Energy in Uzbekistan: Natural and Renewable Resources and Their Use

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Outline

- **Definition of Energy**
- **Energy consumption**
- **World Renewable Energy Resources**
- **Renewable energy resources in Uzbekistan**
- **Methods of converting solar radiation energy**
- **Energy-saving technology strategy in Uzbekistan**
- **Case study**

What is the definition of energy?

Scientists define energy as the ability to do work. Modern civilization is possible because people have learned how to change energy from one form to another and then use it to do work.

What is the source of energy for humans?

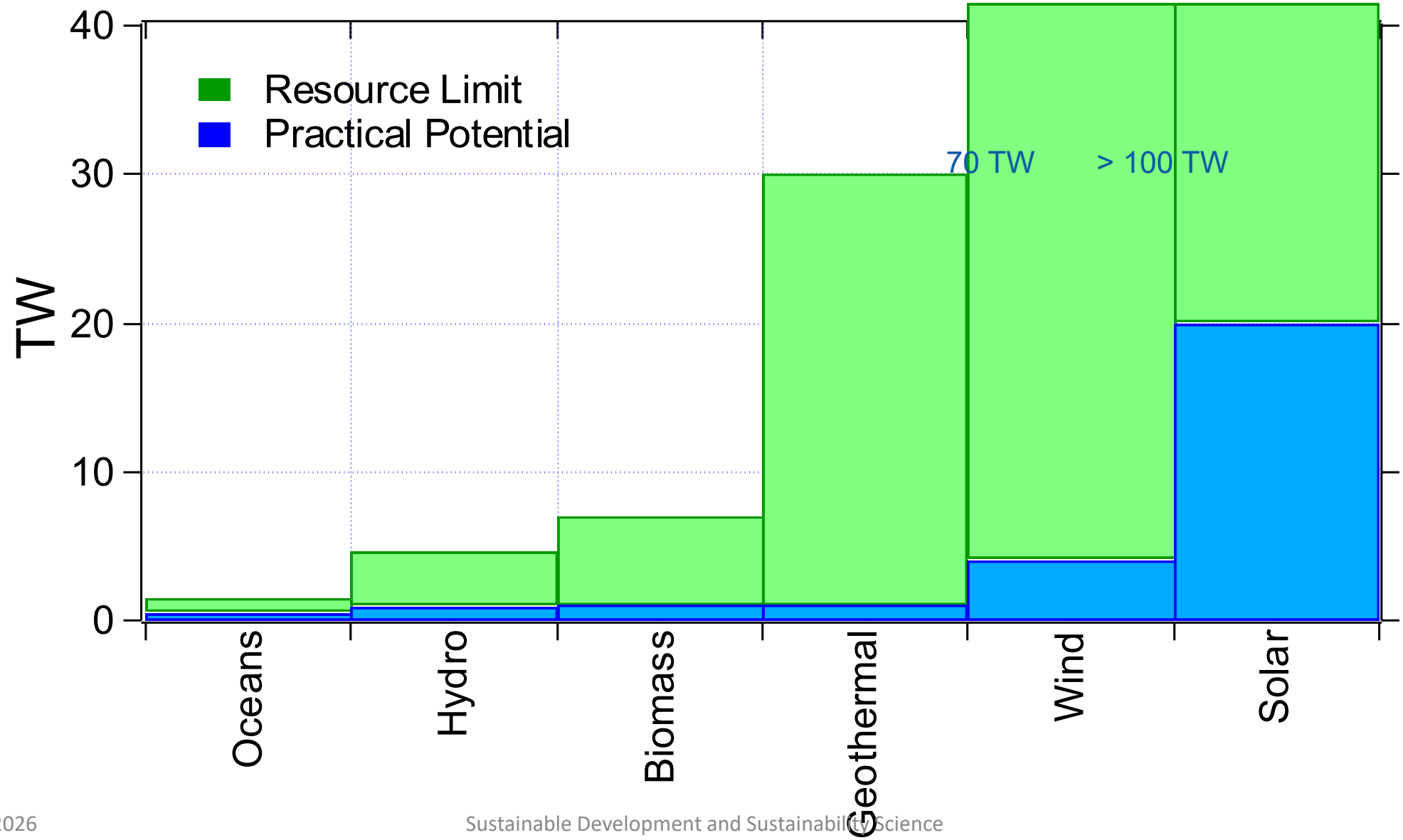
The main source of energy for humans is carbohydrates.

The amount of energy consumed by a person depends on the level of development

Development Stage	Per Capita Energy Consumption (kWh/day)
Primitive society	2.4
Hunter-gatherer society	10
Agricultural society	25-50
Industrial society	50-100
Present day	250

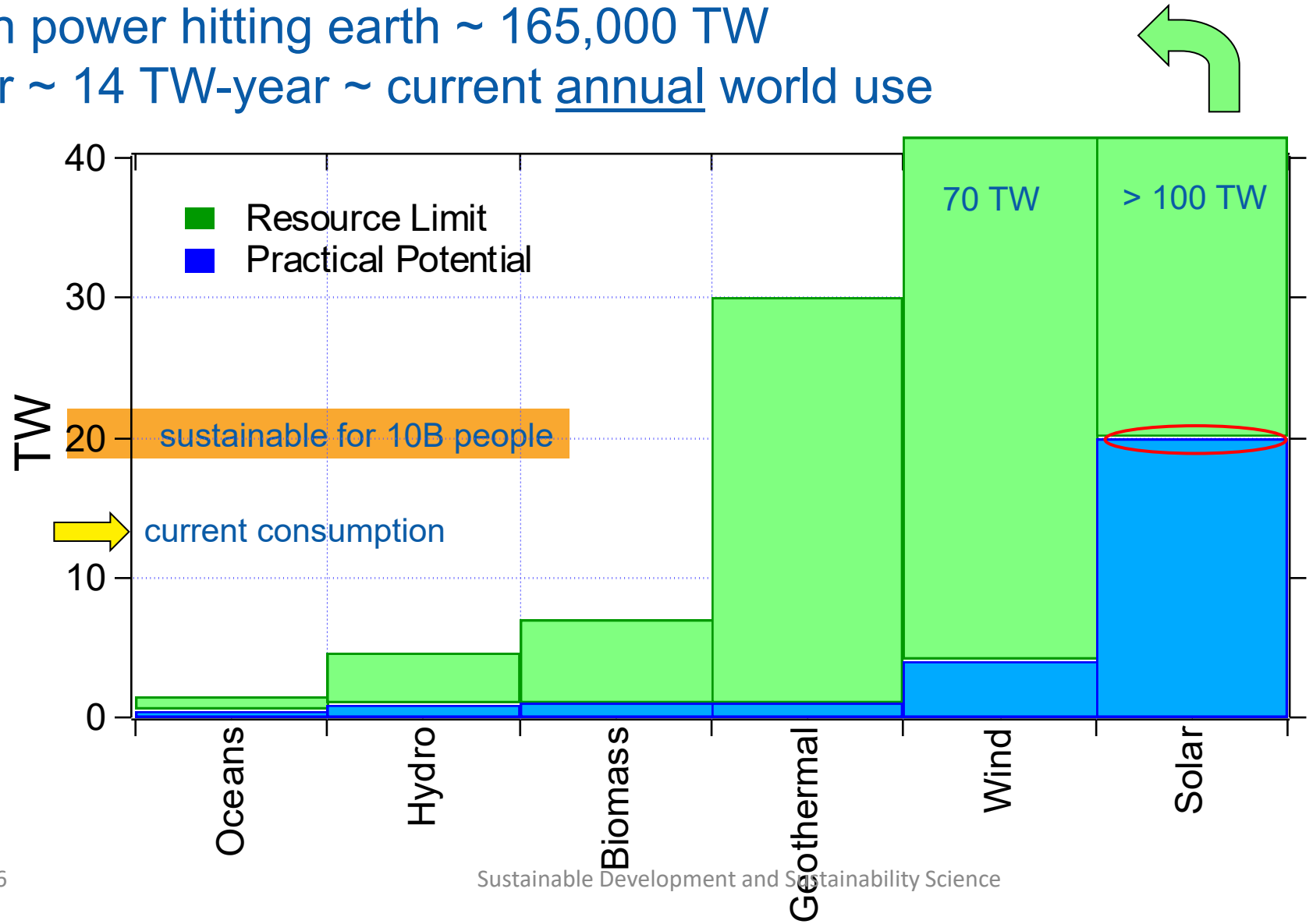
Energy is the basis of the existence of all living organisms. No living thing can do anything without energy, and no society can take a step without energy. The concepts of development and energy usually go hand in hand and cannot be imagined apart from each other.

World Renewable Energy Resources



The Sun is THE BIG Energy Player

Sun power hitting earth ~ 165,000 TW
1 hr ~ 14 TW-year ~ current annual world use



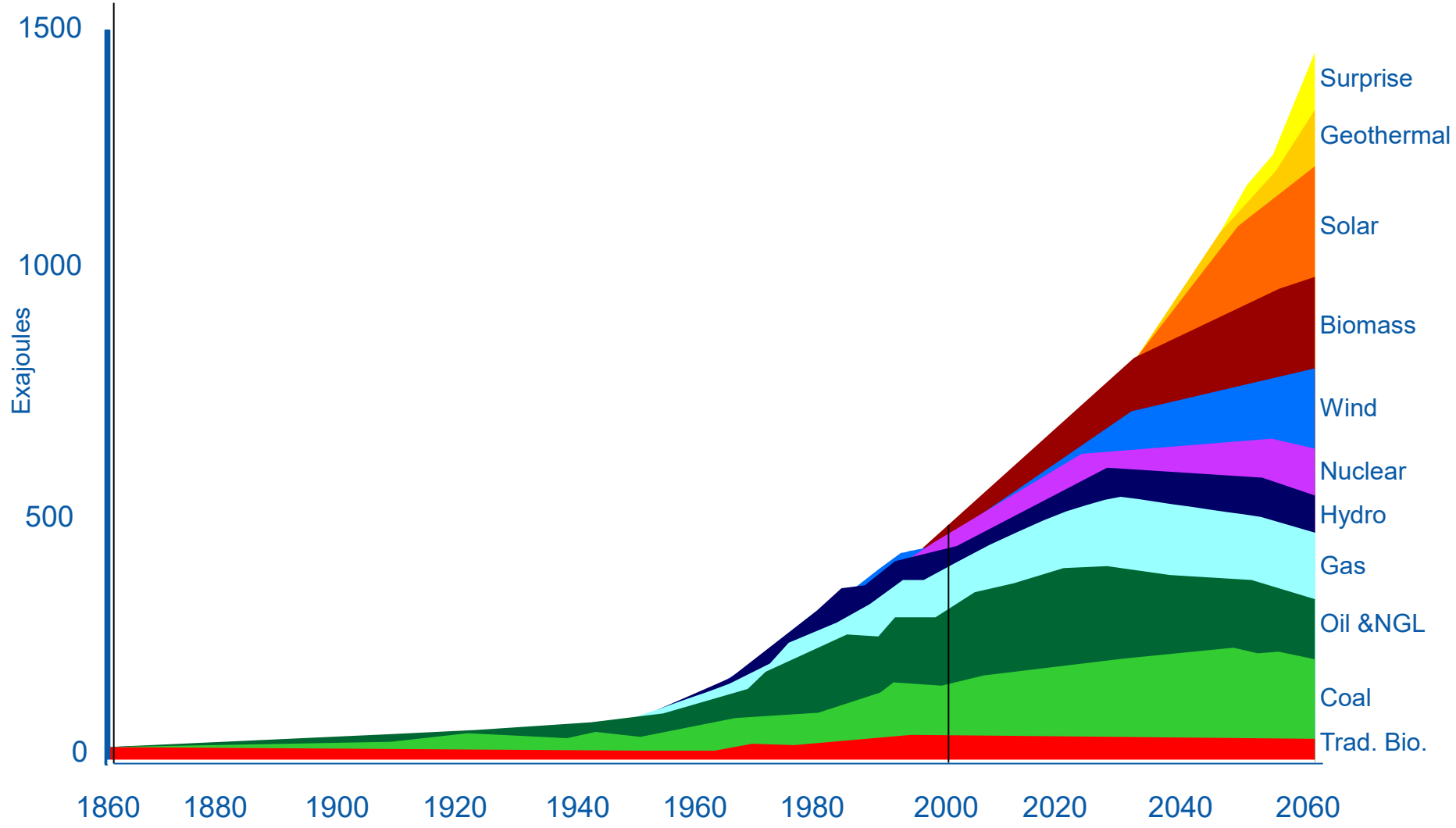
Renewable energy resources in Uzbekistan

№	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

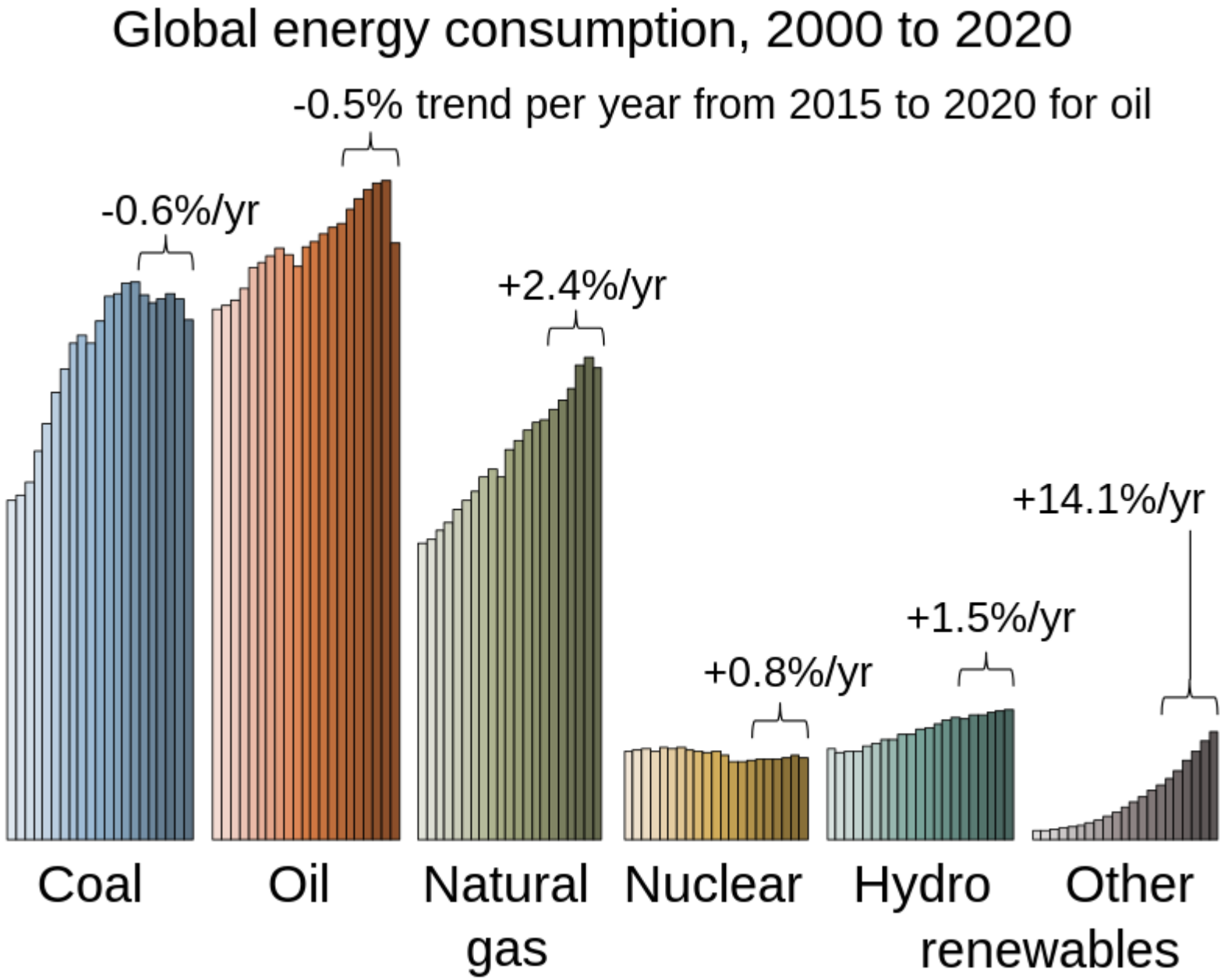
- Energy is the basis of the existence of all living organisms. No living thing can do anything without energy, and no society can take a step without energy. The concepts of development and energy usually go hand in hand and cannot be imagined apart from each other.

- According to the Asian and World Bank estimates, the gross potential of solar energy in the Republic of Uzbekistan exceeds 51 billion tons of oil equivalent, which is 99.7% of all RES studied so far in the country. Due to these resources, it is possible to produce an amount of electricity that is 40 times higher than its annual consumption.

Shell Sustained Growth Scenario



Source: *Shell, The Evolution of the World's Energy Systems*, 1995



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

In 2002 Uzbekistan has 40 Hydro and Thermal power stations. They generated 55,1 million kW electrical energy per year.

86 % - Of them generated in Thermal Power Station and

13 % - Hydro electrical Power Station

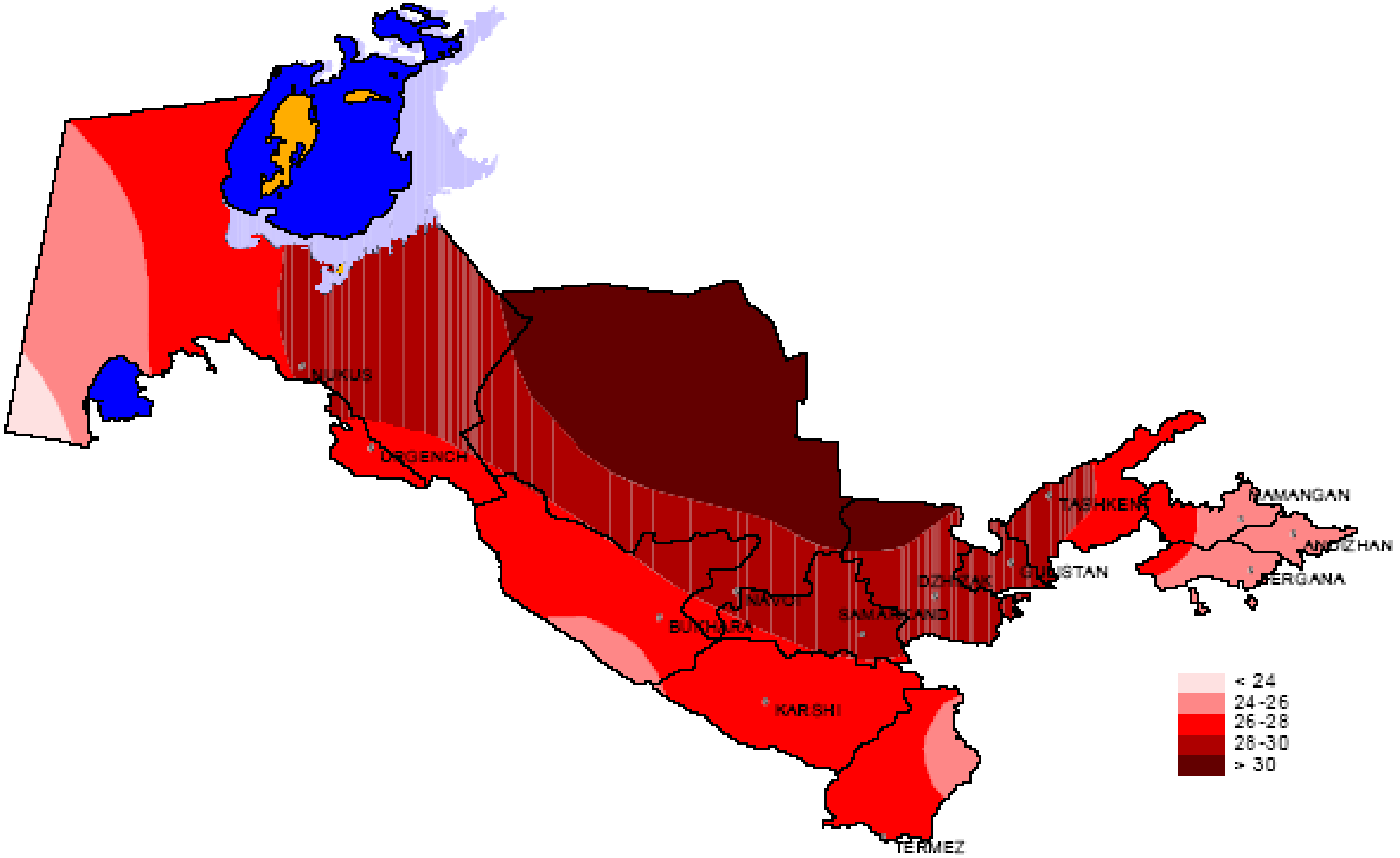
1% - **Renewable energy resources**

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

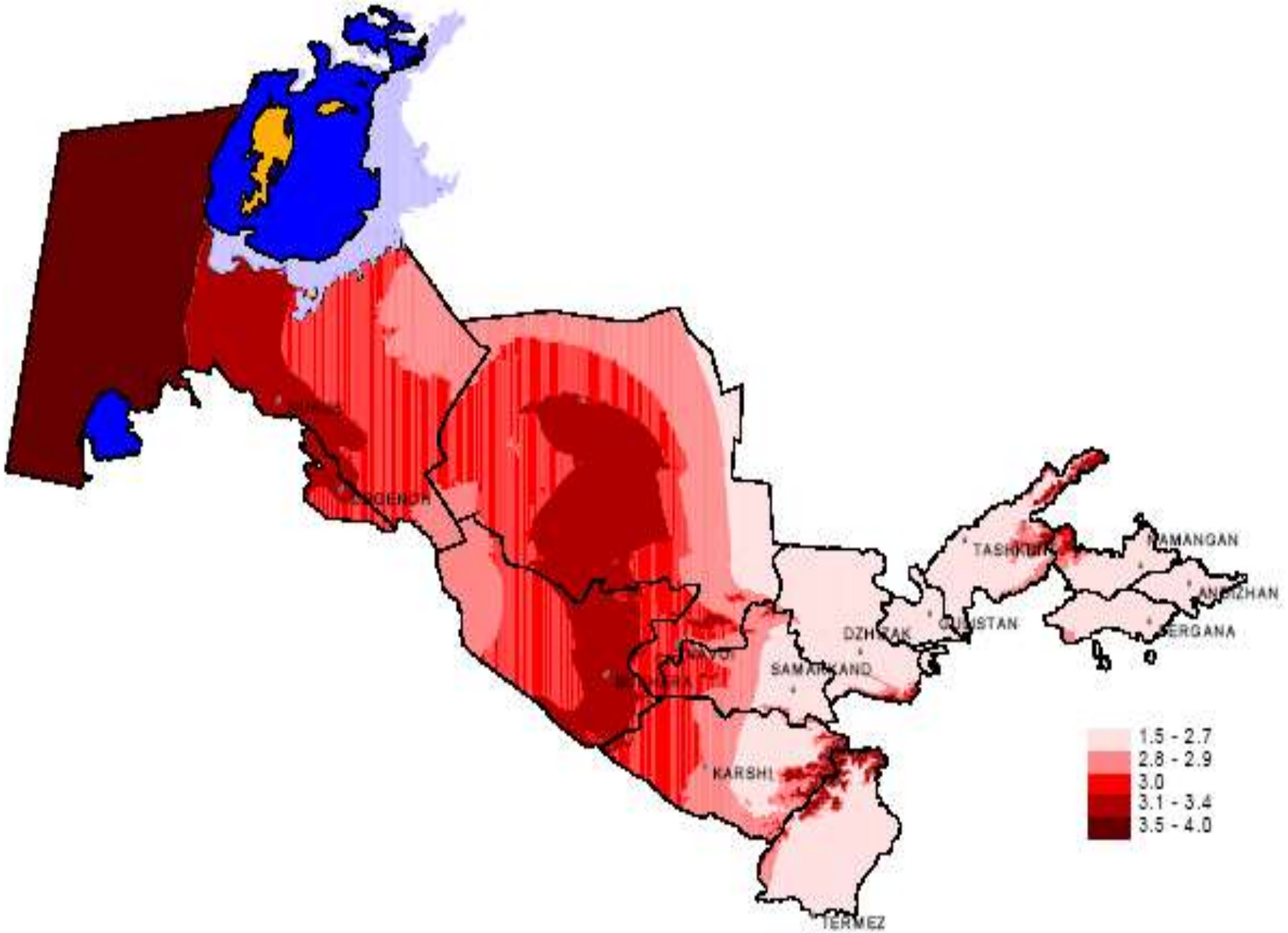
If we use 1 % of them it's 7000 time more than we need

The main part of electrical energy in our Republic is produced in thermal power stations operating on the basis of natural gas. In 2025 year in our country, 86.7 billion kW·h of electrical energy was produced, of which 16.8 billion kW·h falls on renewable energy sources. The amount of electrical energy produced by solar and wind power stations increased 2.1 times within the last one year. At present, in Uzbekistan, 148 power stations with total capacity of 25,797 MW are operating. Of the total capacity, 17,551 MW thermal power stations (68%), 2441 MW hydroelectric stations (9.46%), 3930 MW solar photovoltaic stations (15.23), 1652 MW wind power stations (6.4%), and 223 MW block-stations belonging to separate legal entities or entrepreneurs (0.86%) fall to their share. In the country in 2025 year, 42 new energy projects with total capacity of 4647 MW were implemented, of which 5 are solar power stations with capacity 1413 MW, 4 are wind power stations with capacity 752 MW, 10 battery systems with capacity 1245 MW, 1 thermal power station with capacity 1065 MW, 5 hydroelectric stations with capacity 168 MW, and 2 cogeneration objects with capacity 102 MW, 11 substations with total capacity 1614 MVA (megavolt-ampere), and electrical network with length 420 km were commissioned. Besides this, start was given to 21 new projects with total capacity 3508 MW, including solar, wind power stations, accumulators and cogeneration objects, as well as substations (electrical devices that receive electrical energy, transform it again (increase or decrease voltage) and redistribute it), receiving electrical and gas networks.

Years	Total Energy Production (billion kW·h)	Thermal, %	Hydro, %	Solar, %	Wind, %
2002	55,1	86	13	0,9	0,1
2025	86,7	68	9,46	15,24	6,4
2030	125	60	16	16	8



Daily amounts of direct solar radiation (MJ/m^2) in Uzbekistan



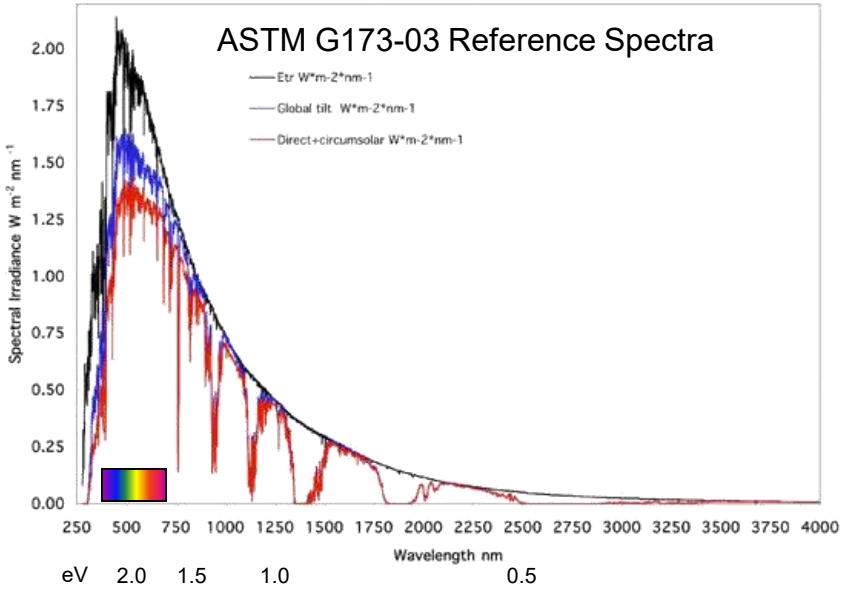
Average annul wind velocity (m/sec) in Uzbekistan

According to the method of converting solar radiation energy into electrical energy, solar cells can be divided into four types: **diode, photoelectrochemical, exciton and thermophotovoltaic.**

Diode-type solar cells are based on a wide range of materials: semiconductors (Si, Ge), multicomponent semiconductor compounds A_3B_5 and A_2B_6, and organic materials whose photoelectric effect is similar to that of semiconductors. In this type of solar cell, the separation of charges generated by external illumination occurs at the interface between two semiconductor with p- and n-type conductivity.

Why So Many PV Technologies?

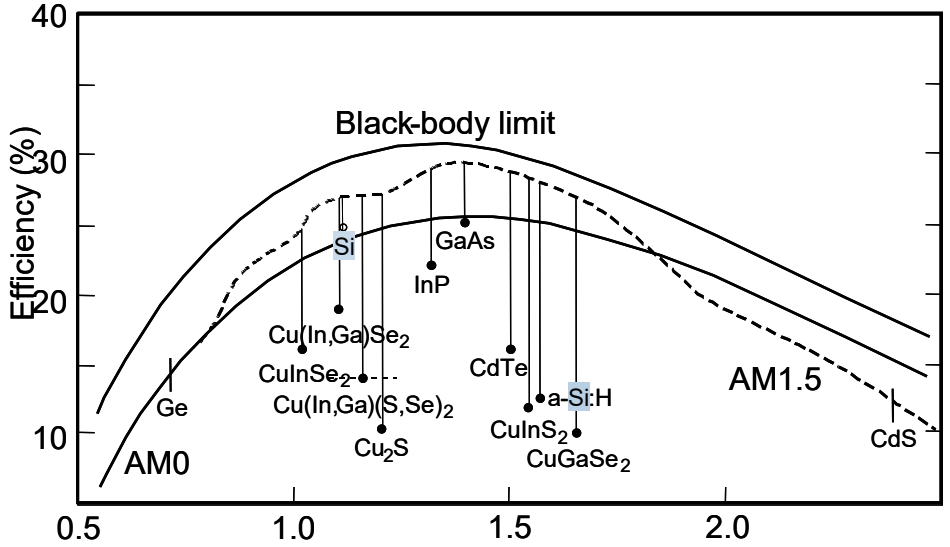
Part of the reason is the sun doesn't shine at one wavelength.



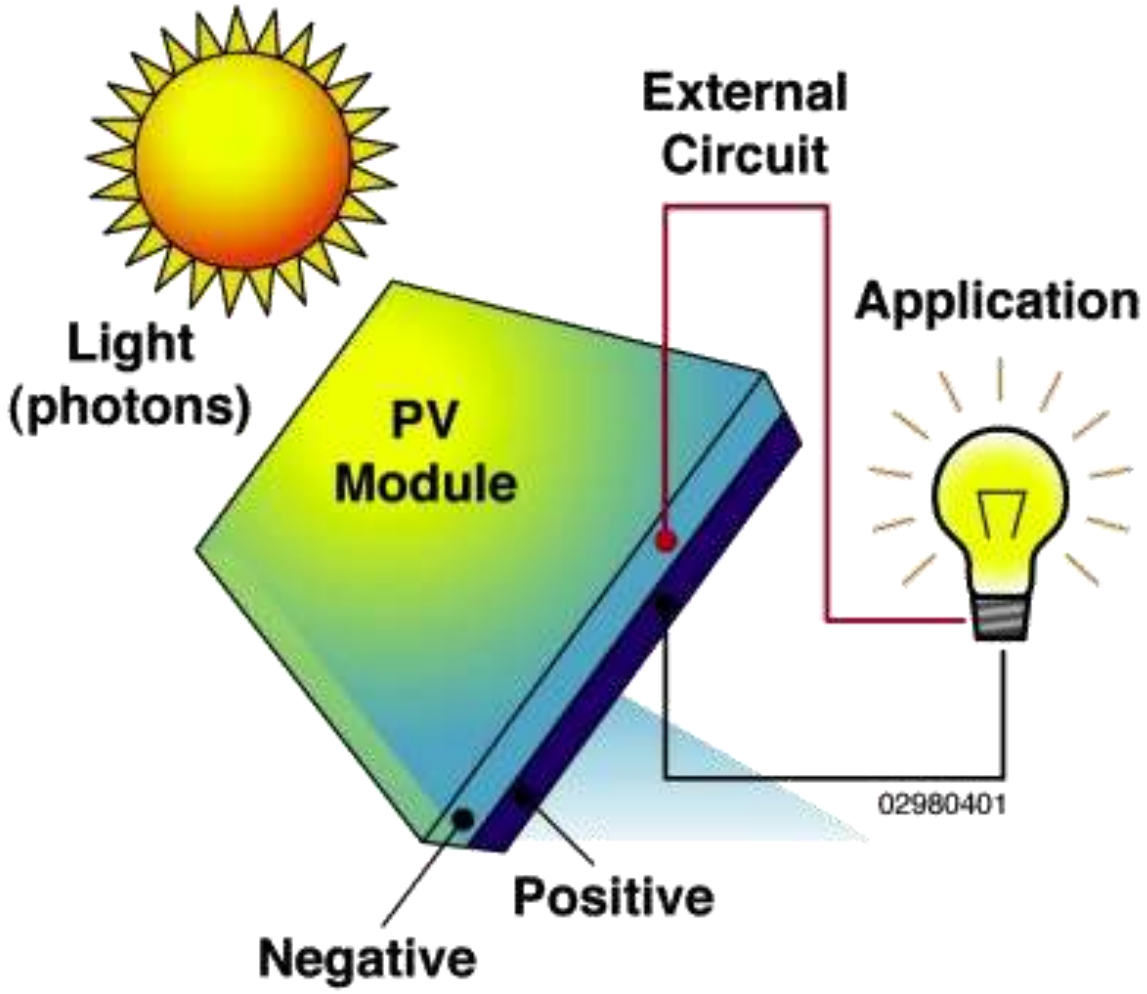
Also….

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

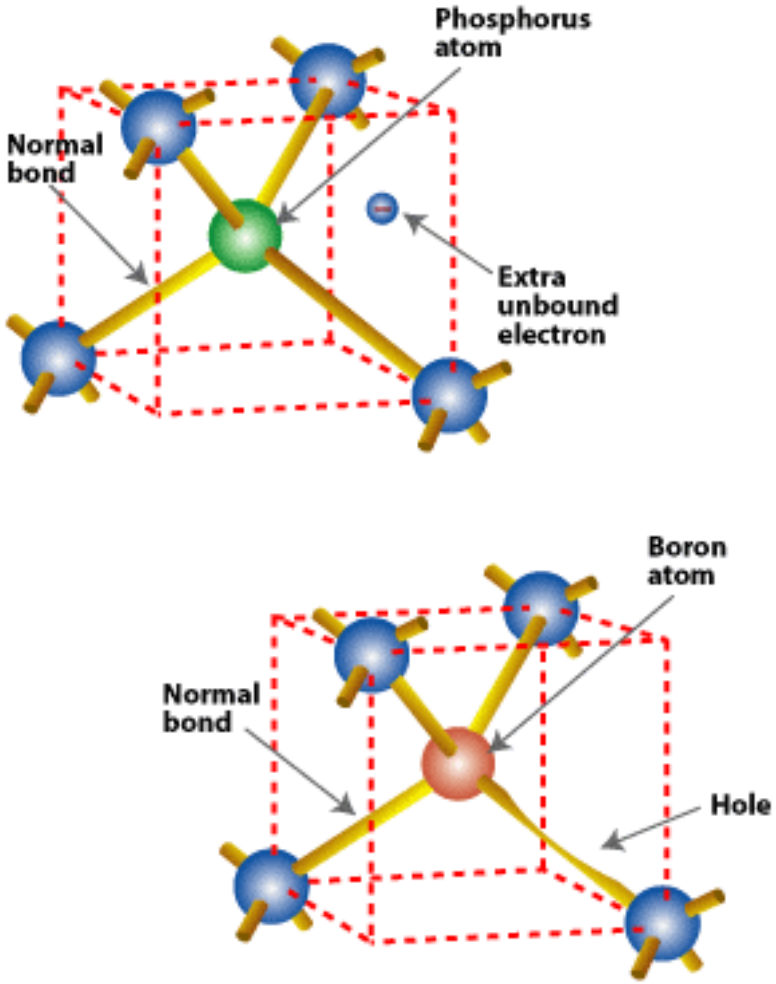
Different materials are used to capture various portions of the solar spectra.

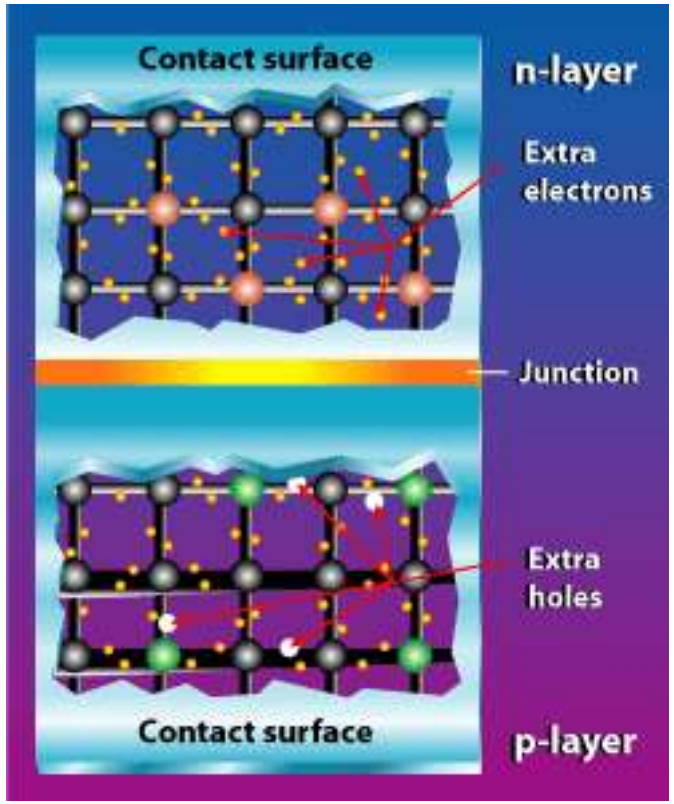


Photovoltiacs Basics

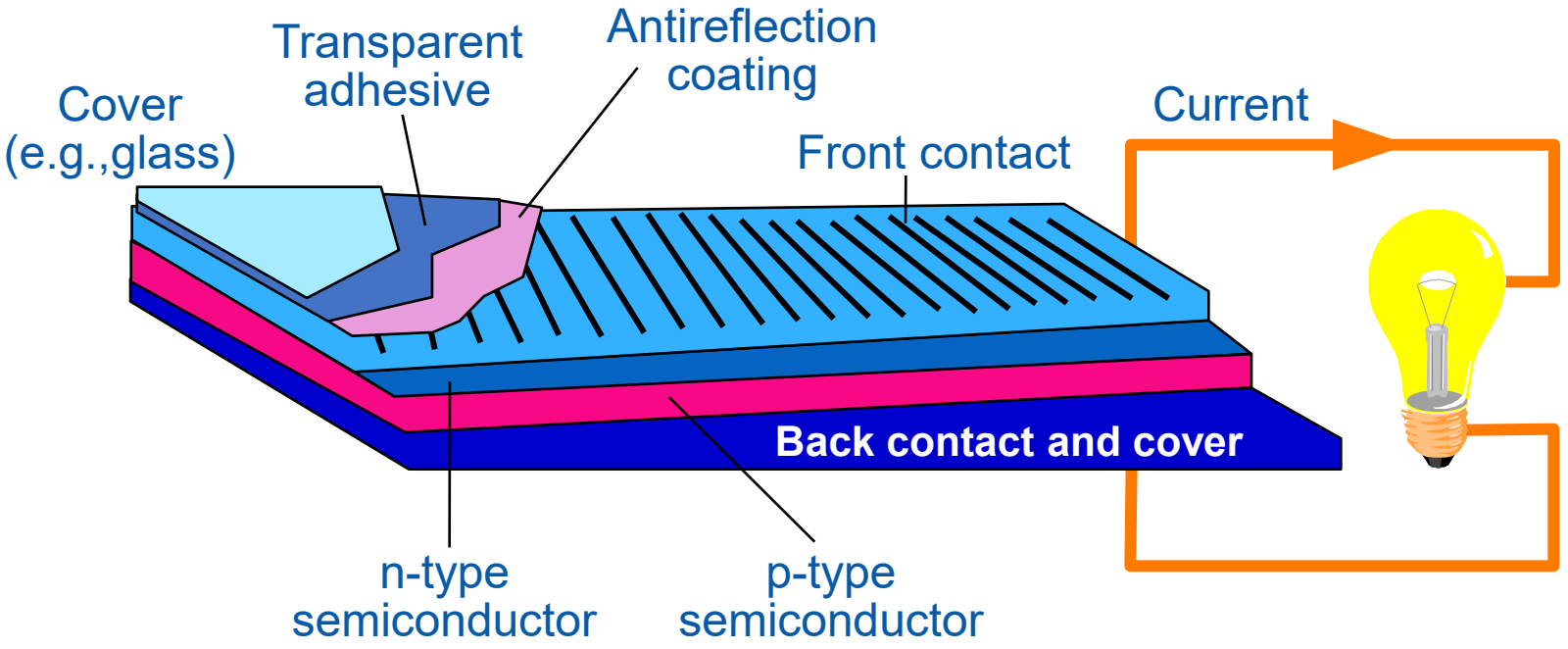


Making Semiconductors n or p tipe





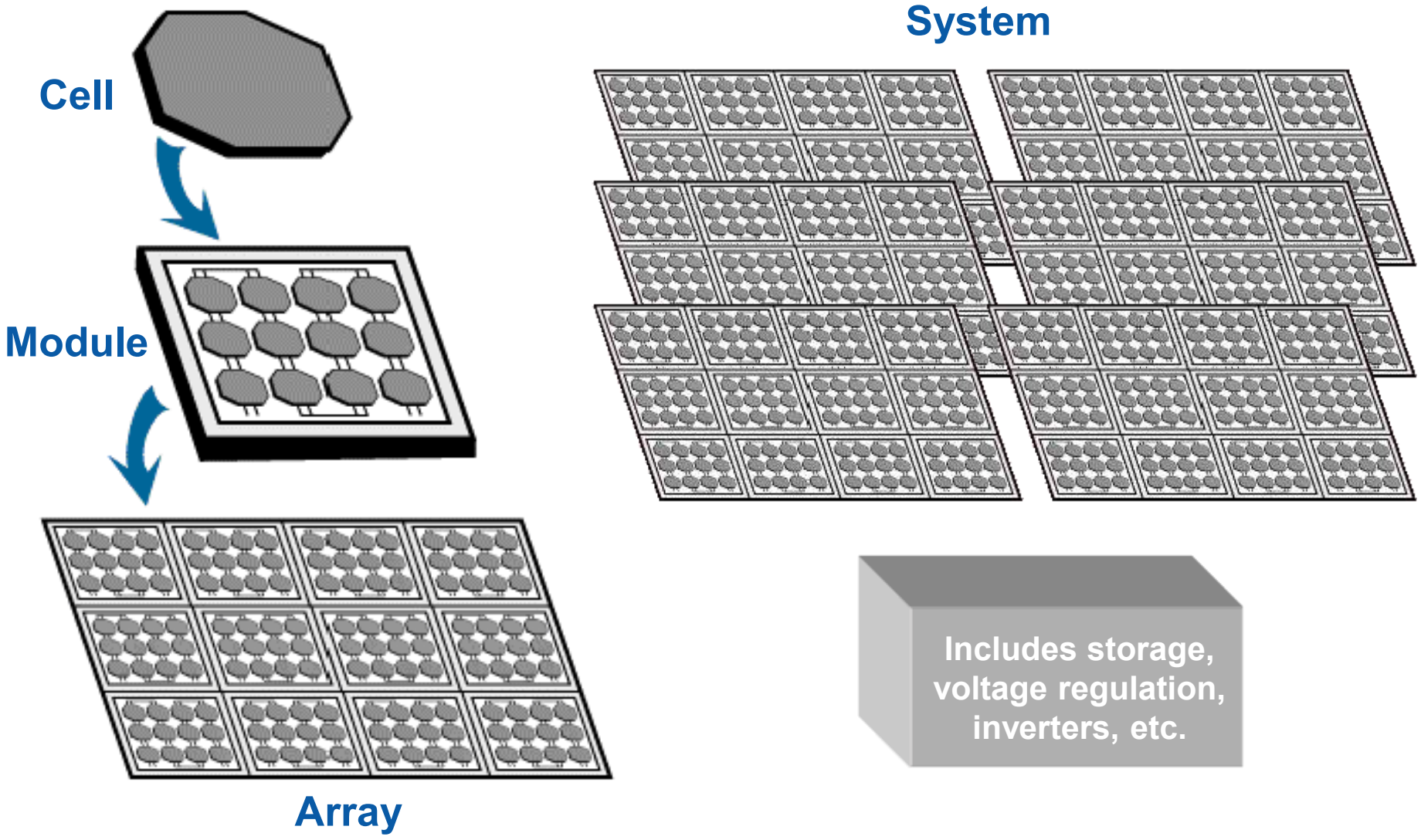
Photovoltaic Cell Structure



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

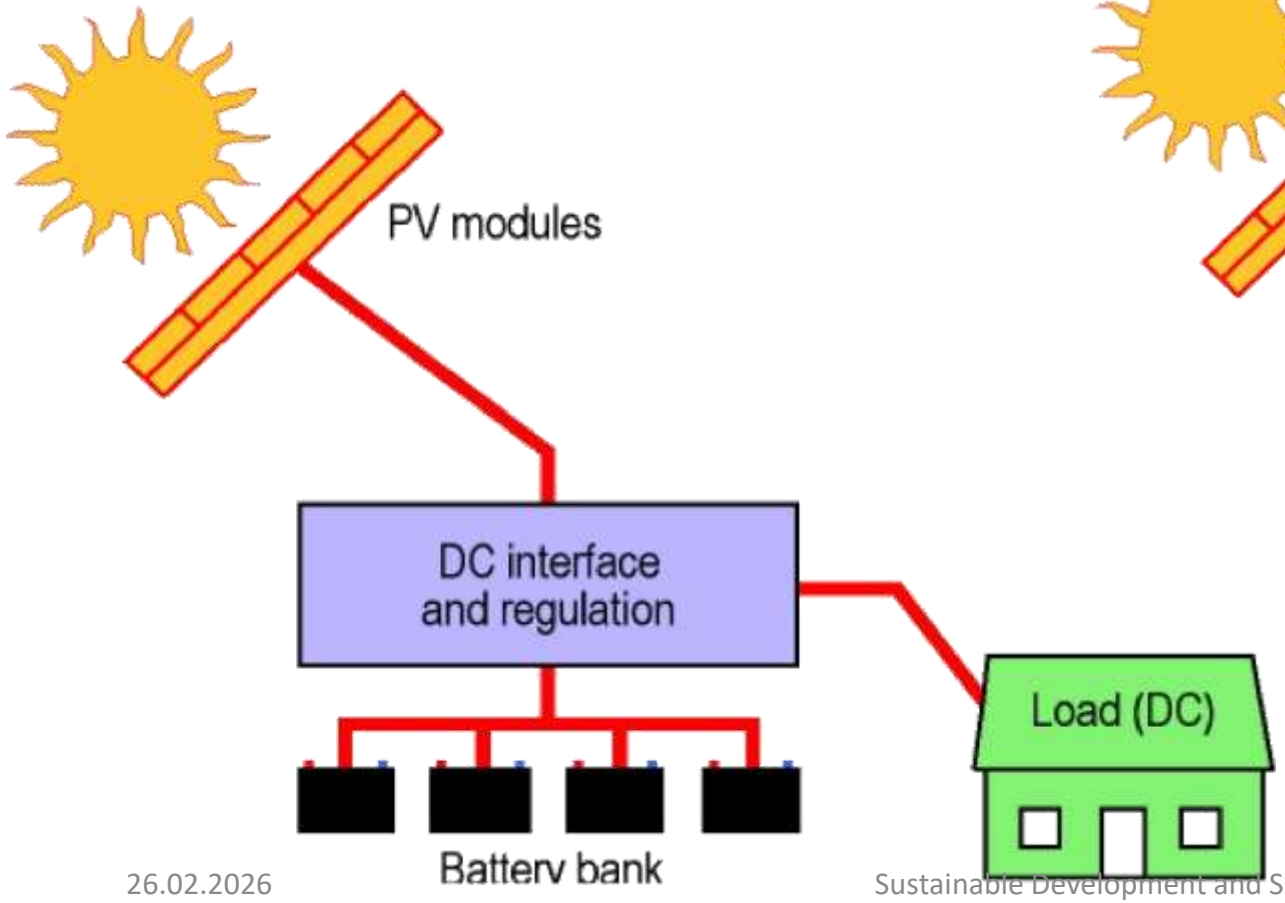
10% efficiency = 100 W/m^2 or 10 W/ft^2

Photovoltaic Building Blocks

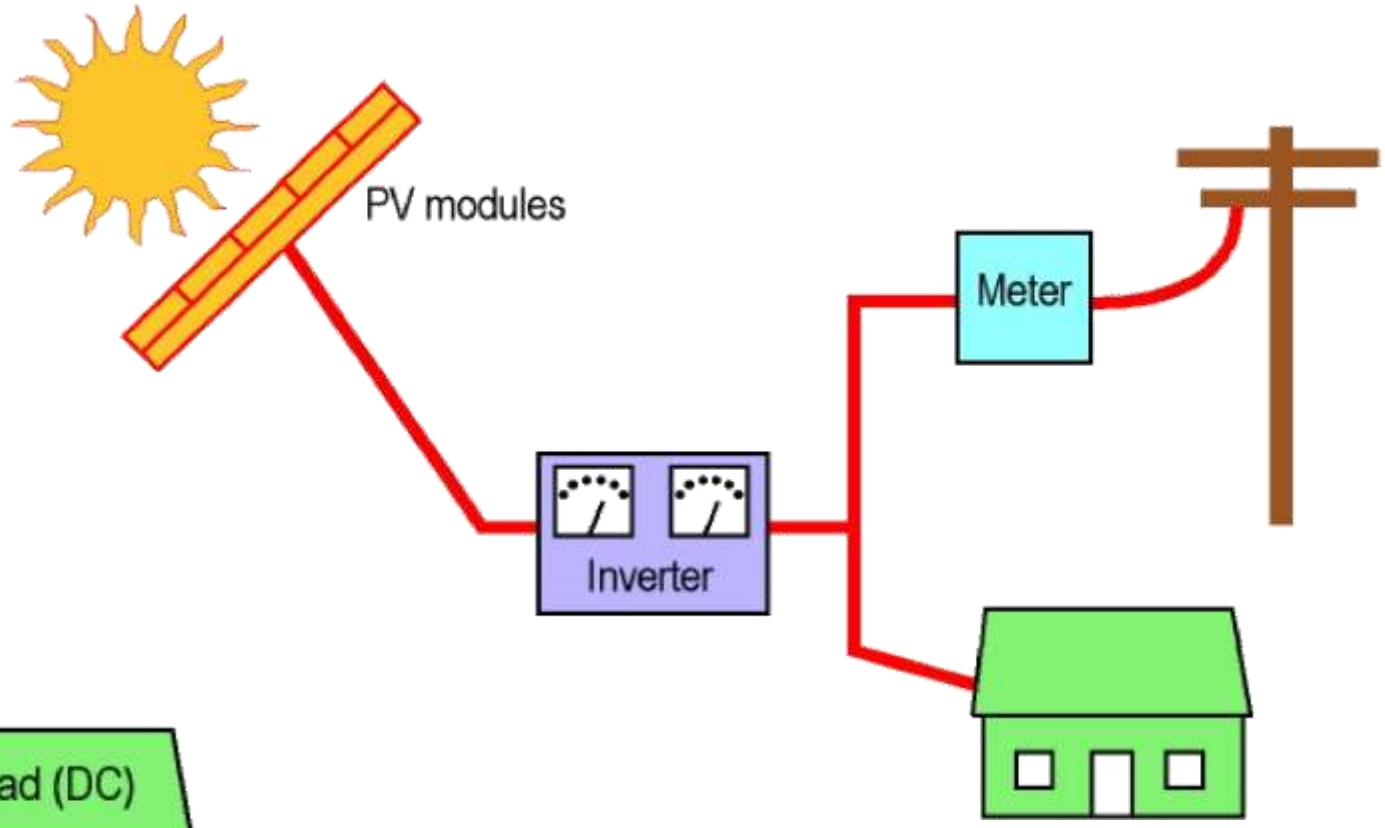


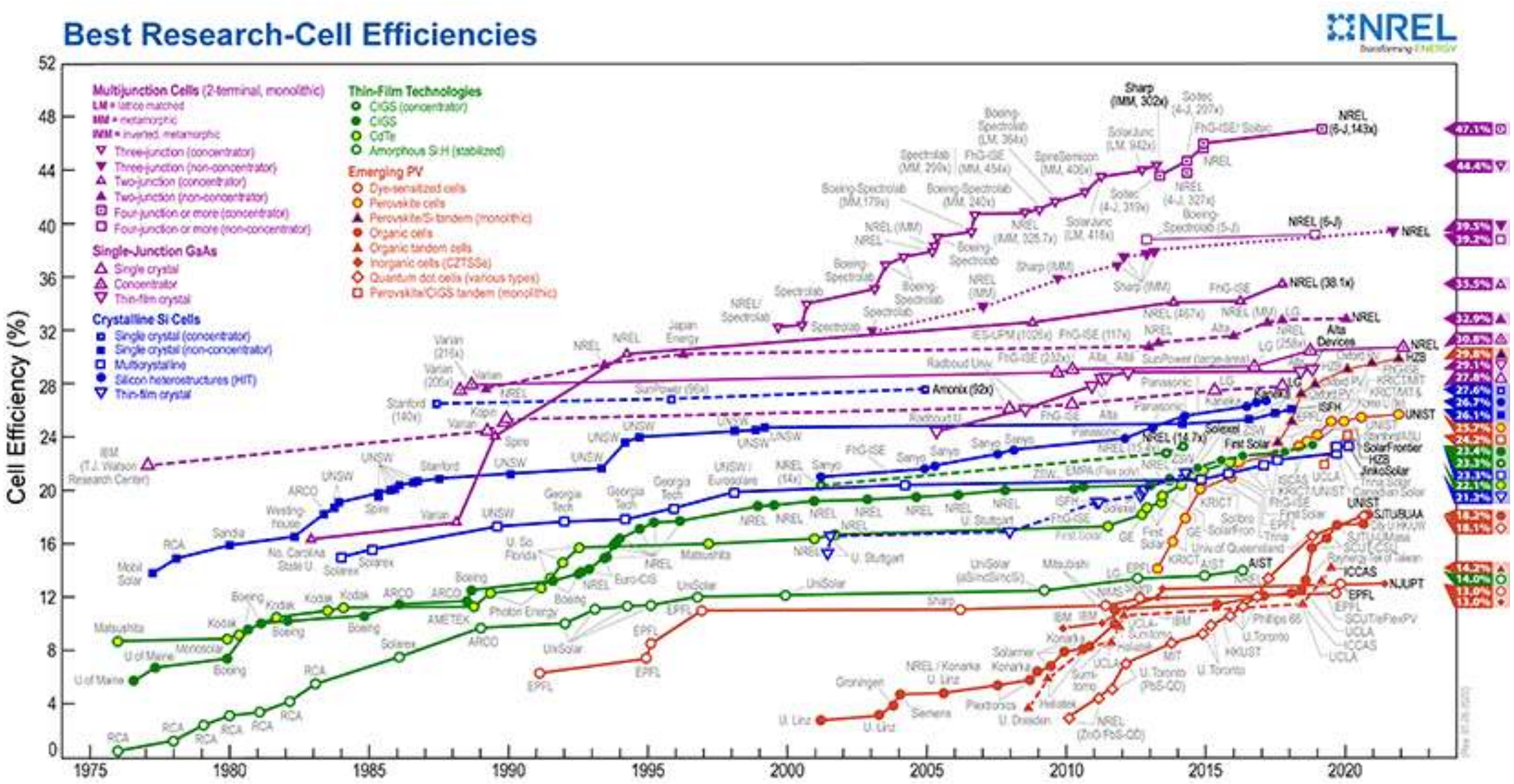
Photovoltaic System Types

DC System



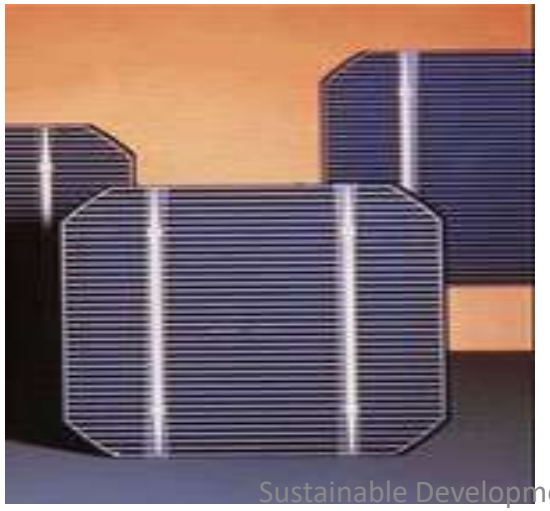
Grid Connected System
(Line Tie or Utility Interface)





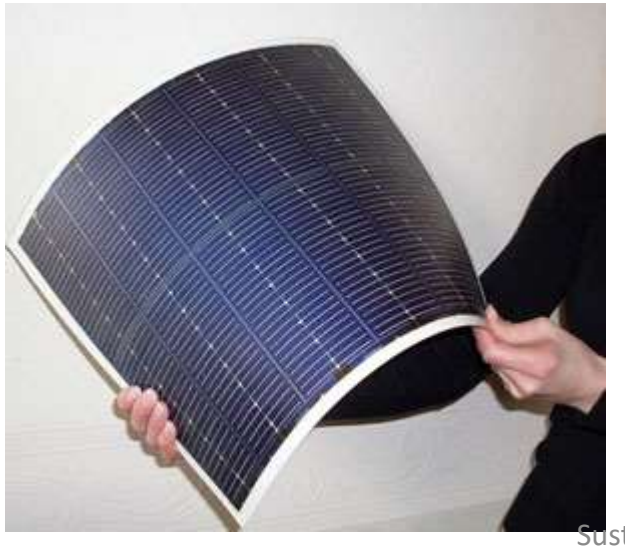
Source: https://www.nrel.gov/pv/cell-efficiency.html

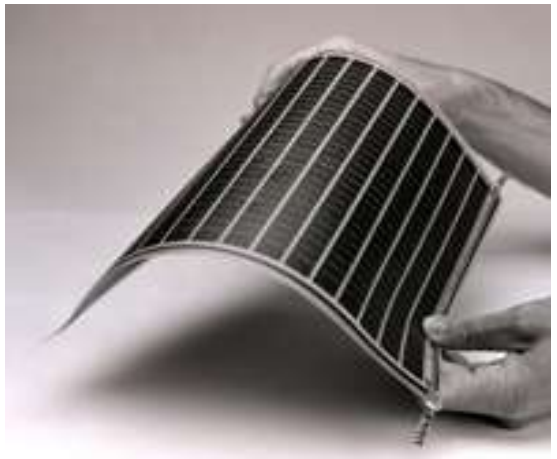
Monocrystal Silicon Solar modules



Polycrystal **Silicon Solar modules**

Amorphous Silicon Solar modules





Renewable energy projects in Uzbekistan

Project Name	Type	Capacity (MW)	Investment ($M)	Investor	Completion Year
Nur Navoi Solar Plant	Solar	100	100	Masdar (UAE)	2021
Karakalpakstan Wind Park	Wind	500	500	ACWA Power (Saudi Arabia)	2024
Tashkent Solar PV	Solar	150	150	Total Eren (France)	2023
Bukhara Wind Farm	Wind	200	250	Siemens Gamesa (Germany)	2025

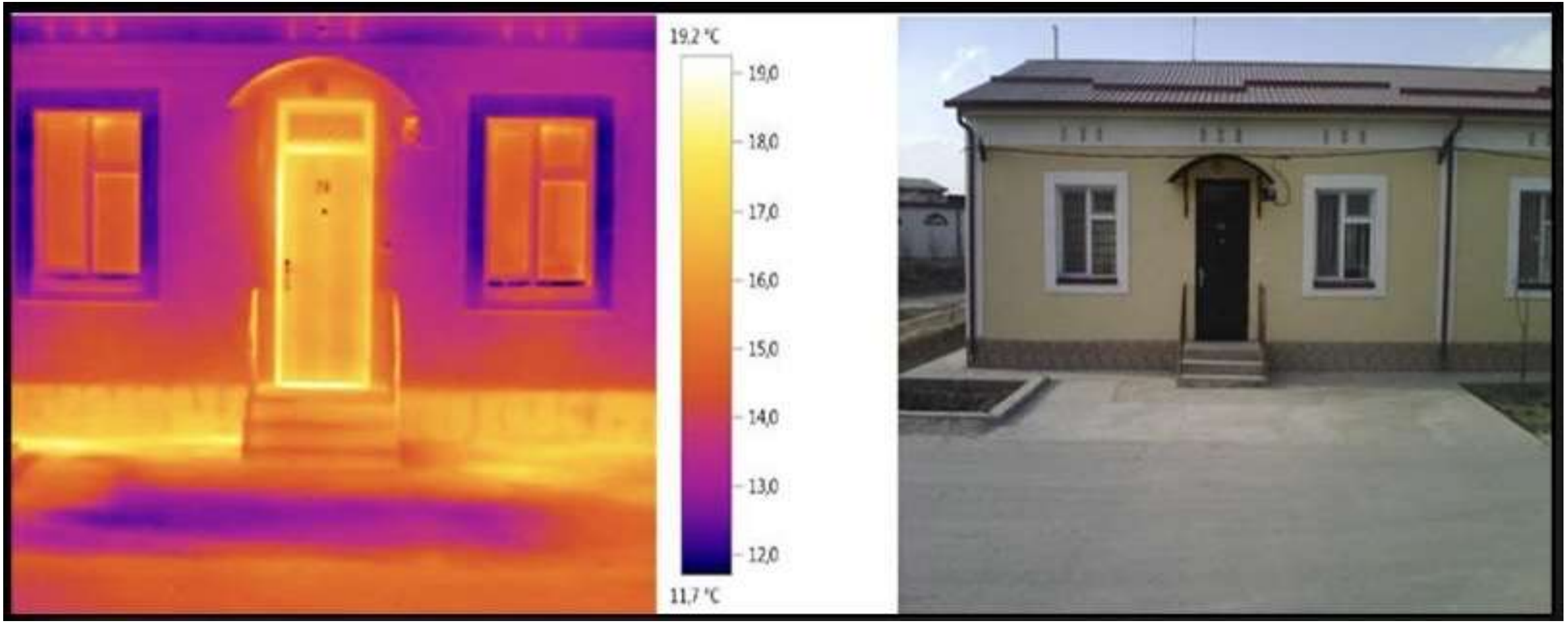
Prospects for the development of renewable energy sources in Uzbekistan

Project Name	Type	Capacity (MW)	Investment ($M)	Completion Year
Samarkand Solar Plant	Солнечная	300	250	2025
Fergana Wind Farm	Ветровая	350	400	2025
Jizzakh Solar PV	Солнечная	150	120	2024
Andijan Biogas Plant	Биогаз	50	75	2024

A nearly zero-energy home in the Tashkent region

A solar-paneled house in Bukhara, October 2022

Thermal imaging survey of buildings (energy audit process)



Wall cladding with basalt


50 YEARS
ADB
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

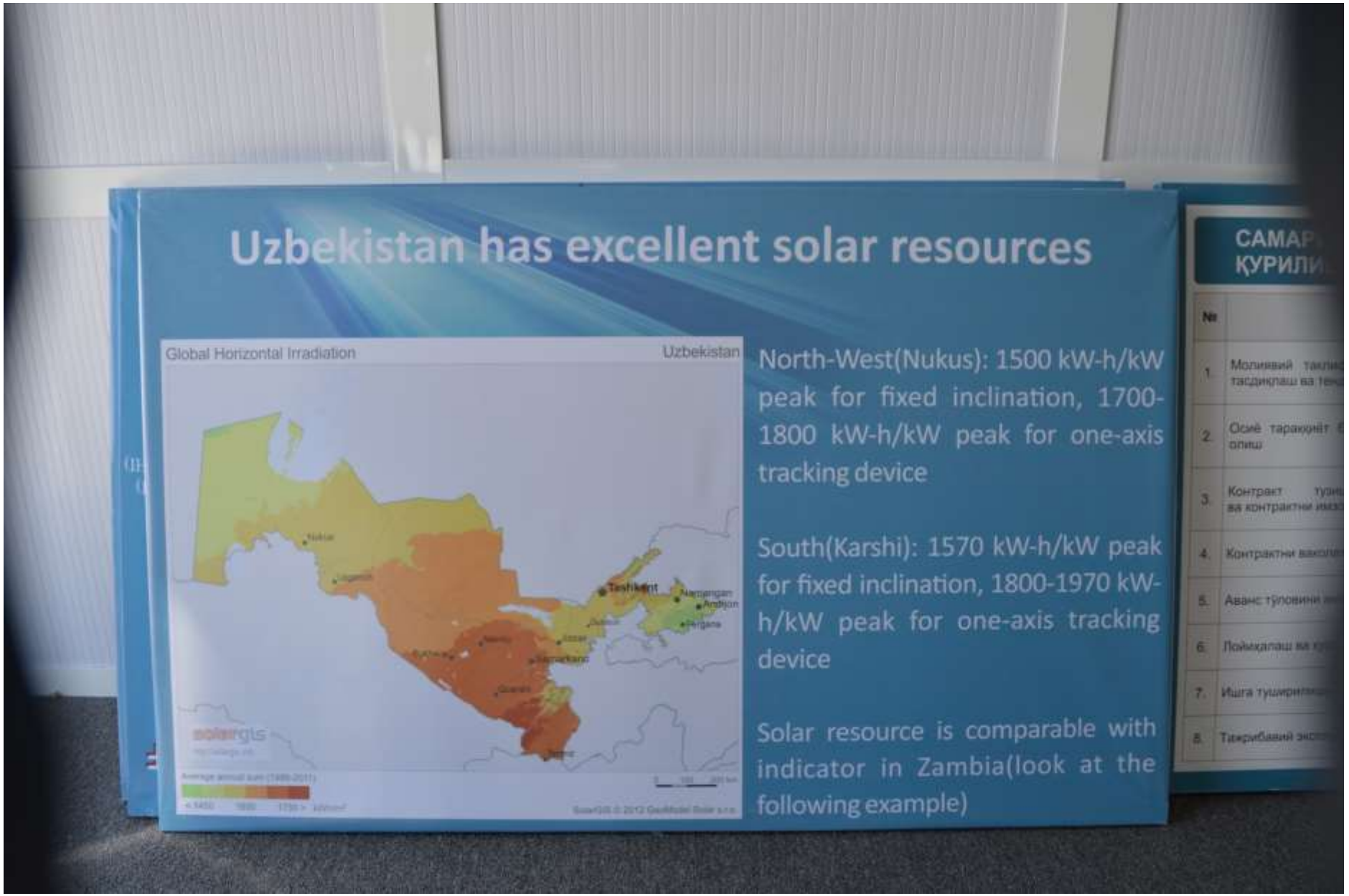

SAMARQAND F.S.


SAMARQAND F.S.


PASSPORT
OF 100 MW SAMARKAND SOLAR POWER PLANT
№
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 mln cubic m. 159
5. Create jobs workers 49
6. The saved natural gas mln cubic m. 50
7. The saved natural gas in 30 years period mln 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
Global Horizontal Irradiation
Uzbekistan
Tashkent
Namangan
Andijan
Fergana
Samarkand
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)


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 179 000
3.2 инверторлар (1 МВт) 106
3.3 оралиқ трансформаторлар (1 МВт) 106
3.4 қувват трансформаторлари (125 МВт) 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
UZBEKENERGO
興業太陽能
SINGYES SOLAR
SHINDONG
ENERCOM
СТРОИТЕЛЬНАЯ ПЛОЩАДКА
САМАРКАНДСКОЙ
100 МВт СОЛНЕЧНОЙ ЭЛЕКТРОСТАНЦИИ


СОЛНЕЧНАЯ ФОТОЭЛЕКТРИЧЕСКАЯ СТАНЦИЯ МОЩНОСТЬЮ 100 МВт В САМАРКАНДСКОЙ ОБЛАСТИ

Case study

How much electricity could be generated in a year if a large Uzbek tract (Andijan-Nukus) were covered with solar panels? How many toxic gases would be avoided in the atmosphere if this were done?

Lecture 3 to read

- Energy and Climate. Chapter 1 *Energy and Sustainable Development*. pp 11-22.

- Energy and Climate. Chapter 2 *How much energy do we use – energy statistics*. pp 23-34.

- Renewable Energy Policy Network for the 21st Century (REN21). *Renewables 2020 Global Status Report. Executive summary* pp. 15-26 (*reference literature*).