

Learn the basics of solar energy technology including solar radiation, photovoltaics (PV), concentrating solar-thermal power (CSP), grid integration, and soft costs.

Solar energy can be harnessed two primary ways: photovoltaics (PVs) are semiconductors that generate electricity directly from sunlight, while solar thermal technologies use sunlight to heat water for ...

It consists of an arrangement of several components, including solar panels to absorb and convert sunlight into electricity, a solar inverter to convert the output from direct to alternating current, as well ...

At a high level, solar panels are made up of solar cells, which absorb sunlight. They use this sunlight to create direct current (DC) electricity through a process called "the photovoltaic effect."

Overview Components Modern system Other systems Costs and economy Regulation Limitations Grid-connected photovoltaic system A photovoltaic system for residential, commercial, or industrial energy supply consists of the solar array and a number of components often summarized as the balance of system (BOS). This term is synonymous with "Balance of plant"; q.v. BOS-components include power-conditioning equipment and structures for mounting, typically one or more DC to AC power converters, also known as inverters, an energy storage device, ...

Solar photovoltaic (PV) uses electronic devices, also called solar cells, to convert sunlight directly into electricity. It is one of the fastest-growing renewable energy technologies and is playing an ...

Electricity-generating capacity for PV panels increases with the number of cells in the panel or in the surface area of the panel. PV panels can be connected in groups to form a PV array. ...

Solar photovoltaic (PV) power generation is the process of converting energy from the sun into electricity using solar panels. Solar panels, also called PV panels, are combined into arrays in a ...

Learn the basics of how photovoltaic (PV) technology works with these resources from the DOE Solar Energy Technologies Office.

Photovoltaic Cells Convert Sunlight Into Electricity The Flow of Electricity in A Solar Cell PV Cells, Panels, and Arrays PV System Efficiency PV System Applications History of PV Systems A photovoltaic (PV) cell, commonly called a solar cell, is a nonmechanical device that converts sunlight directly into electricity. Some PV cells can convert artificial light into electricity. Sunlight is composed of photons, or particles of solar energy. These photons contain varying amounts of energy that correspond to the different wavelengths o... See more on eia.gov Published: Oct 1, 2024. iacfm

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.iacf_head{display:flex;align-items:center;gap:var(--smtc-gap-between-content-small);text-decoration-color:var(--smtc-foreground-content-neutral-primary);box-sizing:border-box;margin-bottom:var(--smtc-gap-between-content-x-small)}.iacfm .iacf_head span{flex:1 1 0;white-space:nowrap;text-overflow:ellipsis;overflow:hidden;color:var(--smtc-foreground-content-neutral-primary);font:var(--bing-smtc-text-global-body3-strong)}.iacfm .iacf_head div{display:flex;height:22px;width:22px;justify-content:center;align-items:center;transition:background 300ms ease-out;margin-right:-3px;border-radius:var(--mai-smtc-corner-list-card-default);overflow:hidden}.iacfm .iacf_head .iacf_chv{color:var(--smtc-foreground-content-neutral-primary)}[dir="rtl"] .iacfm .iacf_head svg{transform:scaleX(-1)}.rel_ent_w{margin:4px 0 9px}.rel_ent_w .rel_ent_w:focus-visible{outline-offset:-6px}.rel_ent_w .rel_ent_crs{margin:6px 0 16px}.b_top .rel_ent_w{margin-top:-4px}.b_top .rel_ent_w .rel_ent_crs{margin-top:0}.b_mm_swipable .rel_ent_w{margin:4px 0 20px}.b_rich .rel_ent_w{margin:-3px -16px 8px}.rel_ent_w .rel_ent_scr:not(.rel_ent_crs){height:50px;overflow:hidden}.rel_ent_c{white-space:nowrap;overflow:hidden;padding-left:1px;height:50px}.aqptmt:not(.rel_ent_crs) .rel_ent_c{display:flex}.rel_ent_wp .rel_ent_c{white-space:initial}.rel_ent_scr .rel_ent_c{overflow-y:hidden;-webkit-overflow-scrolling:touch;overflow-x:auto}.rel_ent_scr:not(.rel_ent_crs) .rel_ent_c{padding-bottom:12px}.b_mm_swipable .rel_ent_c{padding-left:10px;margin-top:-2px;margin-bottom:4px}.b_rich .rel_ent_c{padding-left:15px}.rel_ent_w .rel_ent_crs .slide,.rel_ent_w .rel_ent_crs .slide:hover{width:auto;height:42px;border-radius:20px !important;box-shadow:none !important;overflow:visible}a .rel_ent{display:inline-block;padding:0 16px 0 12px;margin:4px 8px 4px 0;border-radius:20px;border:1px solid #ddd;text-decoration:none;overflow:hidden;height:40px;max-width:80vw}:not(#lgVidAnsContainer)>.aqptmt .rel_ent_c a .rel_ent{overflow:initial;display:flex}.slide a .rel_ent{margin:0;box-shadow:none}.b_sidebar .slide .rel_ent .cico,.rel_ent .cico,.rel_ent>img{display:inline-block;vertical-align:middle;margin:2px 8px 2px -10px;border-radius:50%;background:#f7f7f7;flex-shrink:0}.rel_ent_tw{vertical-align:middle;font-size:12px;color:#444;line-height:16px;height:100%;float:right;display:table}.rel_ent_t{display:table-cell;vertical-align:middle;align-content:center}.aqptmt:not(.spl2) .rel_ent_tw,.aqptmt:not(.spl2) .rel_ent_tw .rel_ent_t{overflow:hidden;text-overflow:ellipsis;white-space:nowrap}.aqptmt:not(.spl2) .rel_ent_tw{display:flex;overflow:hidden;text-overflow:ellipsis;align-items:center;white-space:nowrap}.rel_ent_w:not(.spl2) .rel_ent_t strong{display:inline-block;font-weight:normal}#b_results phead .b_attribution{padding-bottom:8px}.iaplanner .b_moreLink{margin-top:11px}.iaplanner.iarnd .b_moreLink{margin-top:3px}.b_ans .b_rich pserp.b_mBMargin{padding:0;border-top:0}.b_ans #vidans2 .b_rich .rel_ent_w{margin:6px 0 16px}.aqptmt a .rel_ent{border-color:#106ebe}.aqptmt:not(.spl2) .rel_ent_tw,.aqptmt:not(.spl2) .rel_ent_tw .rel_ent_t{font-size:16px}#b_content .acfImgAns .salink{text-align:center;display:block;padding-bottom:var(--smtc-gap-between-content-medium);margin:-2px 0 0 0}#b_content .acfImgAns .salink acf-button-standard{display:inline-block;position:relative}#b_content .acfImgAns .salink::before{border-bottom:1px solid var(--smtc-stroke-ctrl-on-neutral-rest);width:100%;display:block;content:"";top:18px;position:relative}#b_content .acfImgAns .rel_ent_w a .rel_ent{border:1px solid var(--acf-stroke-neutral-decorative)}#b_content

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button:active{background:var(--smtc-background-card-on-primary-default-pressed)}#b_content
.iacfic.mmkiaacf .iacf_crsl[data-wptds-carousel] button svg{transition:initial}#b_content .iacfic.mmkiaacf
.iacf_crsl[data-wptds-carousel] button svg
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.b_ans.b_imgansacf{padding:0!important}#b_content
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0;display:flex;align-items:center;box-sizing:border-box}#b_content .acfImgAns .iaheader
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span{text-decoration:underline}#b_content .acfImgAns .iaheader .iacf_head:hover
.iacf_chv{background:initial}#b_content .acfImgAns .iaheader .iacf_head
div{display:flex;align-items:center;transition:background 300ms
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.iacf_head .iacf_chv{width:22px;justify-content:center;height:22px}#b_content .acfImgAns
.rel_ent_w{margin-top:0}#b_content .acfImgAns .rel_ent_w .b_slideexp{margin:0}#b_content .acfImgAns
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.btn.next{right:-14px}#b_content .acfImgAns .rel_ent_w

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.b_viewport{padding-top:0;margin-left:0;padding-left:0}#b_content .acfImgAns .rel_ent_w .b_viewport
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[data-wptds-carousel-list]{width:fit-content}.iacfca .iacf_colg_crsl .iacfmit{position:absolute}.iacfca
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.cico{border-radius:0}.iacfca:not(.iacfh):has(>.iacf_colg_crsl){height:100%;width:100%;padding:0;overflow:
hidden;border-radius:inherit}.iacfca:not(.iacfh):has(>.iacf_colg_crsl)
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var(--mai-smtc-padding-card-default)*2);transform:translateX(calc(0rem +
var(--mai-smtc-padding-card-default) - (var(--wptds-carousel-control-size)/2)))
translateY(-50%)}[data-wptds-carousel][data-default],[data-wptds-carousel][data-default]::before,[data-wptds-
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*::before,[data-wptds-carousel][data-default]
*::after{box-sizing:border-box;margin:0;padding:0}[data-wptds-carousel][data-default][hidden],[data-wptds-c
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[data-wptds-carousel-control][aria-disabled="true"]{ visibility:hidden;cursor:not-allowed}[data-wptds-carousel][data-default] [data-wptds-carousel-announce]{ block-size:.0625rem;border:0;clip:rect(0 0 0 0);inline-size:.0625rem;margin:-.0625rem;overflow:hidden;padding:0;position:absolute}[data-wptds-carousel][data-default][data-variant="Normal"],[data-wptds-carousel][data-default][data-variant="FullWidth"]{--wptds-carousel-control-opacity:0}[data-wptds-carousel][data-default][data-variant="Normal"]:has([data-wptds-carousel-scroll-container]:focus-visible),[data-wptds-carousel][data-default][data-variant="Normal"]:has([data-wptds-carousel-control]:focus-visible),[data-wptds-carousel][data-default][data-variant="FullWidth"]:has([data-wptds-carousel-scroll-container]:focus-visible),[data-wptds-carousel][data-default][data-variant="FullWidth"]:has([data-wptds-carousel-control]:focus-visible){--wptds-carousel-control-opacity:1}[data-wptds-carousel][data-default][data-variant="Normal"][data-snap] [data-wptds-carousel-scroll-container]{ scroll-snap-type:x proximity}[data-wptds-carousel][data-default][data-variant="Normal"][data-snap]
[data-wptds-carousel-item]{ scroll-snap-align:center;scroll-snap-stop:always}[data-wptds-carousel][data-default][data-variant="Normal"][data-snap]
[data-wptds-carousel-item]:first-of-type{ scroll-snap-align:start}[data-wptds-carousel][data-default][data-variant="Normal"][data-snap]
[data-wptds-carousel-item]:last-of-type{ scroll-snap-align:end}[data-wptds-carousel][data-default][data-variant="FullWidth"] [data-wptds-carousel-scroll-container]{ scroll-snap-type:x mandatory}[data-wptds-carousel][data-default][data-variant="FullWidth"]
[data-wptds-carousel-item]{ inline-size:100%;scroll-snap-align:center;scroll-snap-stop:always}[data-wptds-carousel][data-default][data-variant="FullWidth"]
[data-wptds-carousel-item]:first-of-type{ scroll-snap-align:start}[data-wptds-carousel][data-default][data-variant="FullWidth"]
[data-wptds-carousel-item]:last-of-type{ scroll-snap-align:end}[data-wptds-carousel][data-default][data-variant="FullWidth"]
[data-wptds-carousel-item]>*{ inline-size:100%}[data-wptds-carousel][data-default][data-bleed-inline]
[data-wptds-carousel-controls]{--control-side-gap:.25rem;inline-size:calc(100% - (var(--control-side-gap)*2));transform:translateX(calc(0rem + var(--control-side-gap))) translateY(-50%)}[data-wptds-carousel][data-desktop]
[data-wptds-carousel-control]:hover:not([aria-disabled="true"]):not(:active){--wptds-carousel-control-bg-color:#fff;--wptds-carousel-control-border-color:#ddd;--wptds-carousel-control-box-shadow:0rem .125rem .3125rem rgba(0,0,0,.14);--wptds-carousel-control-fg-color:#111}[data-wptds-carousel][data-desktop][data-variant="Normal"]:has([data-wptds-carousel-scroll-container]:hover),[data-wptds-carousel][data-desktop][data-variant="Normal"]:has([data-wptds-carousel-control]:hover),[data-wptds-carousel][data-desktop][data-variant="FullWidth"]:has([data-wptds-carousel-scroll-container]:hover),[data-wptds-carousel][data-desktop][data-variant="FullWidth"]:has([data-wptds-carousel-control]:hover){--wptds-carousel-control-opacity:1}[dir="rtl"]
[data-wptds-carousel][data-default] [data-wptds-carousel-controls]{ transform:translateX(calc(0rem + (var(--wptds-carousel-control-size)/2))) translateY(-50%)}[dir="rtl"] [data-wptds-carousel][data-default]
[data-wptds-carousel-control][data-direction="start"]>svg{ transform:scaleX(-1)}[dir="rtl"]
[data-wptds-carousel][data-default]
[data-wptds-carousel-control][data-direction="end"]>svg{ transform:scaleX(1)}[dir="rtl"]

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[data-wptds-carousel][data-default][data-bleed-inline]
[data-wptds-carousel-controls]{transform:translateX(calc(0rem - var(--control-side-gap)))
translateY(-50%)).b_dark [data-wptds-carousel][data-default],.b_drk
[data-wptds-carousel][data-default]{--wptds-carousel-control-bg-color:#484644;--wptds-carousel-control-border-color:#545250;--wptds-carousel-control-box-shadow:0rem .125rem .1875rem
rgba(0,0,0,.1);--wptds-carousel-control-fg-color:#d2d0ce}.b_dark [data-wptds-carousel][data-default]
[data-wptds-carousel-control]:active,.b_drk [data-wptds-carousel][data-default]
[data-wptds-carousel-control]:active{--wptds-carousel-control-bg-color:#484644;--wptds-carousel-control-border-color:#545250;--wptds-carousel-control-box-shadow:0rem .125rem .1875rem
rgba(0,0,0,.1);--wptds-carousel-control-fg-color:#d2d0ce}.b_dark [data-wptds-carousel][data-desktop]
[data-wptds-carousel-control]:hover:not([aria-disabled="true"]):not(:active),.b_drk
[data-wptds-carousel][data-desktop]
[data-wptds-carousel-control]:hover:not([aria-disabled="true"]):not(:active){--wptds-carousel-control-bg-color:#605e5c;--wptds-carousel-control-border-color:#545250;--wptds-carousel-control-box-shadow:0rem .125rem .3125rem
rgba(0,0,0,.14);--wptds-carousel-control-fg-color:#faf9f8}.gs_card .iacfic .iacfmit
.iacfimgc,.gs_card .iacfic .iacfmit .cico,.b_wpt_container .iacfic .iacfmit .iacfimgc,.b_wpt_container .iacfic
.iacfmit .cico{width:100%!important;height:100%!important;border-radius:0}.gs_card .iacfic .iacfmit.iacfstc
img,.gs_card .iacfic .iacfmit .iacfimgc img,.b_wpt_container .iacfic .iacfmit.iacfstc img,.b_wpt_container
.iacfic .iacfmit .iacfimgc
img{width:100%;height:100%;object-fit:cover}acf-button-standard{display:block;inline-size:fit-content;max-inline-size:100%}acf-button-standard,acf-button-standard::before,acf-button-standard::after,acf-button-standard
*::before,acf-button-standard
*::after{box-sizing:border-box;margin:0;padding:0}acf-button-standard[hidden],acf-button-standard
*[hidden]{display:none}acf-button-standard[data-visually-hidden],acf-button-standard
*[data-visually-hidden]{block-size:1px;inline-size:1px;margin:unset;padding:unset;border:0;clip:rect(0 0 0 0);clip-path:inset(50%);overflow:clip;position:absolute;white-space:nowrap}.acf-button-standard__btn,.acf-button-standard__link{font:var(--font);color:var(--color)!important;background-color:var(--background-color);border:1px solid
var(--border-color);display:grid;grid-auto-flow:column;align-items:center;gap:var(--smtc-gap-inside-ctrl-to-secondary-icon);cursor:pointer;text-decoration:none!important}.acf-button-standard__btn>*,.acf-button-standard__link>*{min-inline-size:0;max-inline-size:100%}.acf-button-standard__btn[aria-disabled="true"],.acf-button-standard__link[aria-disabled="true"]{opacity:.3;cursor:not-allowed}.acf-button-standard__btn:focus-visible,.acf-button-standard__link:focus-visible{outline-width:2px;outline-style:solid;outline-color:var(--smtc-ctrl-focus-outer-stroke);outline-offset:2px}.acf-button-standard__label{white-space:nowrap;overflow:clip;text-overflow:ellipsis;max-block-size:calc(1*1lh)}acf-button-standard[data-shape="Pill"]
.acf-button-standard__btn,acf-button-standard[data-shape="Pill"]
.acf-button-standard__link{border-radius:var(--smtc-corner-circular)}acf-button-standard[data-size="Default"]
.acf-button-standard__link{padding-block-start:var(--smtc-padding-ctrl-text-top);padding-block-end:var(--smtc-padding-ctrl-text-bottom);padding-inline:var(--smtc-padding-ctrl-horizontal-default)}acf-button-standard[data-style="Secondary"]{--color:var(--bing-smtc-foreground-ctrl-neutral-primary-alt-rest);--background-color:va

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r(--bing-smtc-background-ctrl-neutral-rest);--border-color:transparent}acf-button-standard[data-style="Secondary"]
.acf-button-standard__btn:hover:not([aria-disabled="true"]),acf-button-standard[data-style="Secondary"]
.acf-button-standard__link:hover:not([aria-disabled="true"]){--color:var(--smtc-foreground-ctrl-neutral-primary-hover);--background-color:var(--smtc-background-ctrl-neutral-hover);--border-color:transparent}acf-button-standard[data-style="Secondary"]
.acf-button-standard__btn:active:not([aria-disabled="true"]),acf-button-standard[data-style="Secondary"]
.acf-button-standard__link:active:not([aria-disabled="true"]){--color:var(--smtc-foreground-ctrl-neutral-primary-pressed);--background-color:var(--smtc-background-ctrl-neutral-pressed);--border-color:transparent}acf-button-standard[data-weight="Strong"][data-size="Small"],acf-button-standard[data-weight="Strong"][data-size="Default"]{--font:var(--bing-smtc-text-global-caption1-strong)}acf-button-standard[data-weight="Strong"][data-size="Large"]{--font:var(--bing-smtc-text-global-body3-strong)}acf-icon{display:block;inline-size:fit-content;max-inline-size:100%;pointer-events:none}acf-icon,acf-icon::before,acf-icon::after,acf-icon *,acf-icon*::before,acf-icon*::after{box-sizing:border-box;margin:0;padding:0}acf-icon[hidden],acf-icon*[hidden]{display:none}acf-icon[data-visually-hidden],acf-icon*[data-visually-hidden]{block-size:1px;inline-size:1px;margin:unset;padding:unset;border:0;clip:rect(0 0 0 0);clip-path:inset(50%);overflow:clip;position:absolute;white-space:nowrap}.acf-icon__def{display:none}.acf-icon__icon{display:block;inline-size:auto;color:inherit}[dir="rtl"]
.acf-icon__icon{transform:scaleX(-1)}@media(forced-colors:active){acf-icon{color:ButtonText!important}}acf-icon[data-size="M"] .acf-icon__icon{block-size:16px}#slideexp3_5D2C .slide { margin-right: 8px; }#slideexp3_5D2Cc .b_slidebar .slide { border-radius: 6px; }#slideexp3_5D2C .slide:last-child { margin-right: 1px; }#slideexp3_5D2Cc { margin: -4px; } #slideexp3_5D2Cc .b_viewport { padding: 4px 1px 4px 1px; margin: 0 3px; } #slideexp3_5D2Cc .b_slidebar .slide { box-shadow: 0 0 0 1px rgba(0, 0, 0, 0.05); -webkit-box-shadow: 0 0 0 1px rgba(0, 0, 0, 0.05); } #slideexp3_5D2Cc .b_slidebar .slide.see_more { box-shadow: 0 0 0 0px rgba(0, 0, 0, 0.00); -webkit-box-shadow: 0 0 0 0px rgba(0, 0, 0, 0.00); } #slideexp3_5D2Cc .b_slidebar .slide.see_more .carousel_seemore { border: 0px; }#slideexp3_5D2Cc .b_slidebar .slide.see_more:hover { box-shadow: 0 0 0 0px rgba(0, 0, 0, 0.00); -webkit-box-shadow: 0 0 0 0px rgba(0, 0, 0, 0.00); }Images of Solar photovoltaic Full power generationEnergizer Portable Power Station1500 Watt Solar Power GeneratorPortable Solar Inverter GeneratorTypes of Solar PanelsPatriot Solar Power GeneratorPhotovoltaic Solar Power SystemSolar Power Generation SystemMobile Solar Power GeneratorHomemade Solar Power GeneratorSee allIRENA - International Renewable Energy AgencySolar energySolar photovoltaic (PV) uses electronic devices, also called solar cells, to convert sunlight directly into electricity. It is one of the fastest-growing renewable energy technologies and is playing an ...

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Although PV systems can operate by themselves as off-grid PV systems, this article focuses on systems connected to the utility grid, or grid-tied PV systems. How do these Systems Work?

Power generation from solar PV increased by a record 320 TWh in 2023, up by 25% on 2022. Solar PV accounted for 5.4% of total global electricity generation, and it remains the third largest renewable ...

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