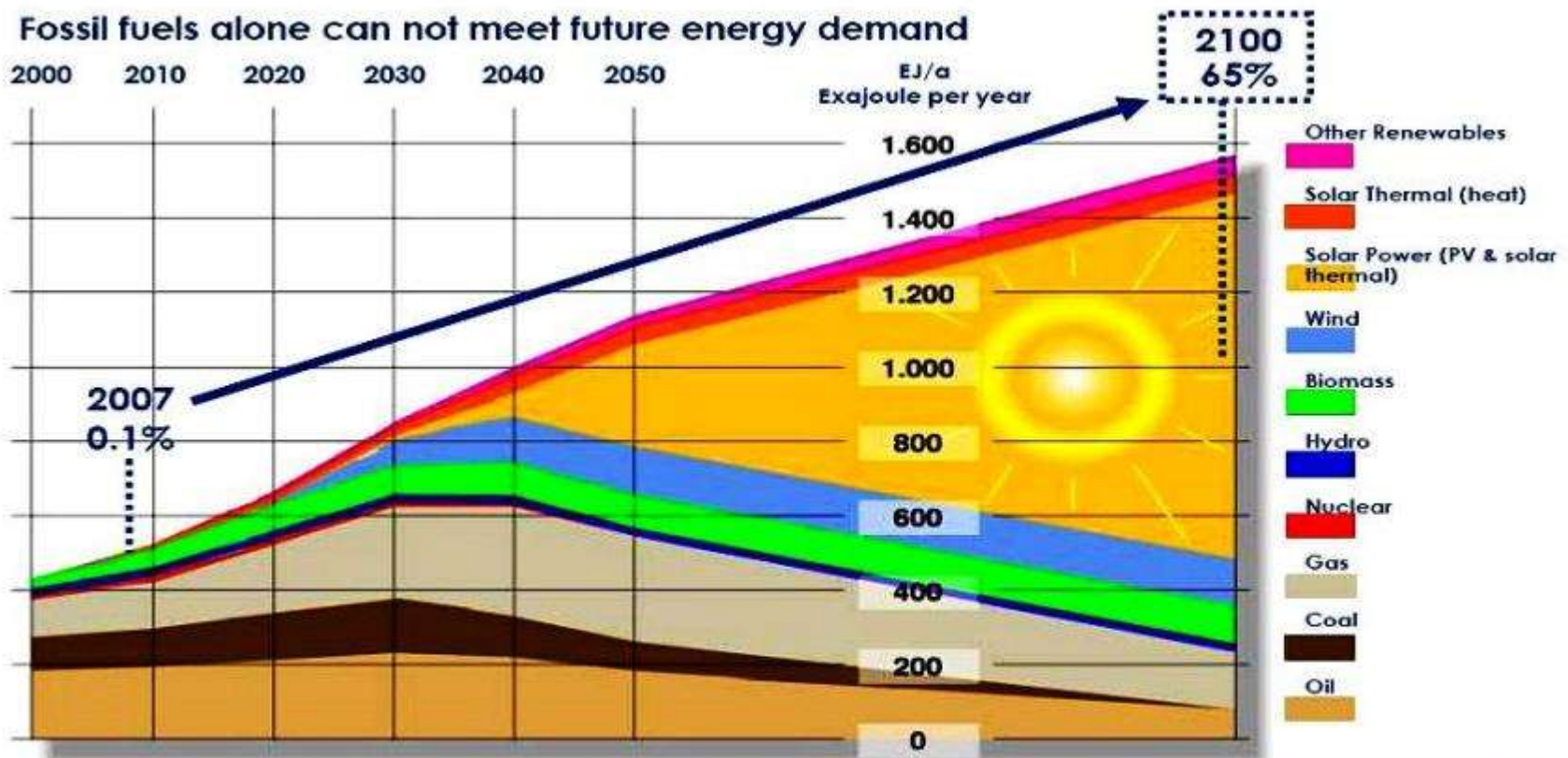
Renewable Capacity Excluding Hydropower



Renewables accounts for over half of new installed power capacity in the world



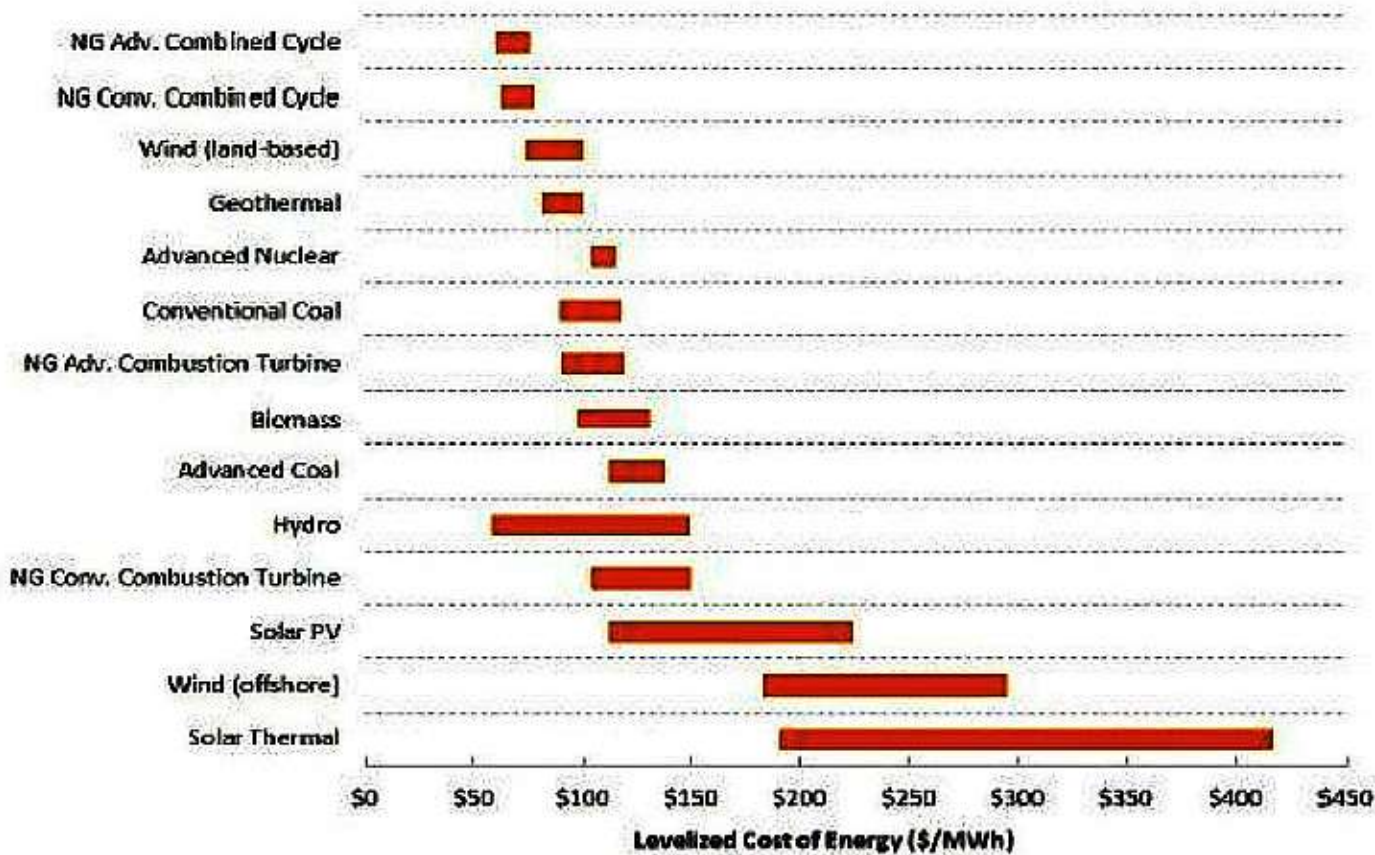
Fossil fuels are **limited** some Renewables also, Solar potential is high



Global primary energy scenario: Renewables 80% of primary energy by 2100



Levelized Cost of New Generation Resources



Data Source: EIA, Levelized Cost of New Generation Resources in the Annual Energy Outlook 2013

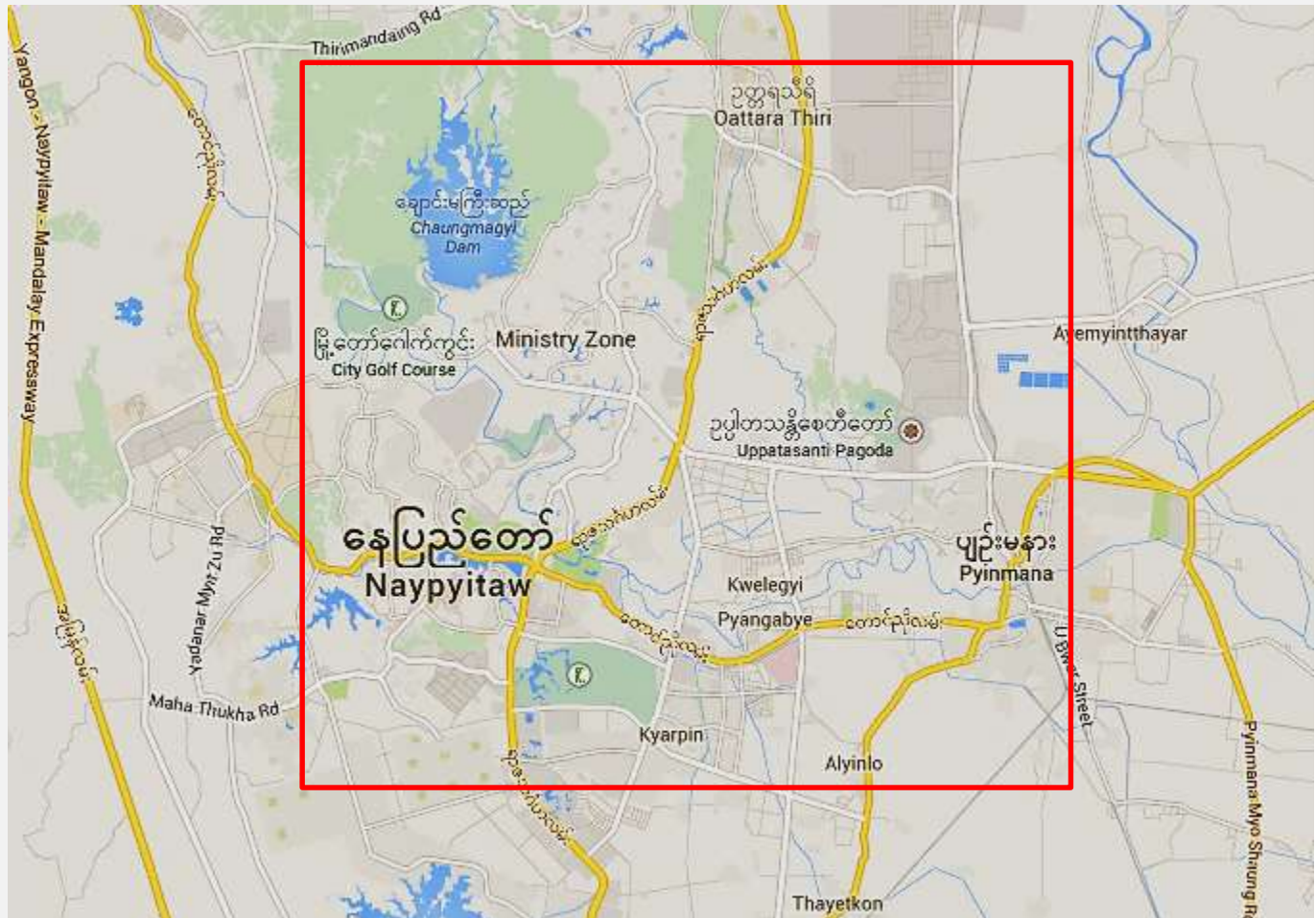


PV Resource

1.532 kWh/a·kWp
to
1.746 kWh/a·kWp
Ø 205 kWh/a·m²

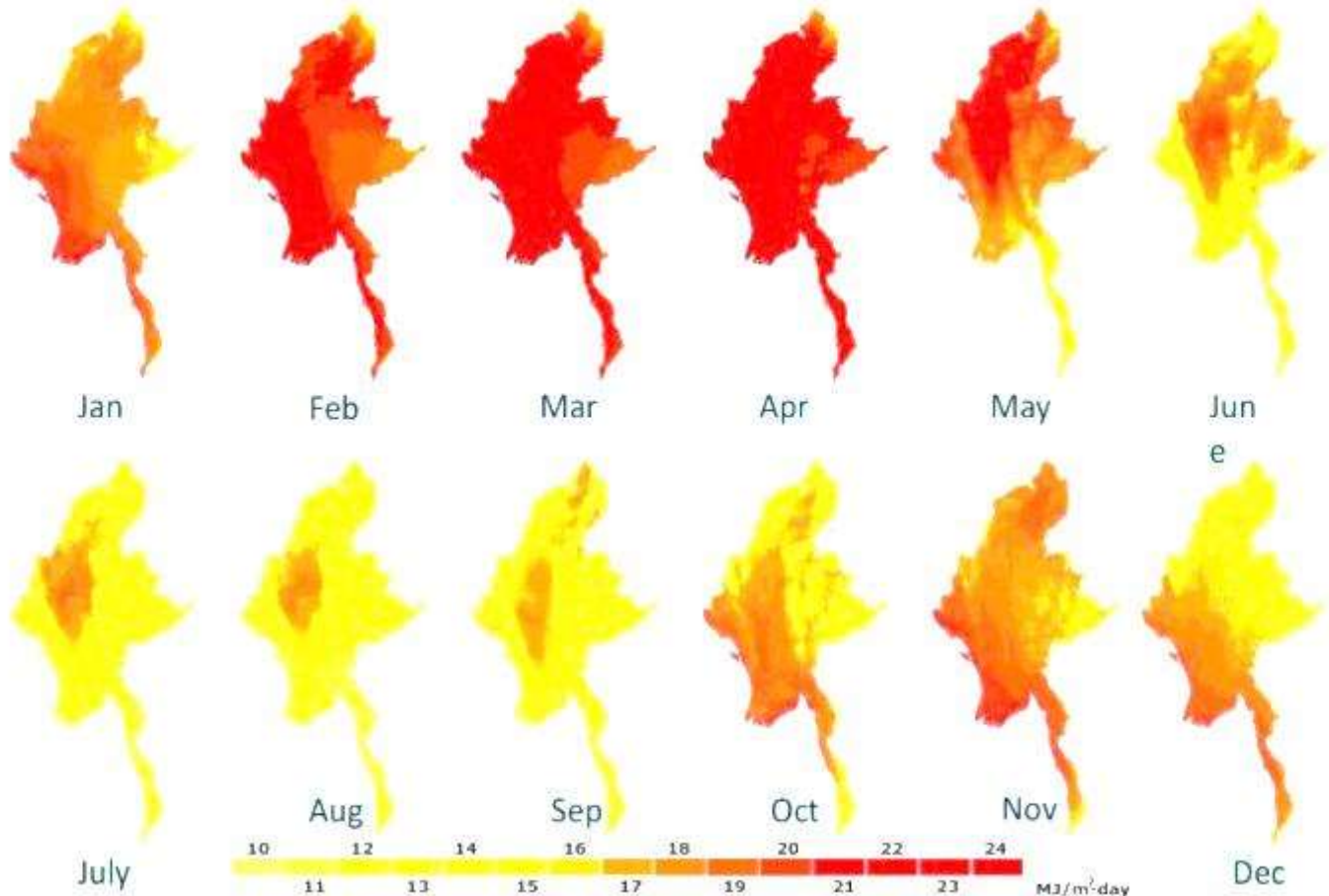
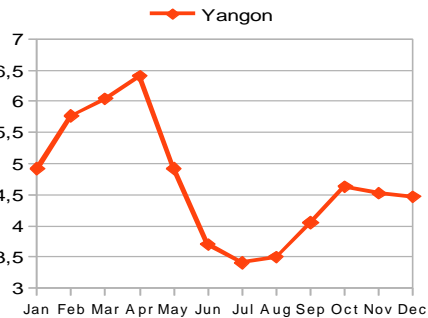
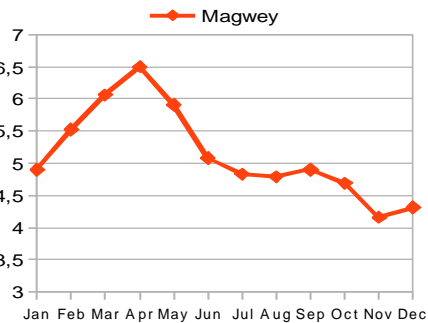
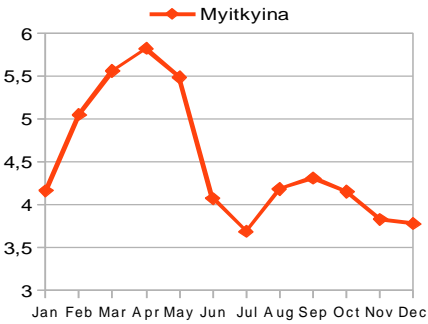
Total E-Production
Myanmar 2013
10,965 GWh/a

PV produces
this energy on
52.8 km²
7.2x7.2 km





Monthly Solar Radiation in Myanmar





Medium daily irradiation

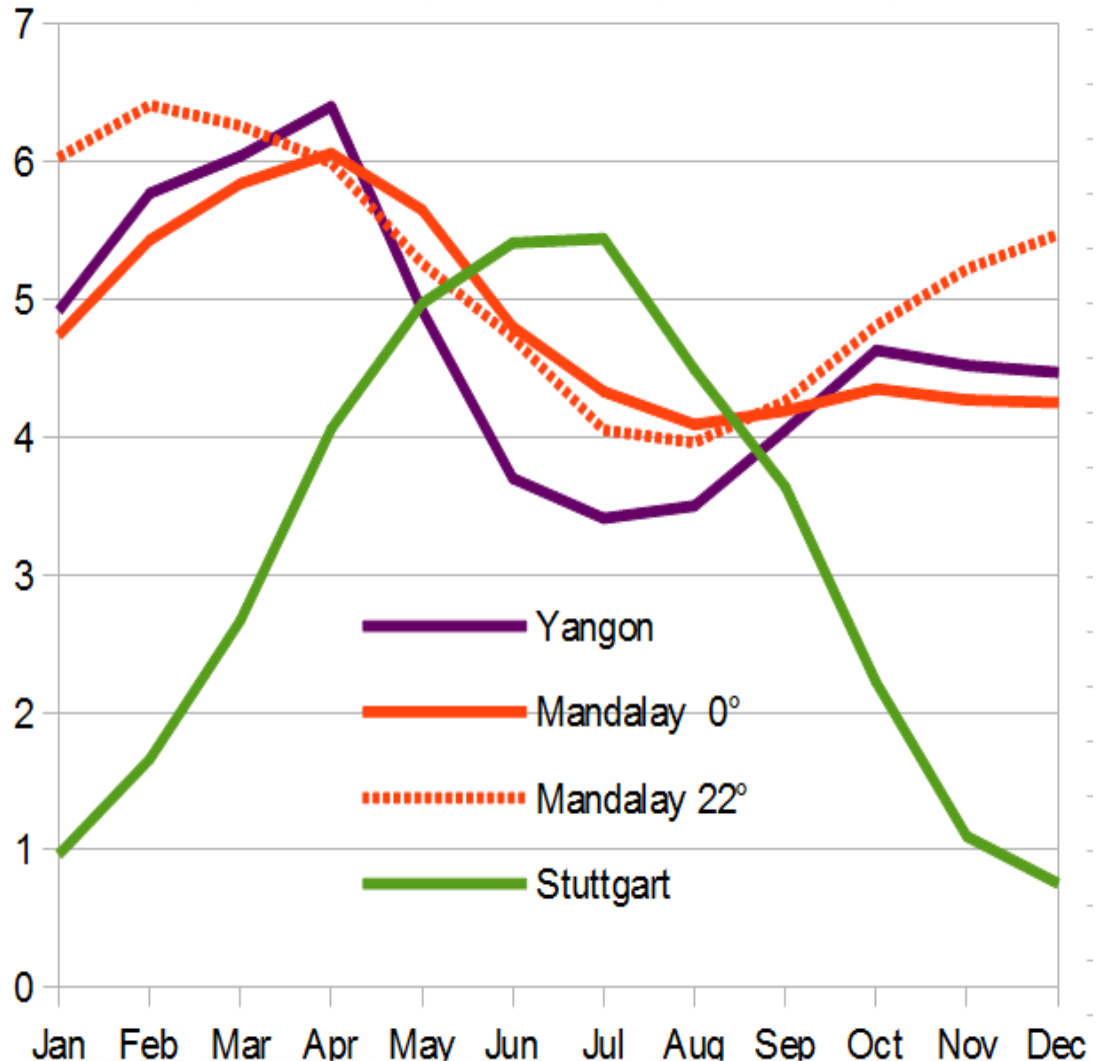
Mandalay 4.83 kWh/m² at 0°
Mandalay 5.2 kWh/m² at 22°

Annual generation

Mandalay
132 kWh/m² at 0°
205 kWh/m² at 22°

**Tilt, temperature, diffusion
affect the solar harvest**

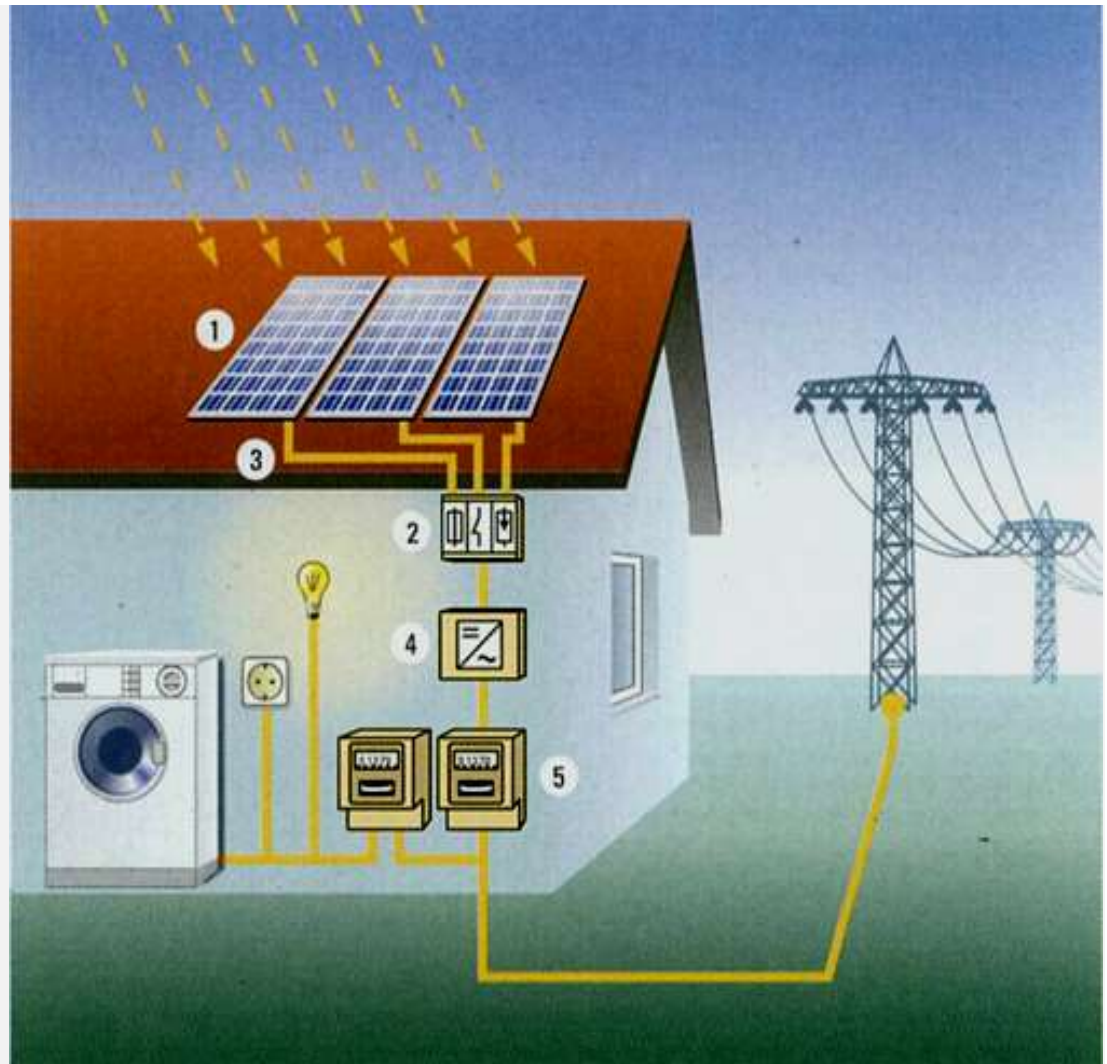
Weather Data :





PV on Grid

- 1) Solar Generator
- 2) Group box & wiring
- 3) Mounting structure
- 4) Inverter
- 5) Meter



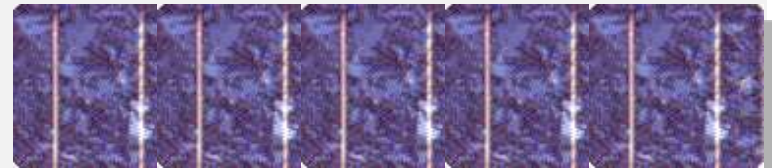


Area Use of different PV Cells :

Monocrystalline 110-160 W/m²



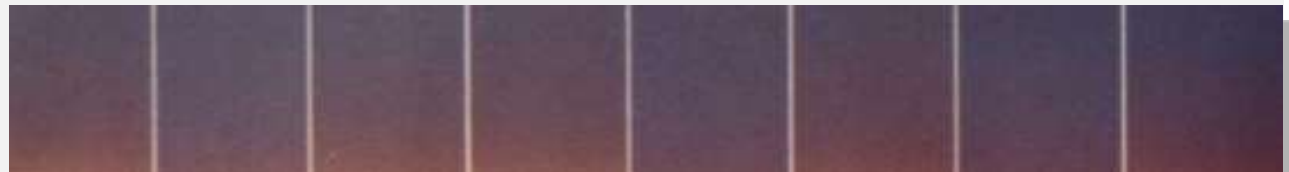
Polycrystalline 100-140 W/m²



Thin-Film 60-100 W/m²



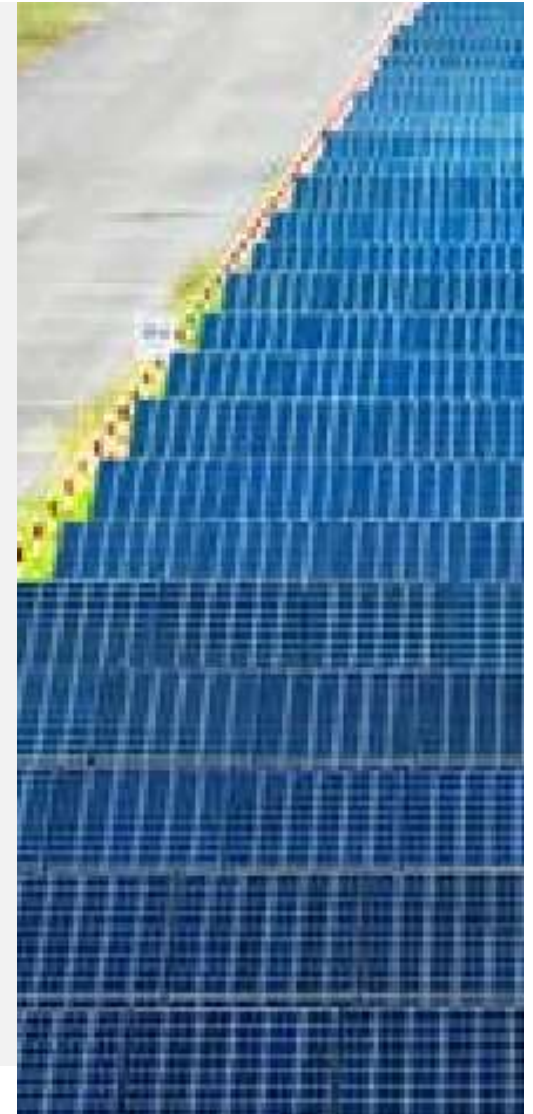
Amorphous 40-80 W/m²





PV on Grid

- 1) Size: 10 kW – 50 kW – 1 MW
- 2) Support: Easy Connection,
Tax deduct, Feed-In-Tariff, Finance ?
- 3) Quality, Certification, Training
- 4) Is there a Market ?





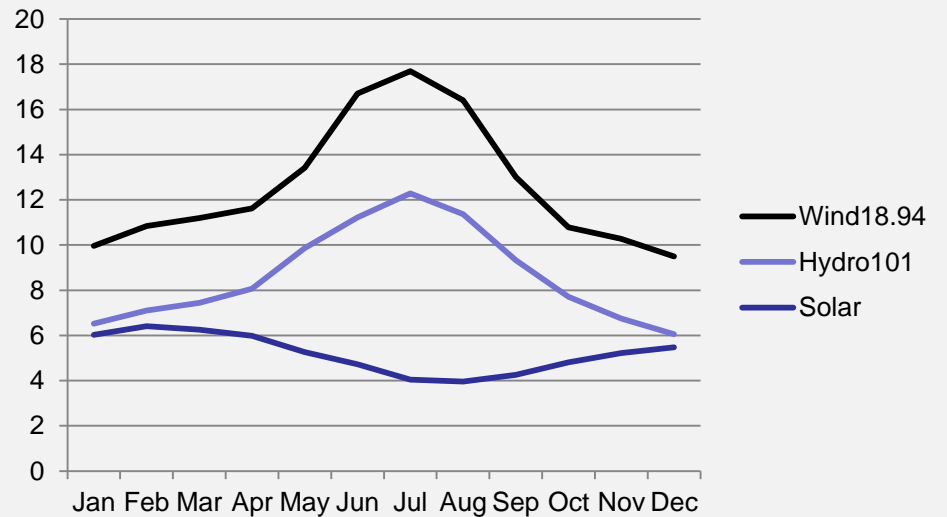
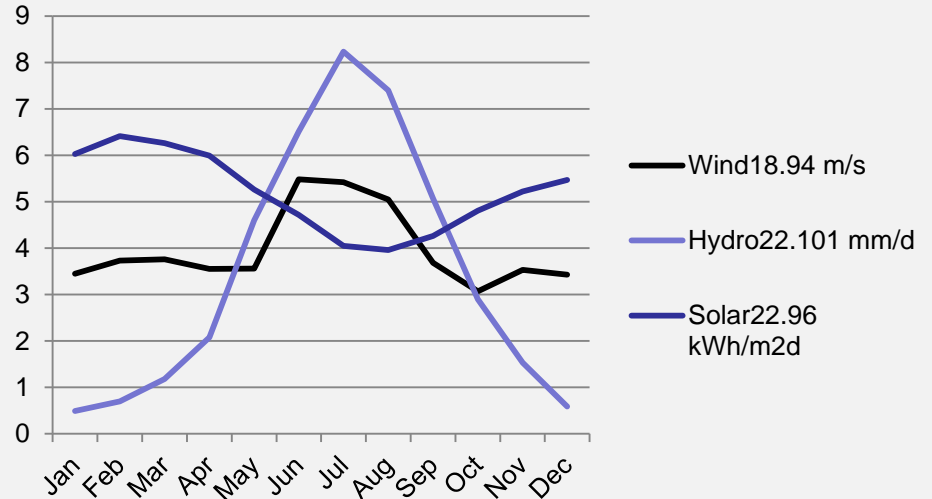
PV on Grid

Power Balancing :

Wind + Solar - ok

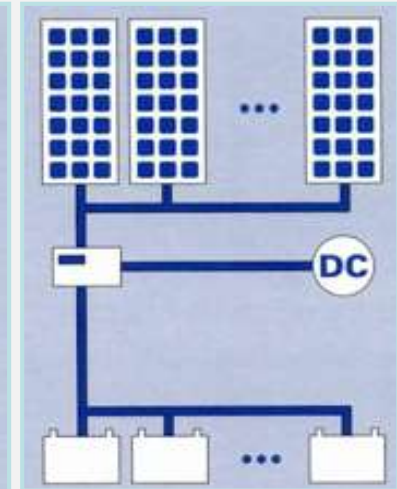
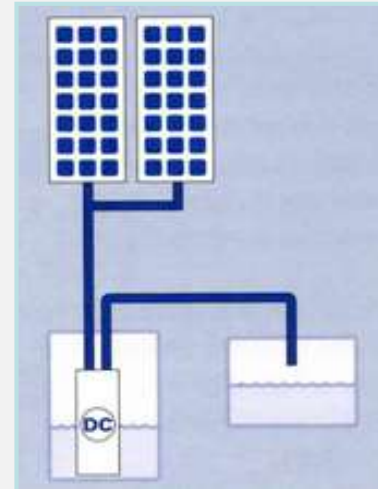
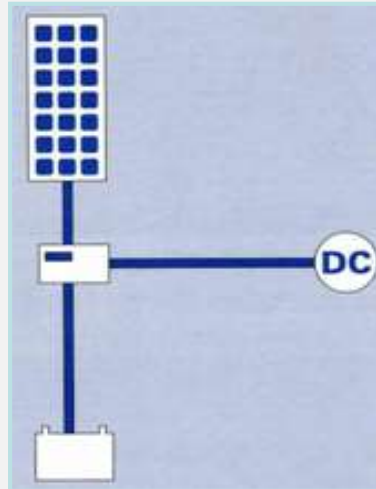
Hydro + Solar - ok

Hydro + Wind - no

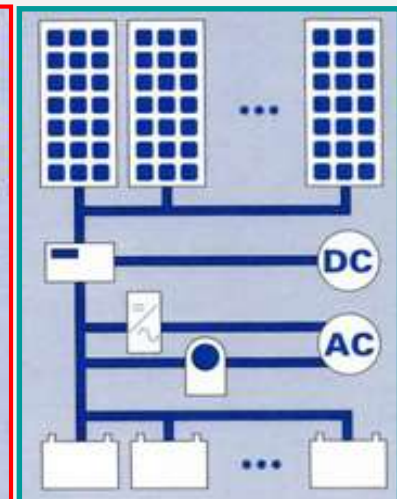
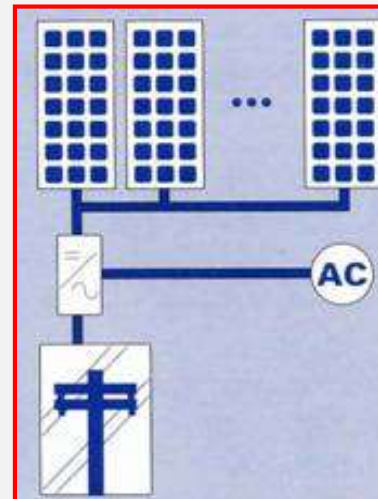
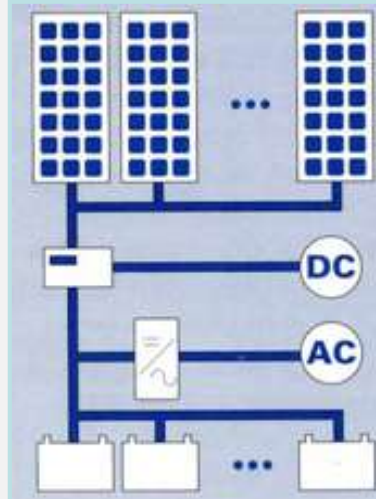




DC Systems:
Stand Alone
PV Pumping
Charging System



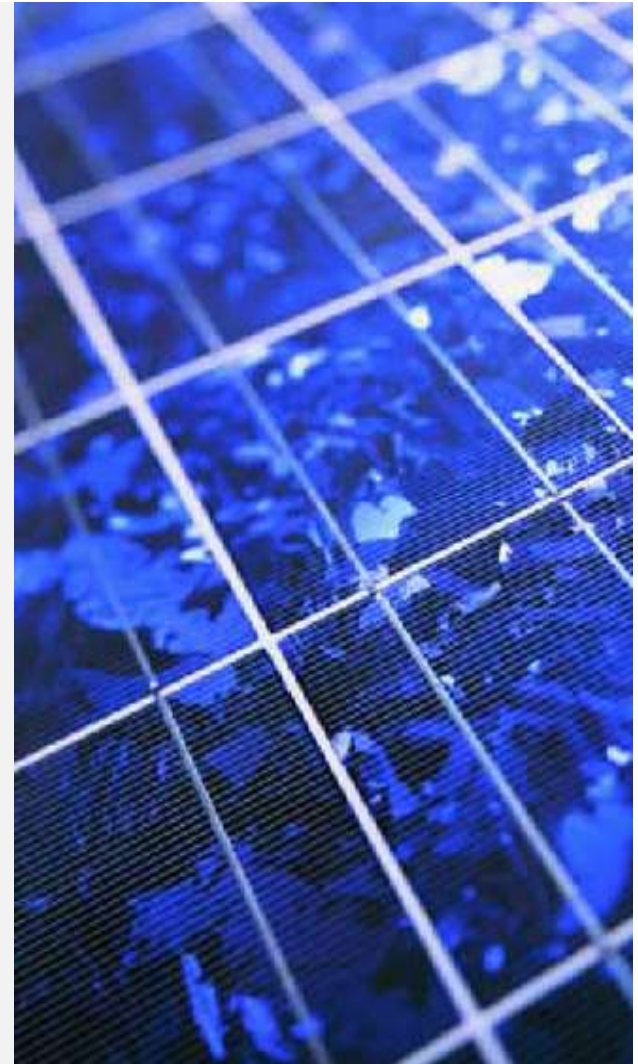
AC Systems:
AC/DC Supply
Grid AC
Hybrid System





Solar Panel Specifications

- Cost [\$/Wp]
- P_{MPP} [W_p]
- U / I_{MPP} [V / A]
- Coefficient U / I_{MPP} [%/K]
- Certification IEC/UL (STC, noct)
- Power Density, Tolerance [+%]
- Construction: Glass, Alu, Encapsulation(EVA), Backside (Tedlar[®]), Connections (Multi-Contact[®])
- Weight, Size
- Warranty (Product / Power)





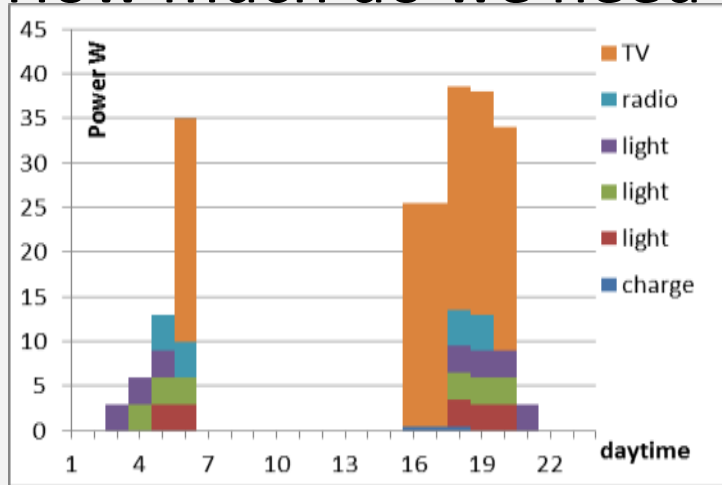
Solar Inverter Specifications

- Power Range
- Voltage Range ,AC/DC
- Efficiency [%]
- MPP-Tracking
- Max Voltage [V]
- Control, Display, Remote
- Grid Safety, $\cos\phi$
- Warranty





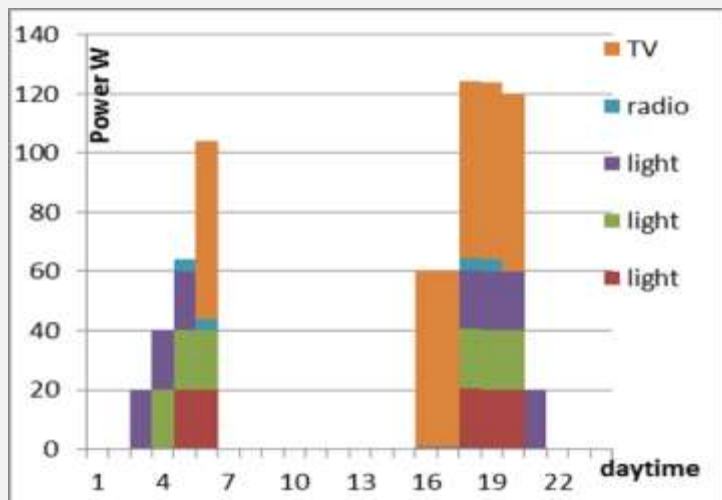
How much do we need



Consumption **Energy Saving Appliances**
255 Wh/d = **93 kWh/a**

3 Low-LED lighting morning and evening
radio or similar, TV/DVD set 25 W
option for charging

Power rate for 100 homes: **3.8 kW**



Consumption **Standard Appliances**
876 Wh/d = **320 kWh/a**

each home 3x20W FL lighting
radio or similar, TV/DVD set 60 W

Power rate for 100 homes: **12.5 kW**



Rural Load Assessment

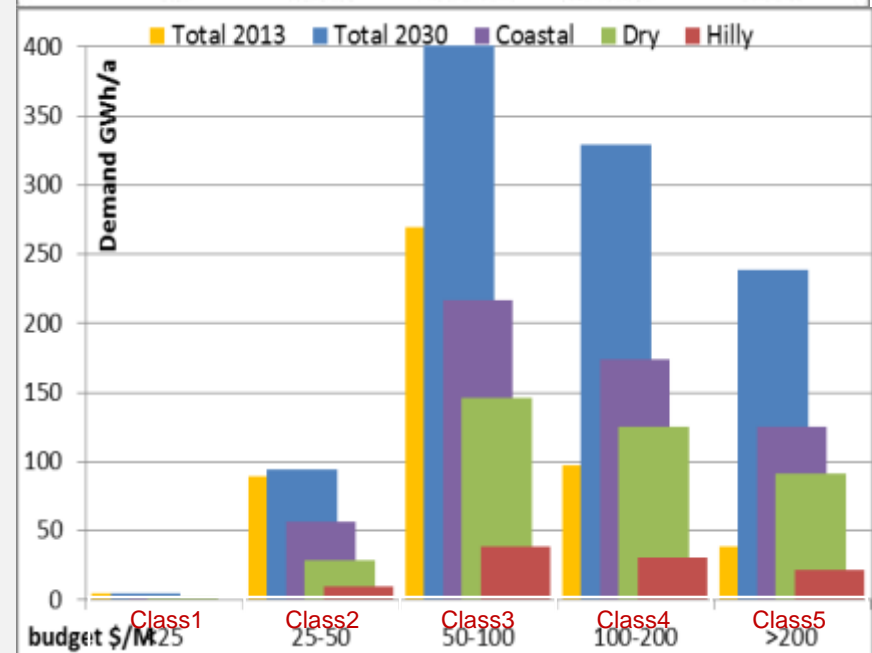
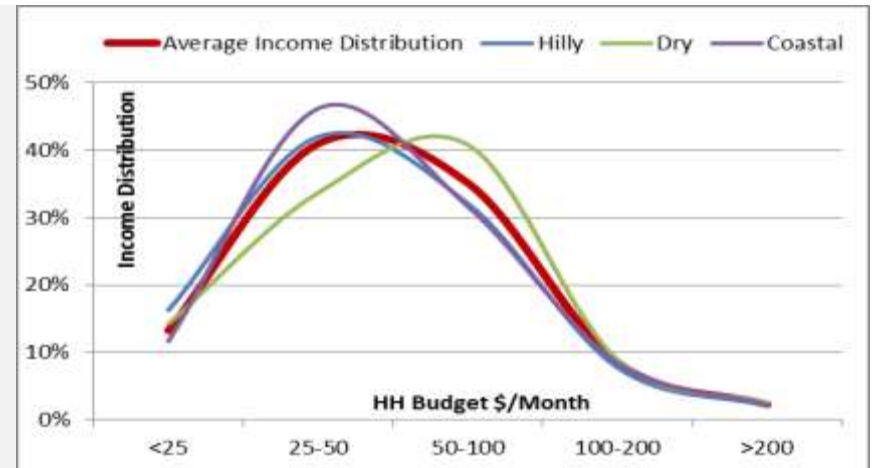
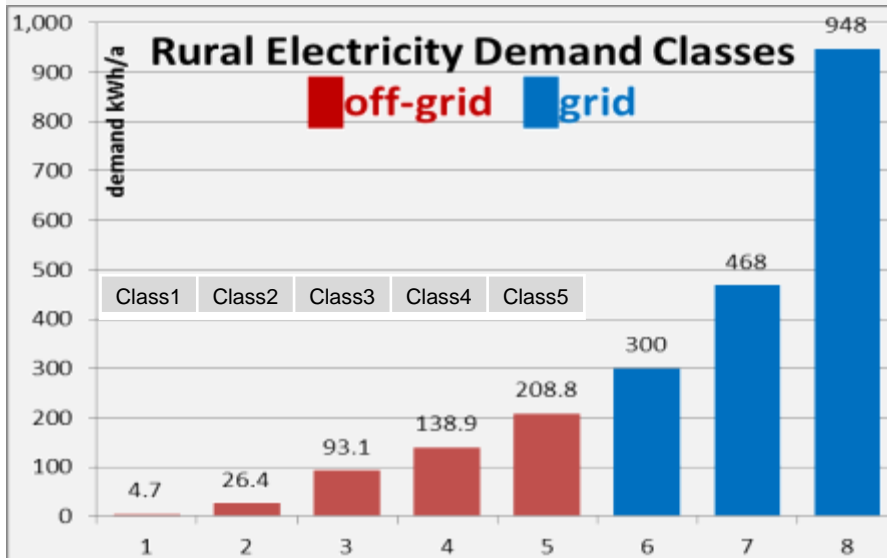
5 off-grid load classes were identified

- Class1 13 Wh/d : light
- Class2 72 Wh/d : lights
- Class3 255 Wh/d : lights TV
- Class4 381 Wh/d : lights TV AC
- Class5 572 Wh/d : lights TV fan AC

followed by **3 on-grid classes** of 300-948 Wh/d

When correlated with **income brackets** >

Result shows **Demand Distribution** >





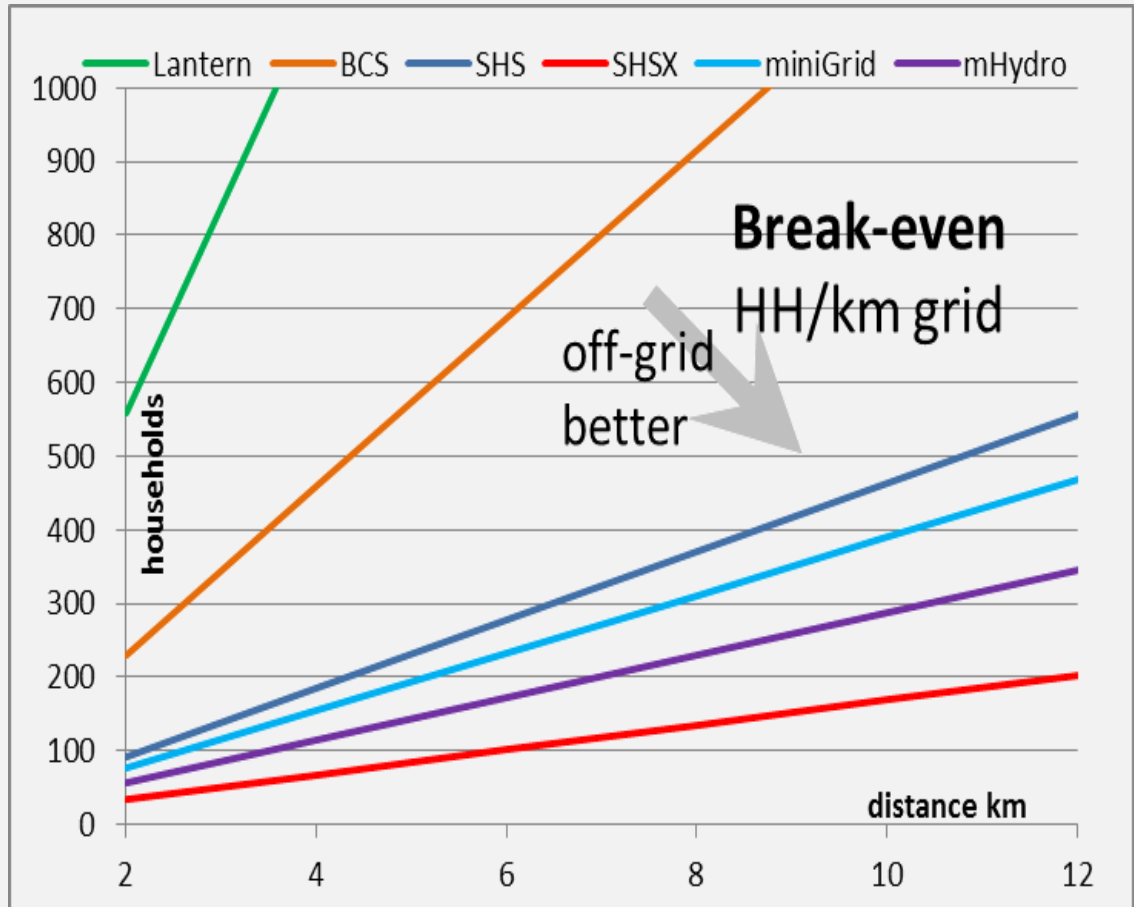
Supply Options

RE Technologies economically compare with grid expansion

Small, remote villages : RET
 Large, close village : Grid

RET service is limited,

- Match Design
- Scale up to Demand
- Allow rapid roll-out
- Allot less expense
- Prepare for grid



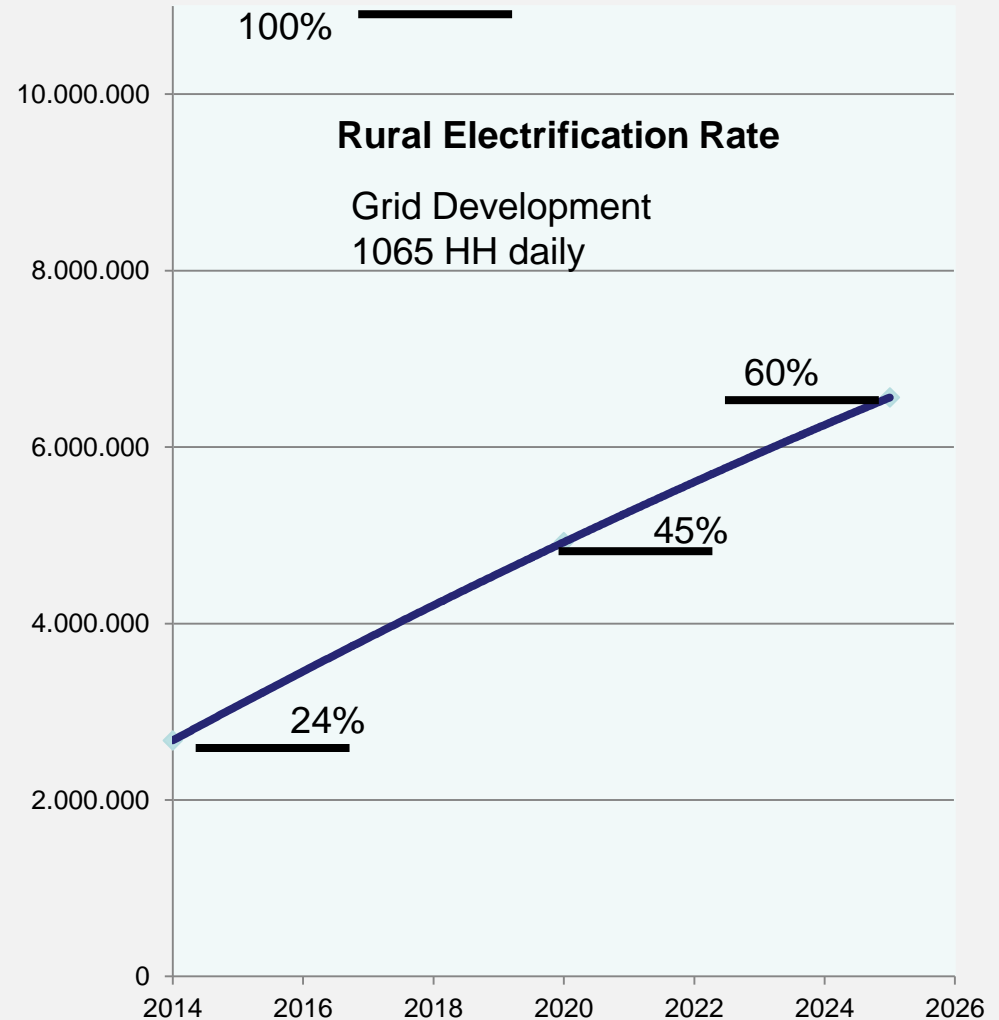


8,262,324 of 10,937,500 rural Households unelectrified = 76%

Grid: electrif. to 40% by 2025
388,732 new connections/a
1065 new connections daily

Complement with
Micro-Hydro
Biomass
Solar

What should be done ?





RE Share and Cost

RE rural electrification est.

1.24 GW cost at 3,105 Mio\$

= 58 \$ per citizen

745 MW (60%) at 1,862 Mio\$

RE grows fast in build-up phase,
slower in saturation

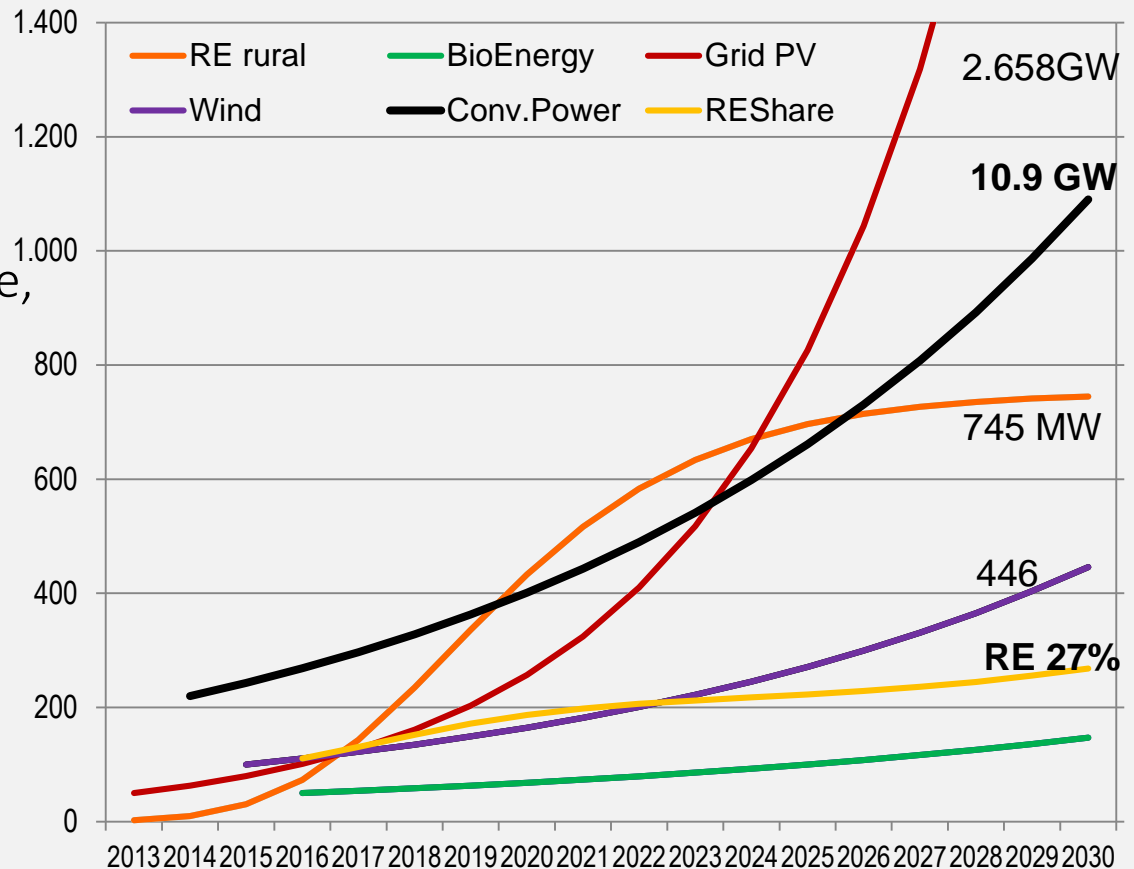
Grid PV grows strongest :

2.6 GW no GoM investment

Wind 446 MW, Bio 147 MW

later, slower, no GoM invest.

RE to reach 27% of added
power generation





Project development

- Select village (transparent)
- Information drive
- Arrange Downpayment
- Buy, transport material
- Install, commission
- Train users
- Arrange Service
- Collect fees for service, repair
- Provide service, repair, monitoring,
- Provide expansion





Renewable Energy Agency

- Get **data** (resources, material, regulations)
- **Train** (installers, technician, designer)
- **Plan** development, expansion
- Select, **prioritize** projects
- Secure **Financing**
- **Organize**, supervise installations
- **Standards** and tenders
- **Quality Assurance**
- **Monitor** progress, service
- **Coordinate** different activities





Action Plan	Renewable Energy Development Myanmar
Assess	<ul style="list-style-type: none"> Which resources are available How can we use them Do we have the capacity What are cost, time
Plan	<ul style="list-style-type: none"> Identify demand Compute supply options
Policy	<ul style="list-style-type: none"> Define targets, priorities Support and incentives Activities and Responsibilities
Strategy	<ul style="list-style-type: none"> What is the most efficient way to reach targets How can sufficient capacity, finance be secured
Roadmap	<ul style="list-style-type: none"> How much can be done over time Define Stages, Milestones, Indicators



Stages of Rural Electrification in Thailand



กรมการไฟฟ้า
พลังงานทดแทน
และอนุรักษ์พลังงาน

1. Evolution of RE in Thailand

4 Stages of RE in Thailand

New Rural Household Electrification Stage





Five Guidelines for Renewable Energy

- Provide citizens **sufficient** energy at **sustainable** cost
- Encourage citizens to **contribute** to electricity **service**, help the **Weak**
- Give **priority** to viable **distributed generation** from Renewable Energy Sources
- **Prefer private** to public development in Renewable Energy generation
- Ensure proper **standards**, attractive financing and continuous **training**

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Think BIG - Start small - Scale Fast