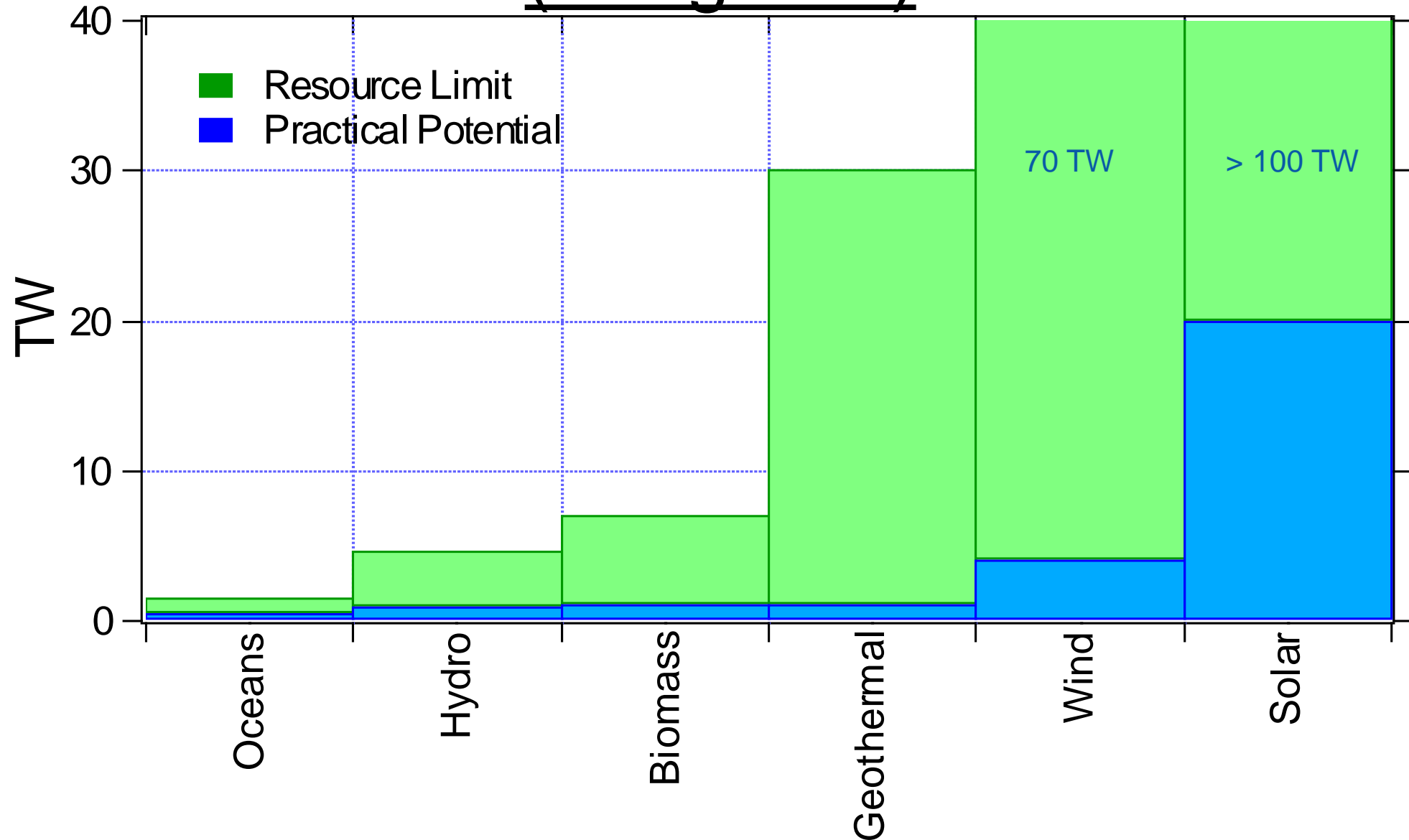


Renewable energy resource in Uzbekistan

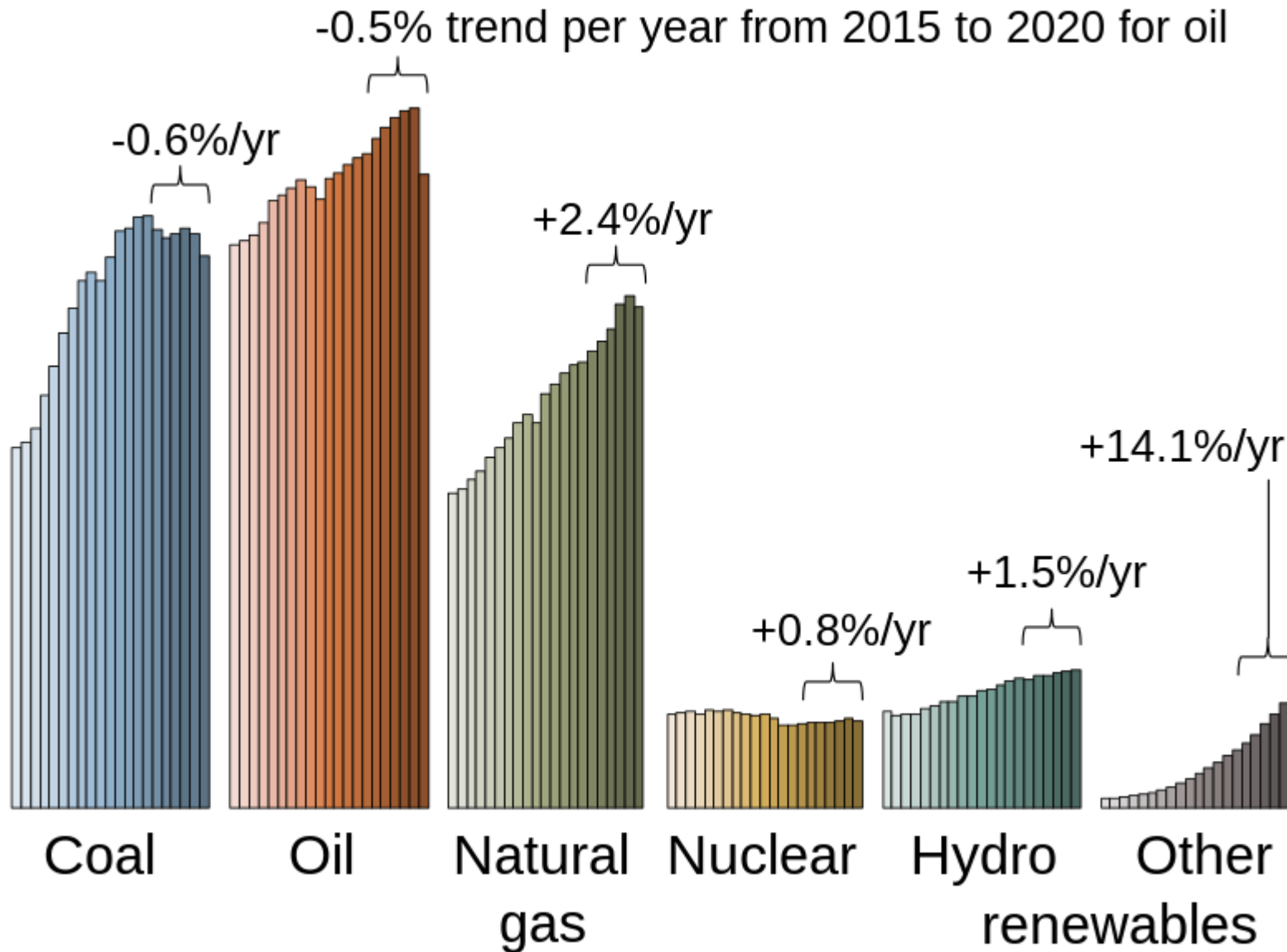
Zavkiddin Mirtoshev and Eshkuvat Arzikulov

Samarkand State University

Sustainable Resource Potential (it is global)



Global energy consumption, 2000 to 2020

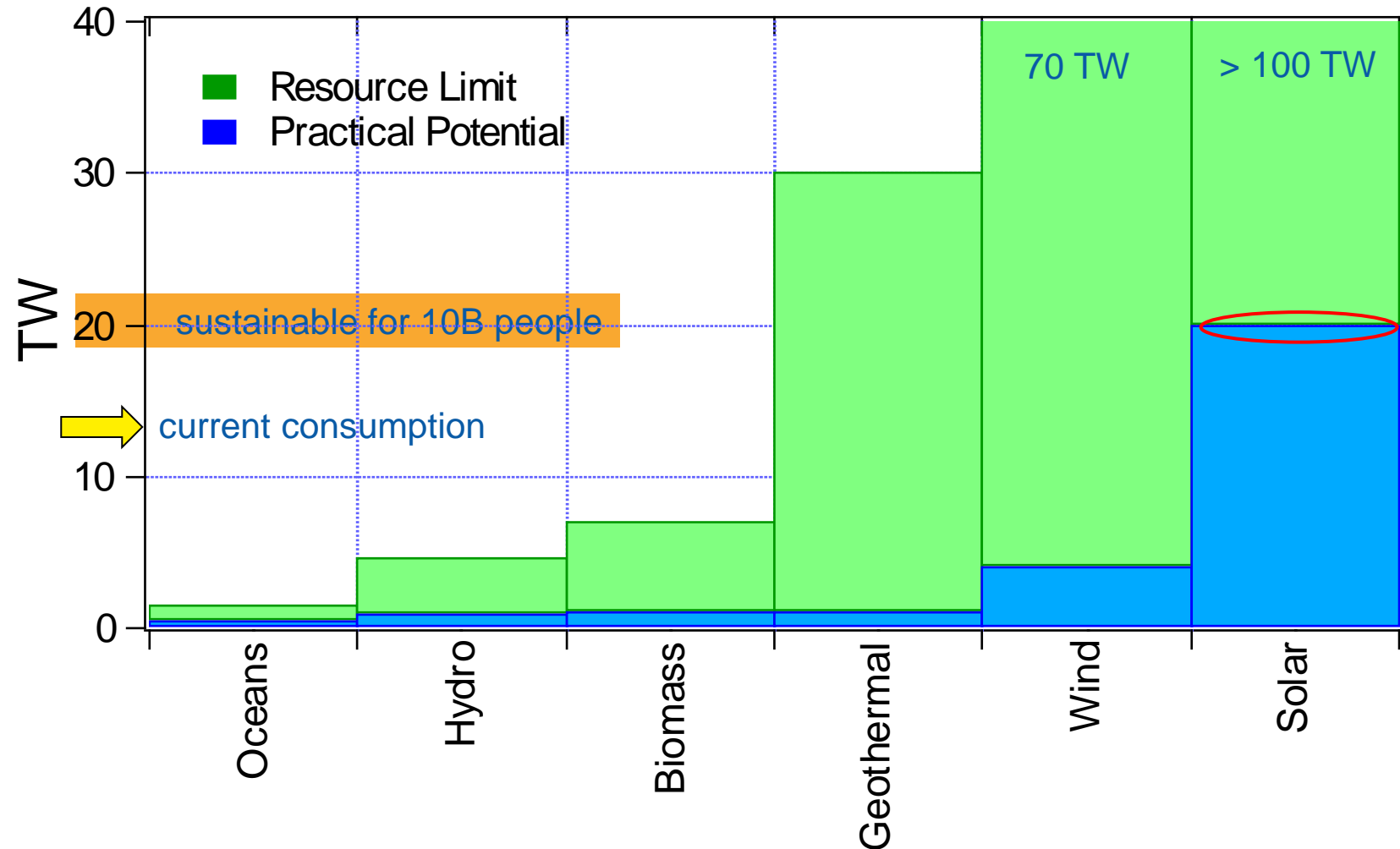


Source: Jackson et al.: Persistent fossil fuel growth threatens the Paris Agreement and planetary health. *Environmental Research Letters* (14), 2019.

The Sun is THE BIG Energy Player

Sun power hitting earth ~ 165,000 TW

1 hr ~ 14 TW-year ~ current annual world use



Uzbekistan has 40 Hydro and Thermal power stations. They generated 15 million kW electrical energy per year.

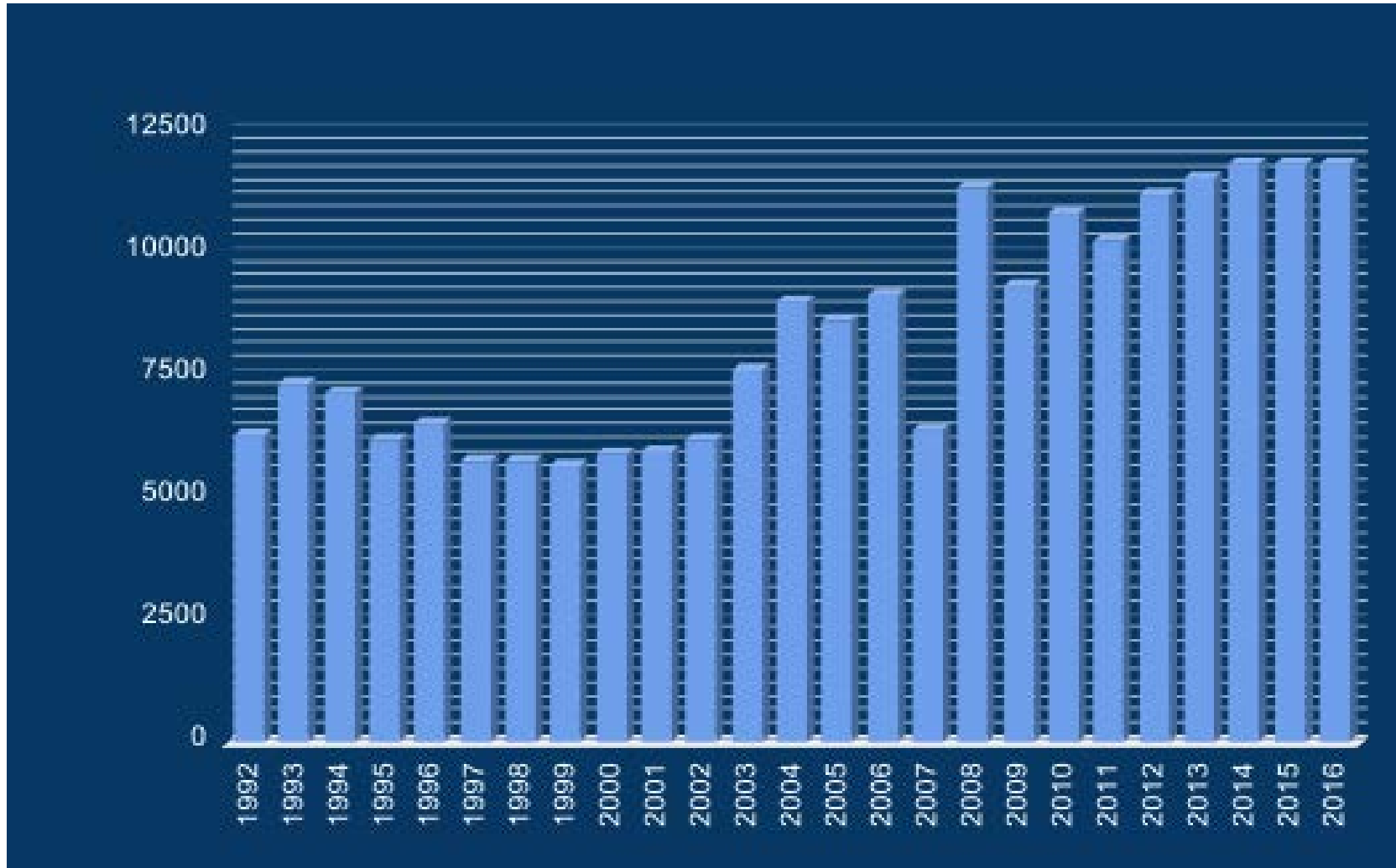
83 % - Of them generated in Thermal Power Station and

17 % - Hydro electrical Power Station

Annual Solar potential in Uzbekistan 50 billion 953 million tons of oil equivalent

If we use 1 % of them it's 120 time more than we need

Electricity production at hydroelectric power stations in Uzbekistan, 1992-2016, million kWh



Gross domestic product (GDP),
billion dollars - 227.980

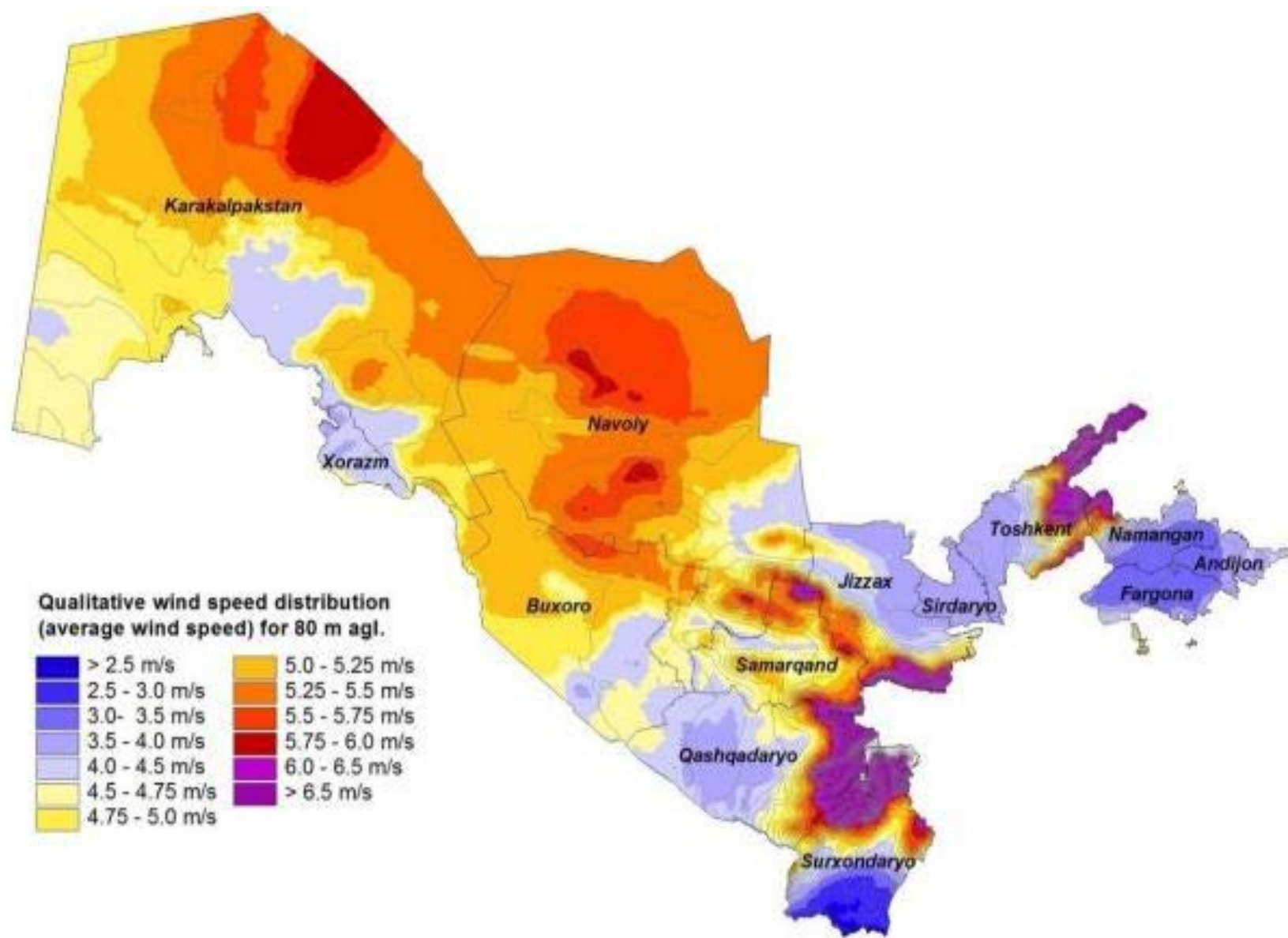
Installed net capacity of power plants, MW -
14195

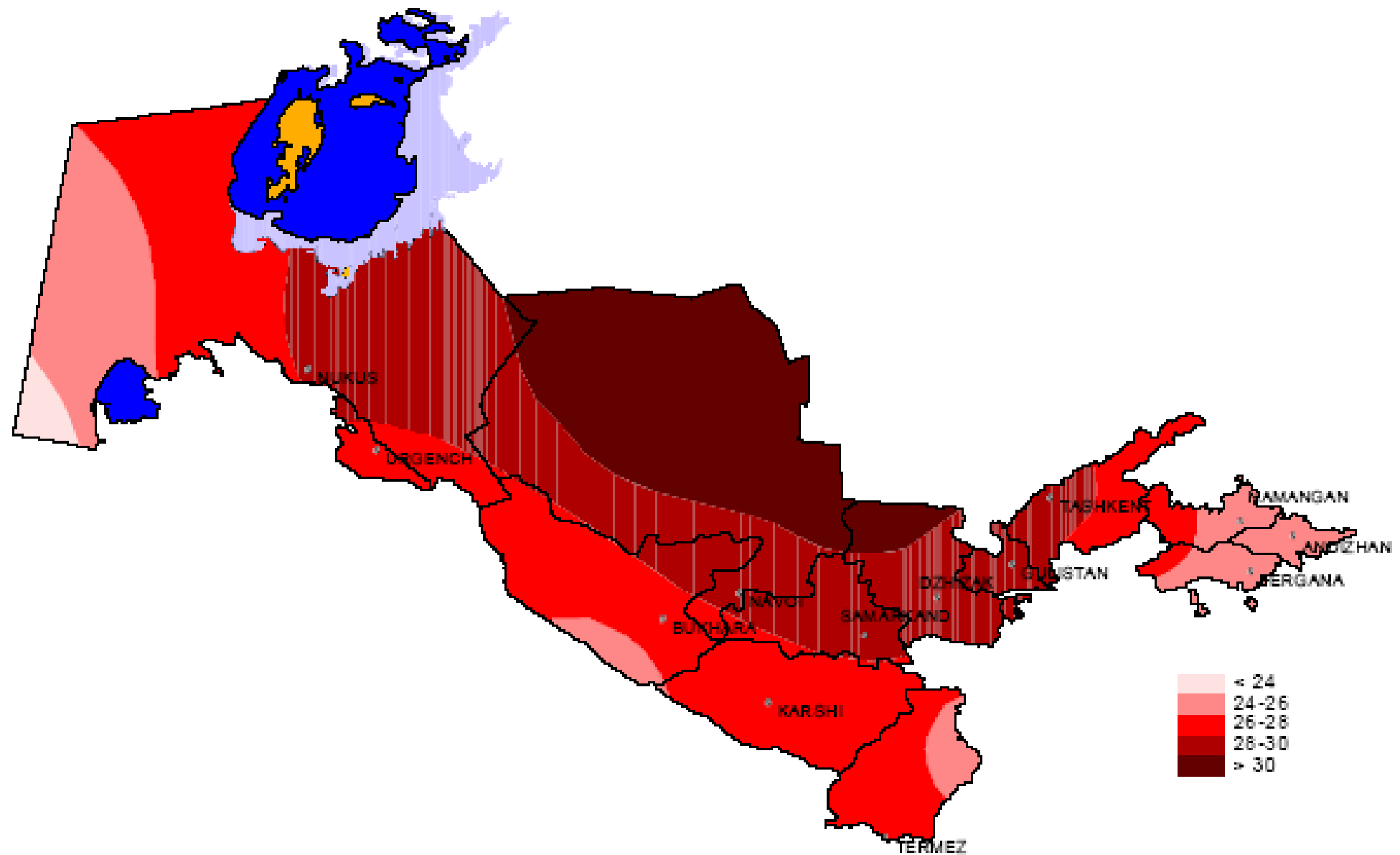
Gross electricity production, mln kWh -
62408

Final electricity consumption, million kWh -
53515

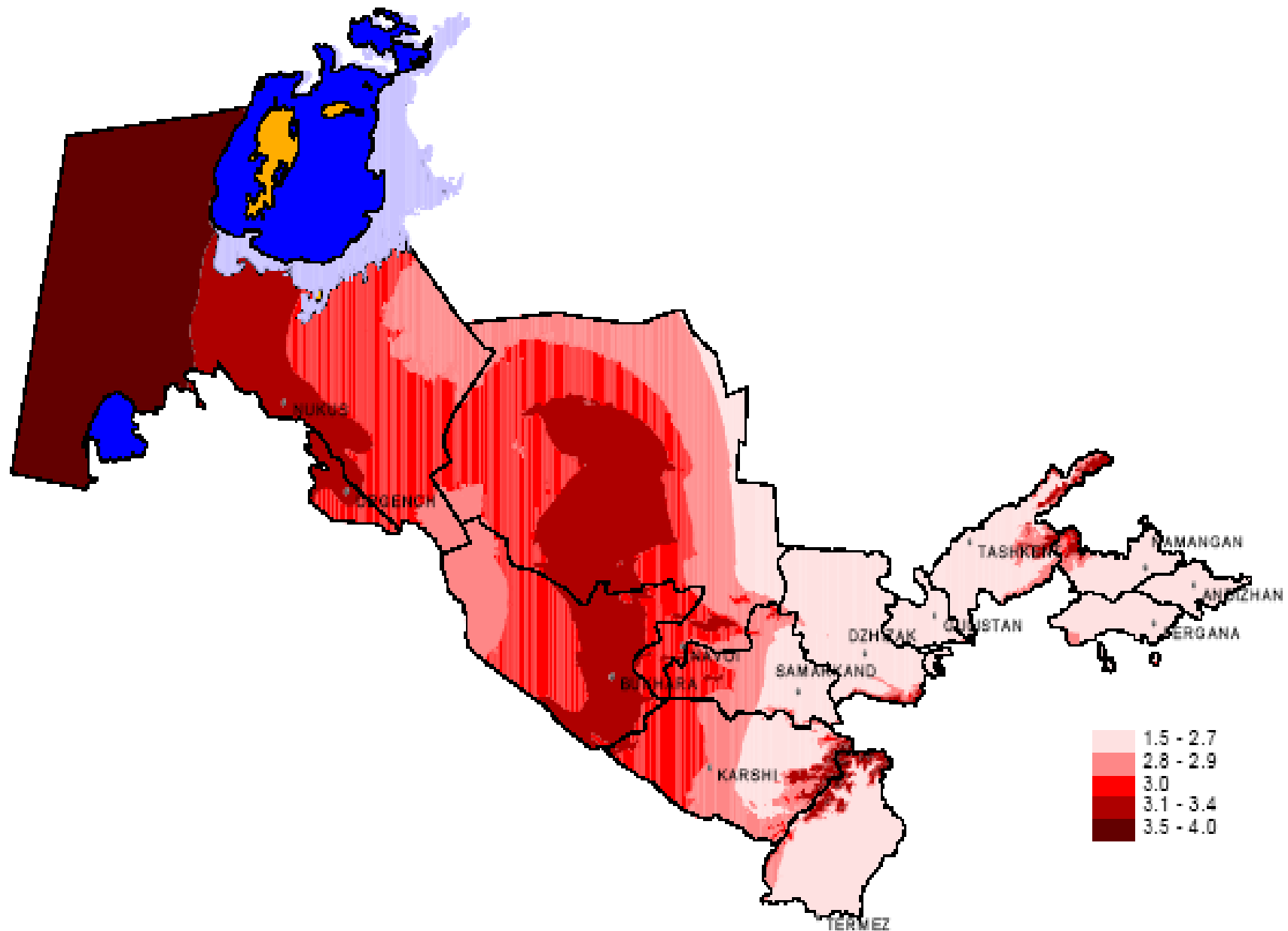
Table 1. Renewable energy resources in Uzbekistan

№	State of Reserves	Total	Energy				
			Hydraulic	Solar	Wind	Geo-thermal	Biomass
1	Gross reserves (million tons of o.e.)	50986,9	9,2	50973,0	2,2	0,2	2,3
2	Technical reserves (million tons of o.e.)	179,3	1,8	176,8	0,4	n/a	0,3
3	Utilized (million tons of o.e.)	0,6	0,6	0,0	0,0	0,0	0,0
4	Total of the technical reserve utilized (%)	0,3	33,3	0,0	0,0	0,0	0,0





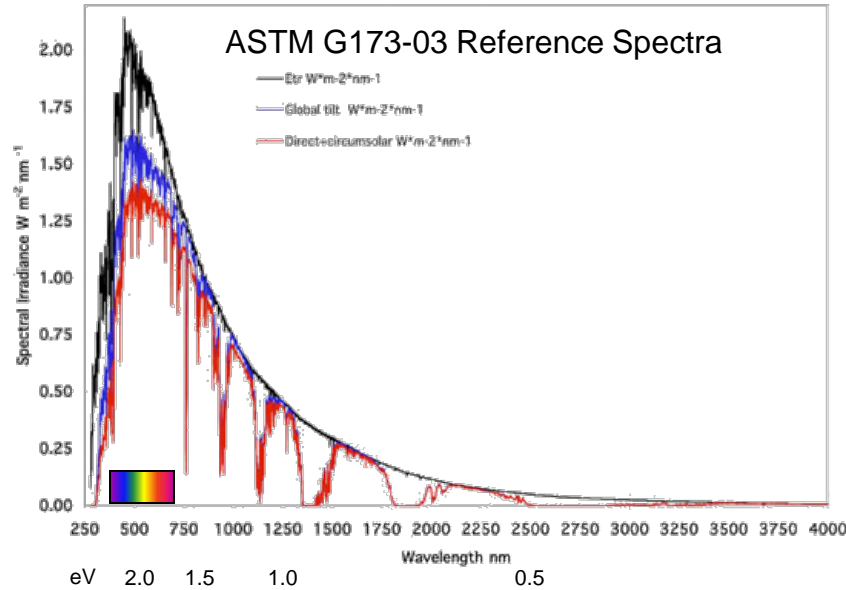
Daily amounts of direct solar radiation (MJ/m²) in Uzbekistan



Average annual wind velocity (m/sec) in Uzbekistan

Why So Many PV Technologies?

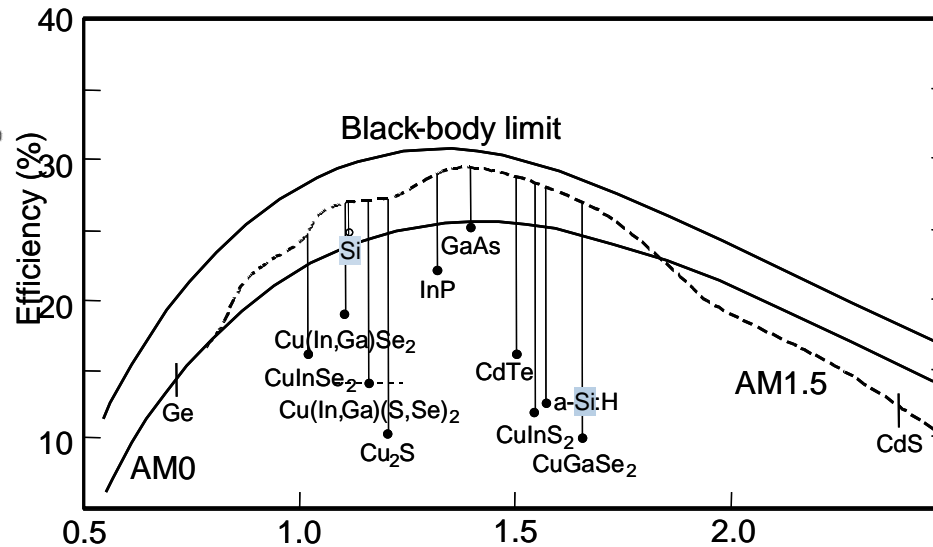
Part of the reason is the sun doesn't shine at one wavelength.



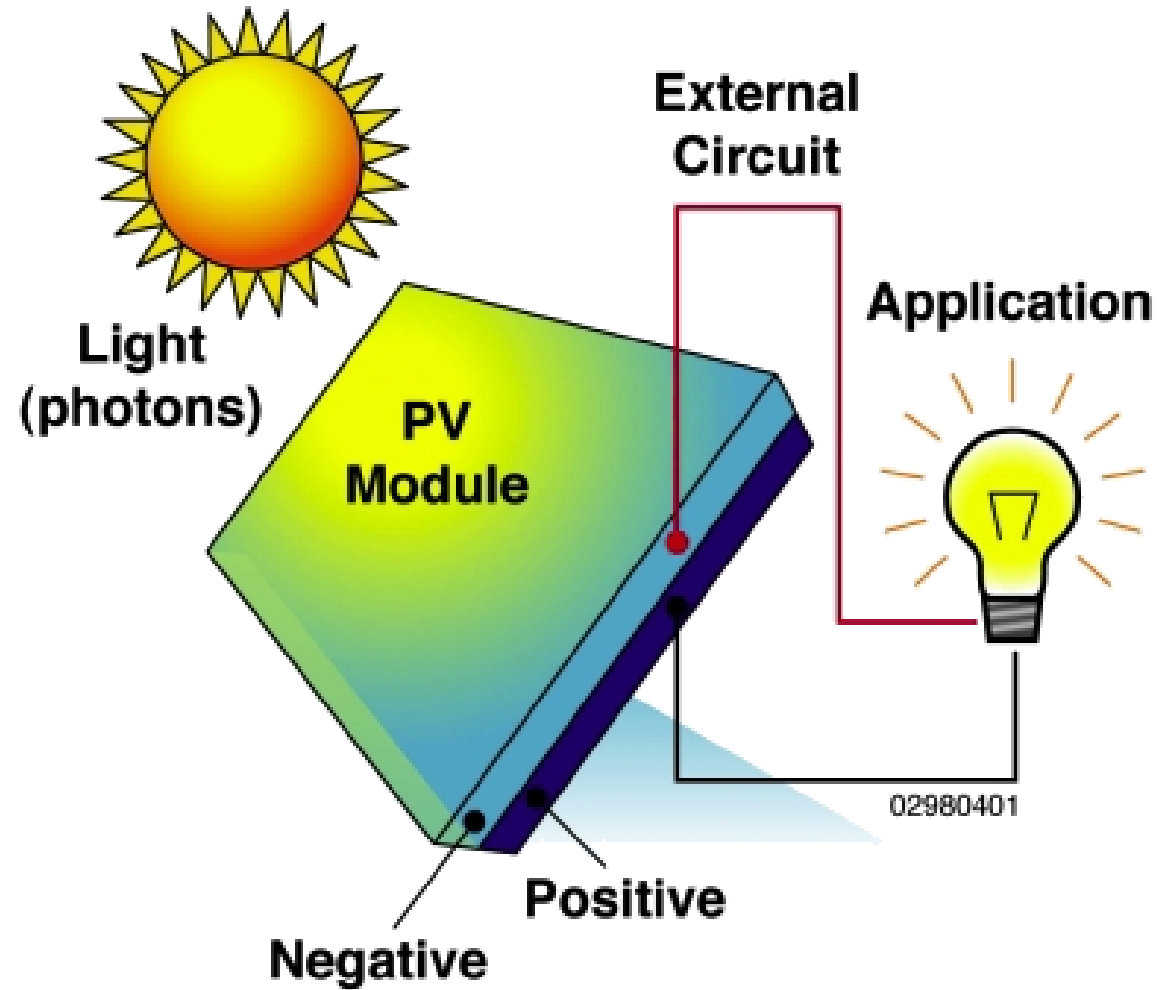
Also....

- manufacturing cost vary
- site resource varies
- installation priorities
- materials utilization

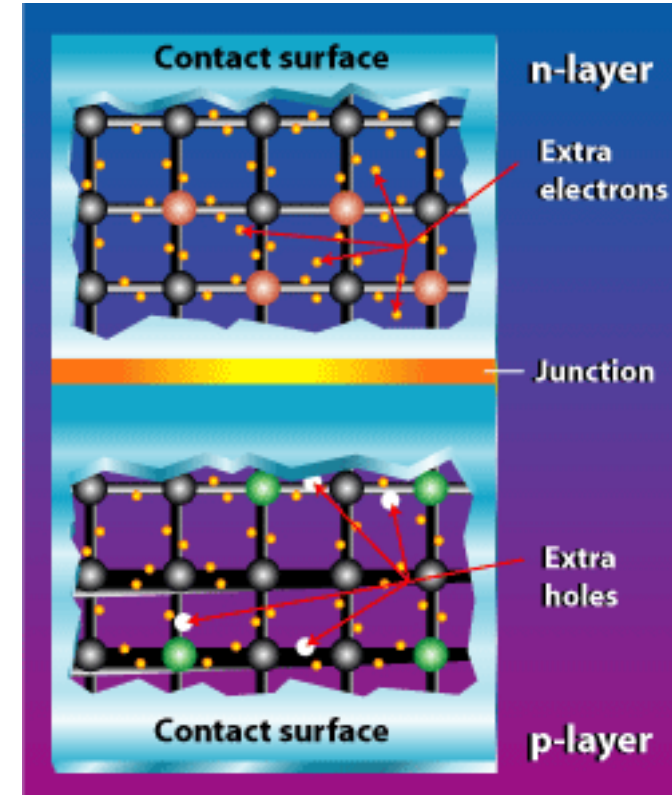
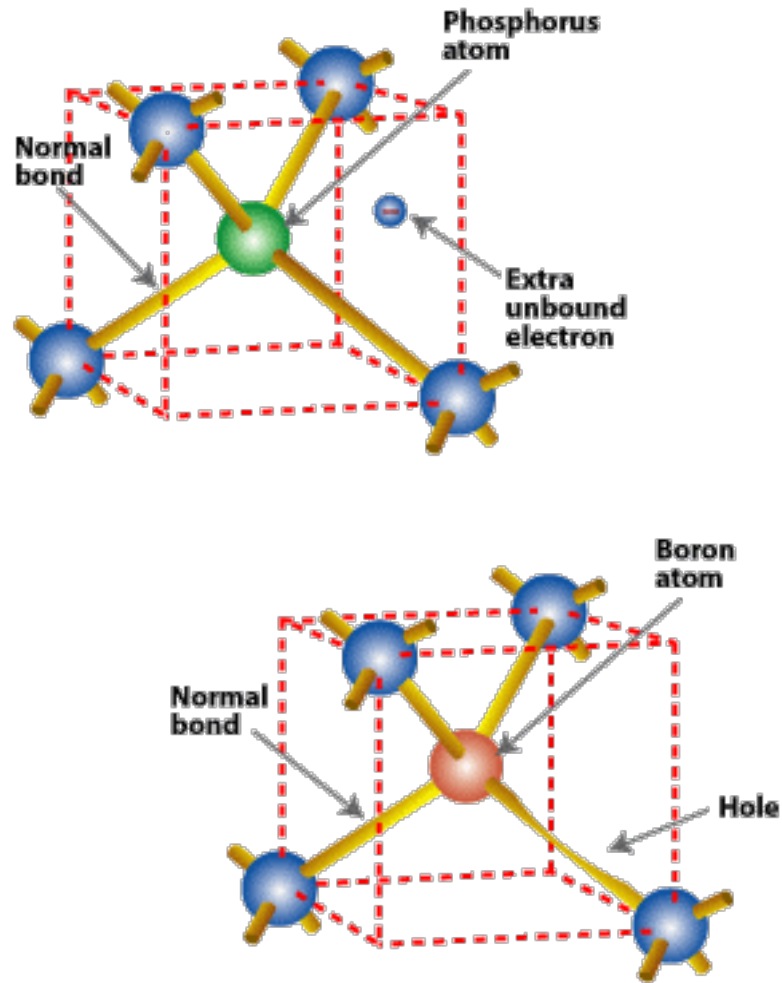
Different materials are used to capture various portions of the solar spectra.



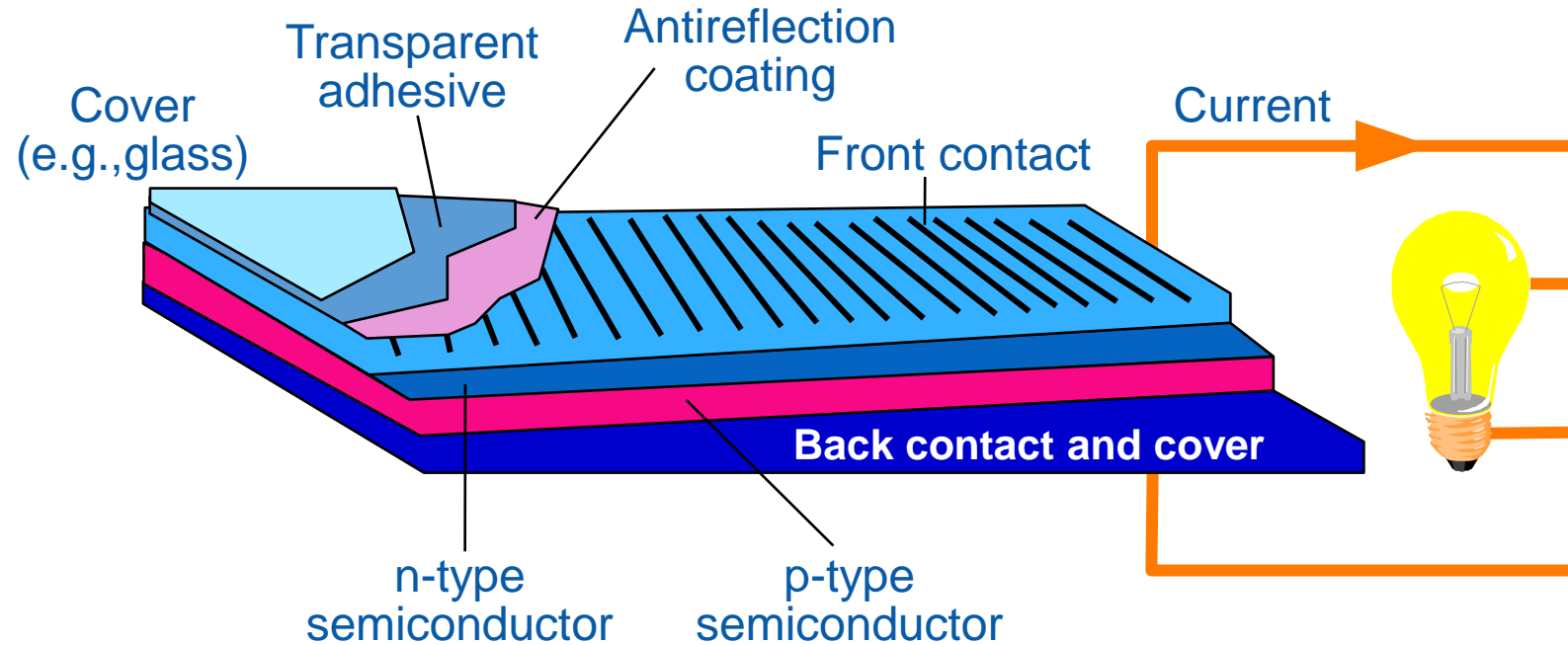
Photovoltaics Basics



Making Semiconductors n or p type



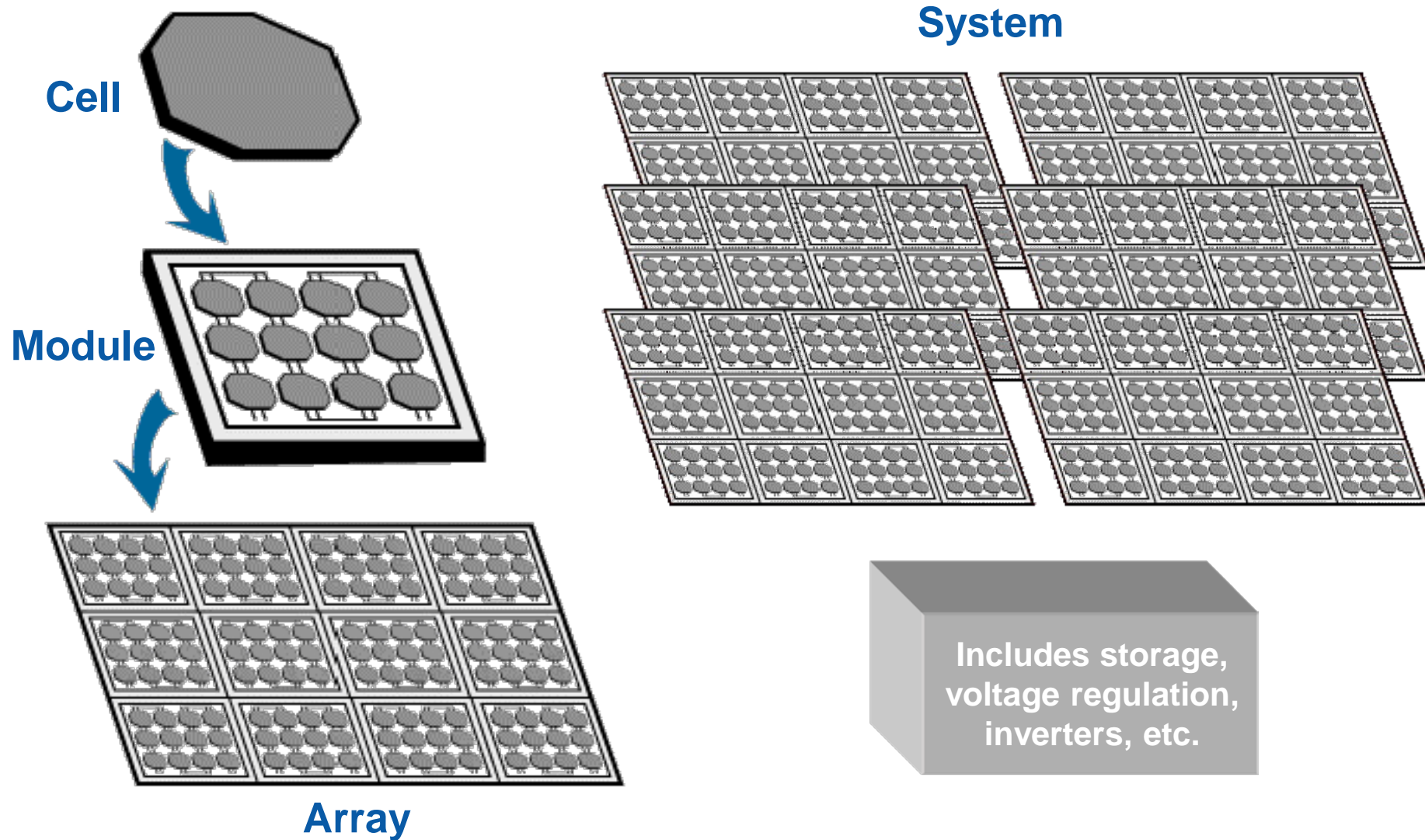
Photovoltaic Cell Structure



$$\text{Solar cell efficiency (\%)} = \frac{\text{Power out (W)} \times 100\%}{\text{Area (m}^2\text{)} \times 1000 \text{ W/m}^2}$$

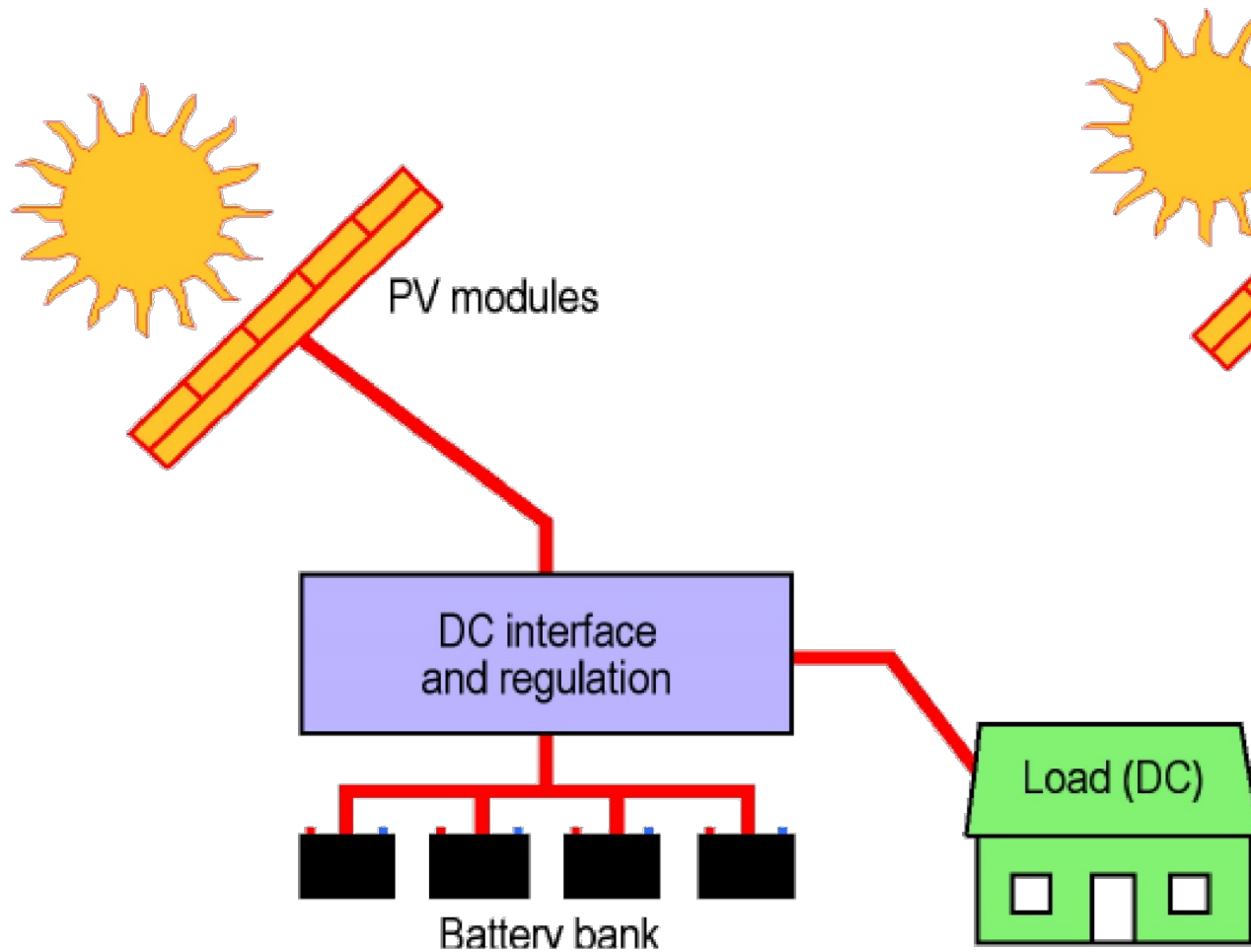
10% efficiency = 100 W/m² or 10 W/ft²

Photovoltaic Building Blocks

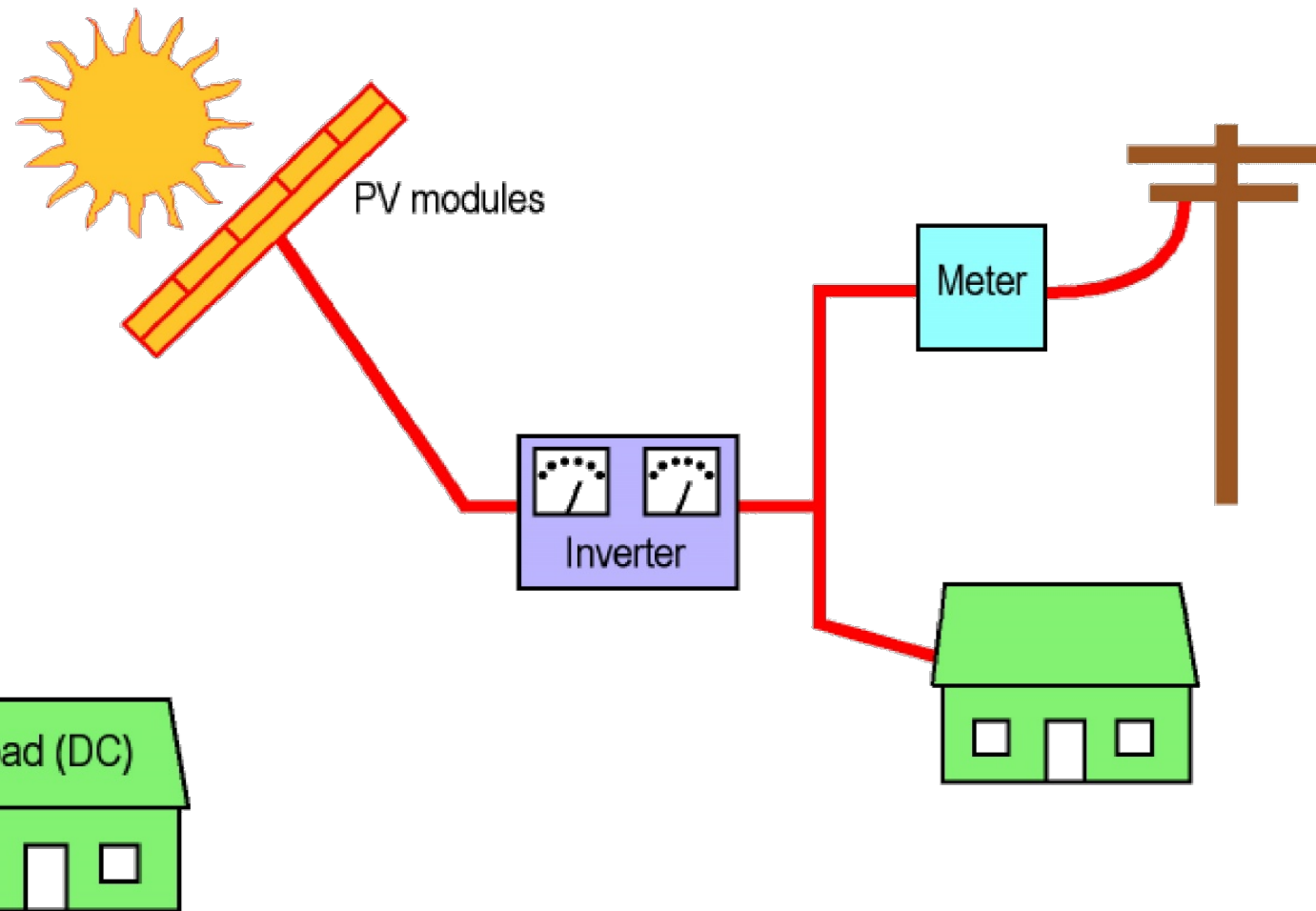


Photovoltaic System Types

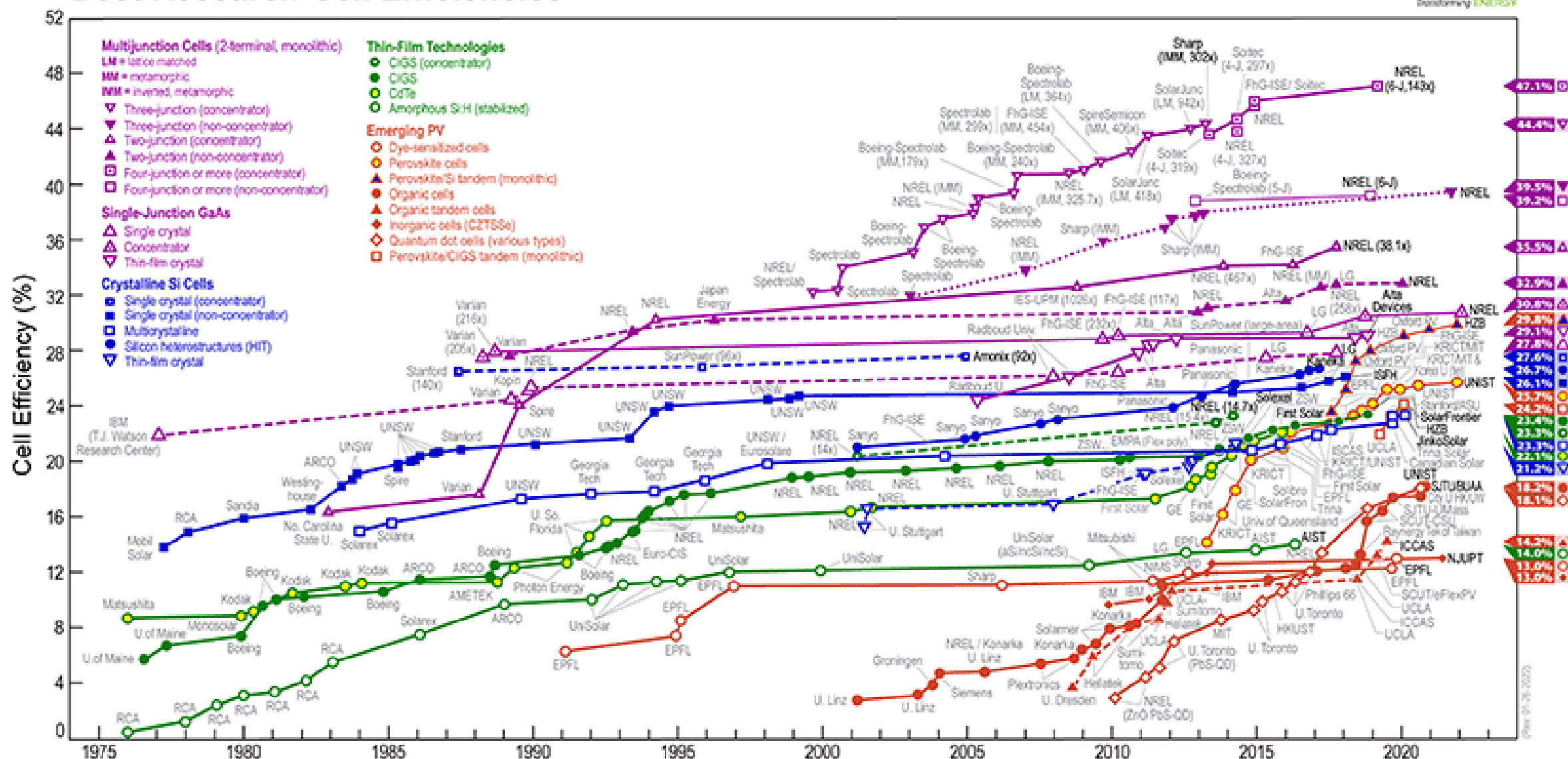
DC System



Grid Connected System (Line Tie or Utility Interface)



Best Research-Cell Efficiencies



Source: <https://www.nrel.gov/pv/cell-efficiency.html>

Case study

(Andijan-Nukus) How much electricity can be produced in a year if the surface of a large Uzbek tract is covered with solar panels? If this is done, how much **GHG** gases will not be released into the atmosphere?



**Construction of 100 MW
photovoltaic solar power plant
in Samarkand region**

**1 March 2017
Pastdargom district
Samarkand region**

**Самарқанд вилоятида қуввати 100 МВт
бўлган қуёш фотоэлектрли станциясини
қурилиши**

**1 март 2017 йил
Пастдарғом тумани
Самарқанд вилояти**





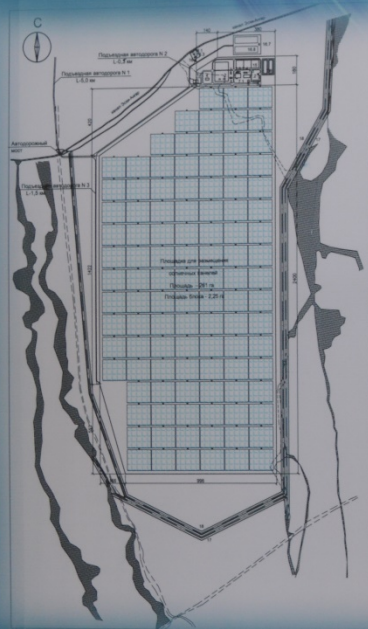




P A S S P O R T OF 100 MW SAMARKAND SOLAR POWER PLANT

No	Indicators	Unit of measurement	Value
1.	Area for the construction of solar plant (255 Hectares in Pastdogrom region, 150 Hectares in Nurobod region)	Hectares	405
2.	Installed power	MW	115
3.	Assembly equipment:		
3.1	photovoltaic modules	pcs	479 000
3.2	inverters (1 MW)	pcs	106
3.3	in-between transformers (1 MW)	pcs	106
3.4	power transformers (125 MW)	pcs	2
4.	Annual production	min cubic m.	159
5.	Create jobs	workers	49
6.	The saved natural gas	min cubic m.	50
7.	The saved natural gas in 30 years period	min cubic m.	1 220

CONSTRUCTION OF 100MW SOLAR PV POWER PLANT IN SAMARKAND REGION



- Power plant will consist of 106 blocks and produce 115 MW of power Inverters (1MW)-106 units;

- Transformers LW/MV – 106 units;
- Transformers MV/60MVA-2 units;
- Transformers MV/HV 125 MVA-2 unit.

The implementation of the project is to be done according to the decree of the President of the Republic of Uzbekistan dated 01.03.2013 # 4512 "On measures for further development of alternative energy sources"

According to the results of survey and analysis 404 ha was allocated to the construction of PV solar plant in Samarkand region, including 254 ha in Pastdargom district and 150 ha in Nurabad district consequently.

Expected results from the implemented project:

- Increase renewable energy generation and reduce the gas emissions in Uzbekistan
- Power generation -159GWh per year
- Job creation in the amount of - 50 units

PROJECT'S EXPECTED BENEFITS



**160
GWh**

**ANNUAL ELECTRICITY
PRODUCTION**



20K

**HOUSEHOLDS SUPPLIED
WITH CLEAN ENERGY**



**160
TONS**

**GREENHOUSE GAS EMISSION
REDUCTION PER ANNUM**



49

**NEW JOBS IN SAMARKAND
REGION**

SCALE UP SOLAR ENERGY IN UZBEKISTAN

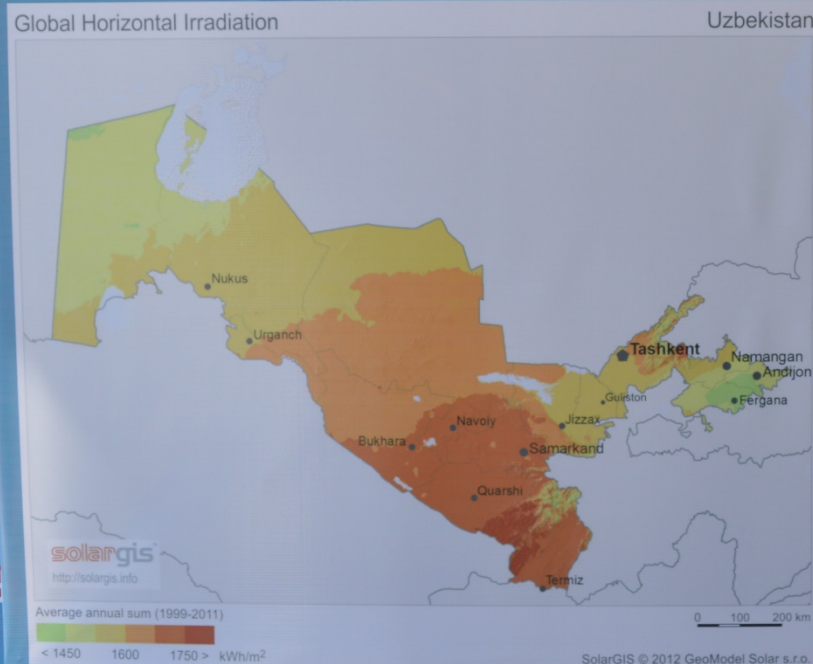
A) SOLAR ENERGY PROJECTS PIPELINE:

- 100 MW SHERABAD PV PLANT (ADB)
- 100 MW NAVOI PV PLANT (EBRD)
- 100 MW NAMANGAN PV PLANT (IFC)

B) SAMARKAND PV PLANT WILL
DEVELOP UZBEKENRGO'S CAPACITY
IN OPERATION AND MAINTENANCE OF
UTILITY-SCALE PV PLANTS



Uzbekistan has excellent solar resources



North-West(Nukus): 1500 kW-h/kW peak for fixed inclination, 1700-1800 kW-h/kW peak for one-axis tracking device

South(Karshi): 1570 kW-h/kW peak for fixed inclination, 1800-1970 kW-h/kW peak for one-axis tracking device

Solar resource is comparable with indicator in Zambia(look at the following example)

САМАР ҚУРИЛИШ

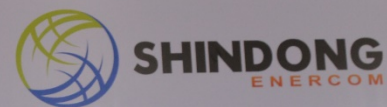
№	
1.	Молиявий тақлид тасдиқлаш ва тенд
2.	Осиё тараққиёт б олиш
3.	Контракт тузи ва контрактни имзо
4.	Контрактни ваколат
5.	Аванс тўловини ам
6.	Лойиҳалаш ва кур
7.	Ишга туширилиш
8.	Тажрибавий экспл

ҚУВВАТИ 100 МВт БЎЛГАН ҚУЁШ СТАНЦИЯСИ П А С П О Р Т И

№	Кўрсаткичлари	Ўлчов бирлиги	Қиймати
1.	Қуёш станциясини қуриш учун ажратилган ер майдони (Пастдарғом туманида 255 Га, Нуробод туманида 150 Га)	Га	405
2.	Ўрнатилган қувват	МВт	115
3.	Ўрнатиладиган ускуналар:		
3.1	фотоэлектр панеллари	дона	479 000
3.2	инверторлар (1 МВт)	дона	106
3.3	оралиқ трансформаторлар (1 МВт)	дона	106
3.4	қувват трансформаторлари (125 МВт)	дона	2
4.	Йиллик ишлаб чиқиш	млн.кВт.соат	159
5.	Ташкил қилинадиган ишчи ўринлари	ходим	49
6.	Иқтисод қилинадиган табиий газ	млн.куб.м	50
7.	Станциянинг 30 йиллик иш даври мобайнида табиий газ иқтисоди	млн.куб.м	1 220



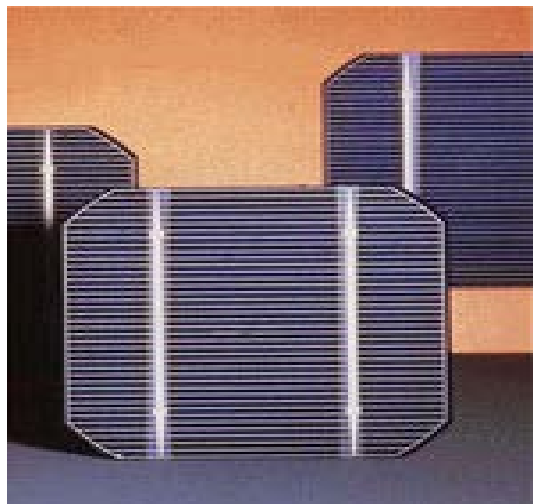
SAMARKAND 100MW SOLAR POWER CONSTRUCTION SITE



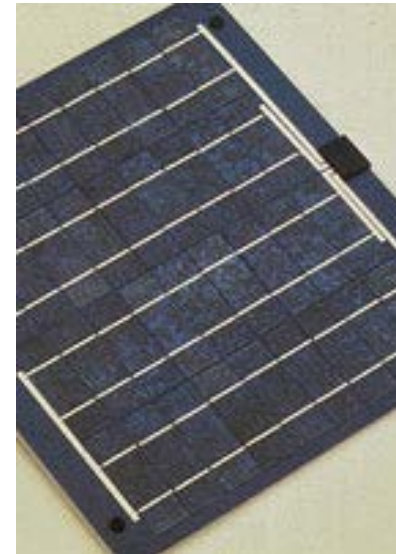
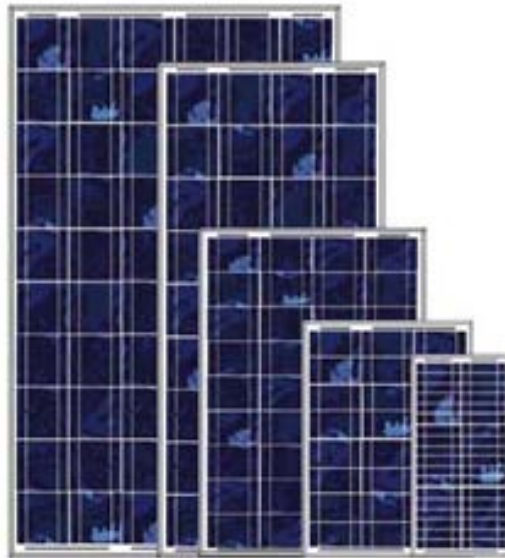
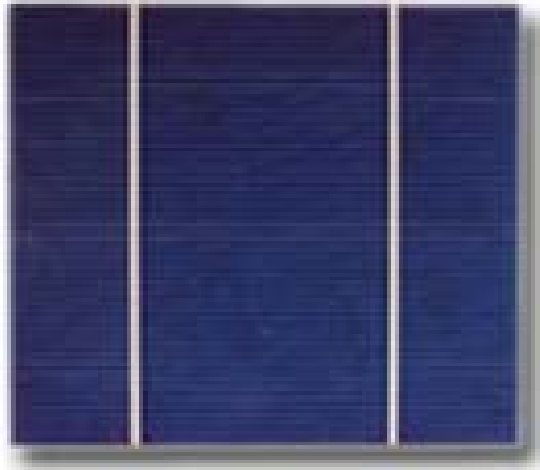
СТРОИТЕЛЬНАЯ ПЛОЩАДКА
САМАРКАНДСКОЙ
100 МВт СОЛНЕЧНОЙ ЭЛЕКТРОСТАНЦИИ



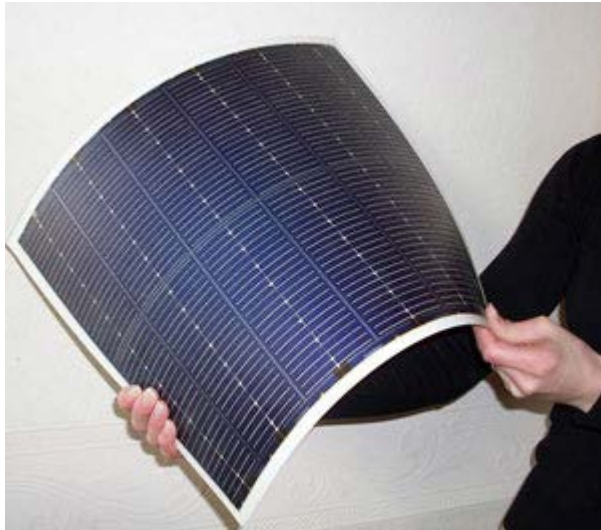
Solar cells based on monocrystalline silicon



Solar modules based on polycrystalline silicon



Solar modules based on amorphous silicon





Lecture 3 to read

- Energy and Climate. Chapter 1 *Energy and Sustainable Development*. pp 11-22. (<http://www.aralsjon.nu/en/sdss-course-2023/uzwater-compendia>)
- Energy and Climate. Chapter 2 *How much energy do we use – energy statistics*. pp 23-34. (<http://www.aralsjon.nu/en/sdss-course-2023/uzwater-compendia>)
- Renewable Energy Policy Network for the 21st Century (REN21). *Renewables 2023 Global Status Report. Executive summary*. (<https://www.iea.org/reports/renewables-2023/executive-summary>) (7 pages)