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# Photovoltaic arrays for German municipalities

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# How does Photovoltaic (PV) work ?

- 'photo' = light, 'voltaic' = electric potential
- Photovoltaic systems use cells to convert solar radiation into electricity.
  - One or two layers of a **semi-conducting material**.
  - Sunshine > Cell creates **electric field** across the layers, causing electricity to flow.
  - The greater **the intensity** of the light, the greater the flow of electricity is.
  - It can also generate electricity **on cloudy days**.
  - The most common semi conductor material used in photovoltaic cells is **silicon**
- A **photovoltaic array** is a linked collection of photovoltaic modules.





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# PV Solar Electricity Potential in Europe

**Photovoltaic Geographical Information System - Interactive Maps**

[EUROPA](#) > [EC](#) > [JRC](#) > [IE](#) > [RE](#) > [\\$OLAREC](#) > [PVGIS](#) > [Interactive maps](#) > [europe](#)
[Contact](#) [Important legal notice](#)

cursor position: 59.415, 20.303  
 selected position:

e.g., "Ispra, Italy" or "45.256N, 16.9589E"

[Solar radiation](#) | [Temperature](#) | [Other maps](#)

**PV Estimation** | Monthly radiation | Daily radiation

**Performance of Grid-connected PV**

Radiation database:  [What is this?]

PV technology:

Installed peak PV power  kWp

Estimated system losses [0; 100]  %

**Fixed mounting options:**

Mounting position:

Slope [0; 90]  °  Optimize slope

Azimuth  °  Also optimize azimuth  
(Azimuth angle from -180 to 180. East=-90, South=0)

**Tracking options:**

Vertical axis Slope [0; 90]  °  Optimize

Inclined axis Slope [0; 90]  °  Optimize

2-axis tracking

Horizon file

**Output options**

Show graphs  Show horizon

Web page  Text file  PDF

[\[help\]](#)

<http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php?lang=en&map=europe#>

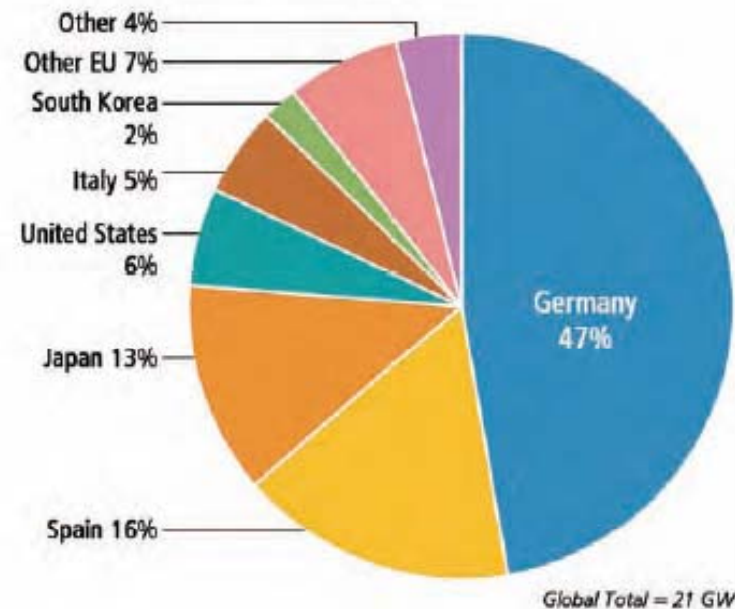


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# Current status and Perspectives

- PV in more than 100 countries
- PV is the **fastest growing** power-generation technology in the world.
- Ground-mounted or built onto the roof or into walls of a building (Building Integrated Photovoltaics (BIPV))

Figure 8. Solar PV Existing Capacity, Top Six Countries, 2009

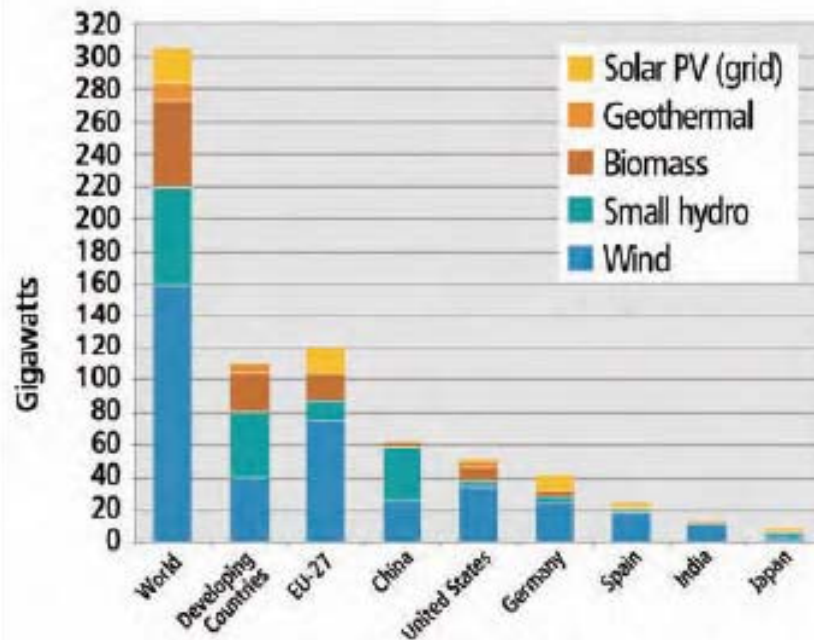




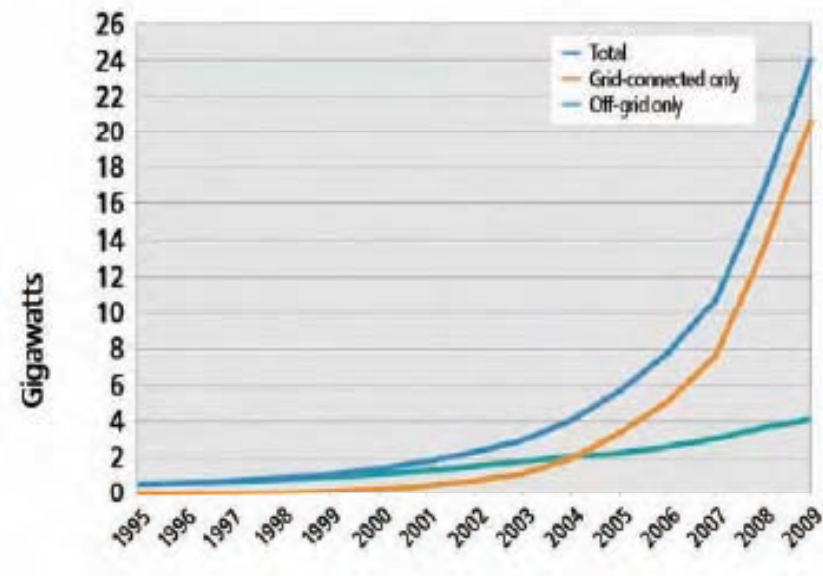
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# Current status and Perspectives

**Figure 4. Renewable Power Capacities:  
Developing World, EU, and Top Six Countries, 2009**



**Figure 7. Solar PV, Existing World Capacity,  
1995–2009**



*REN21 Renewable Energy Policy Network for the 21st Century, Renewables 2010, Global Status Report*



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## 2. EU Policy on energy from Renewable Energy Sources





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## 2.1 Renewables Directive 2009/28/EC

- The **Renewables Directive** is a European Union directive, published 23rd April, 2009.
  - mandates **levels of renewable energy** use within the European Union
  - official title is **2009/28/EC**
  - **pre-agreed proportion** of energy consumption from renewable sources for the member countries
  - the EU as a whole shall obtain at least **20% of total energy from Renewables by 2020**.
- The directive amends and repeals the **2001 Directive on Electricity Production from Renewable Energy Sources**.



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## National targets for the proportion of final energy consumption from renewable sources in 2020

National renewable targets<sup>22</sup>

	Share of energy from renewable sources in final consumption of energy, 2005	Target for share of energy from renewable sources in final consumption of energy, 2020
Belgium	2.2%	13%
Bulgaria	9.4%	16%
The Czech Republic	6.1%	13%
Denmark	17.0%	30%
Germany	5.8%	18%
Estonia	18.0%	25%
Ireland	3.1%	16%
Greece	6.9%	18%
Spain	8.7%	20%
France	10.3%	23%



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Italy	5.2%	17%
Cyprus	2.9%	13%
Latvia	34.9%	42%
Lithuania	15.0%	23%
Luxembourg	0.9%	11%
Hungary	4.3%	13%
Malta	0.0%	10%
The Netherlands	2.4%	14%
Austria	23.3%	34%
Poland	7.2%	15%
Portugal	20.5%	31%
Romania	17.8%	24%
Slovenia	16.0%	25%
The Slovak Republic	6.7%	14%
Finland	28.5%	38%
Sweden	39.8%	49%
United Kingdom	1.3%	15%



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## 3. German context

### 3.1 Feed-In Tariff - Renewable Energy Sources Act / EEG

**An adequate mechanism to develop grid-connected  
Photovoltaic markets**

- The European photovoltaic market has been pulled by the **successful development of the German market.**
- The **revision of the Renewable Energy Sources Act (Feed-in-tariff law)** in 2003 has confirmed the leadership of Germany with **80% of the European market share.**
- It offers customers an **attractive price** for selling their produced electricity to the utility grid.



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# Feed-In Tariff



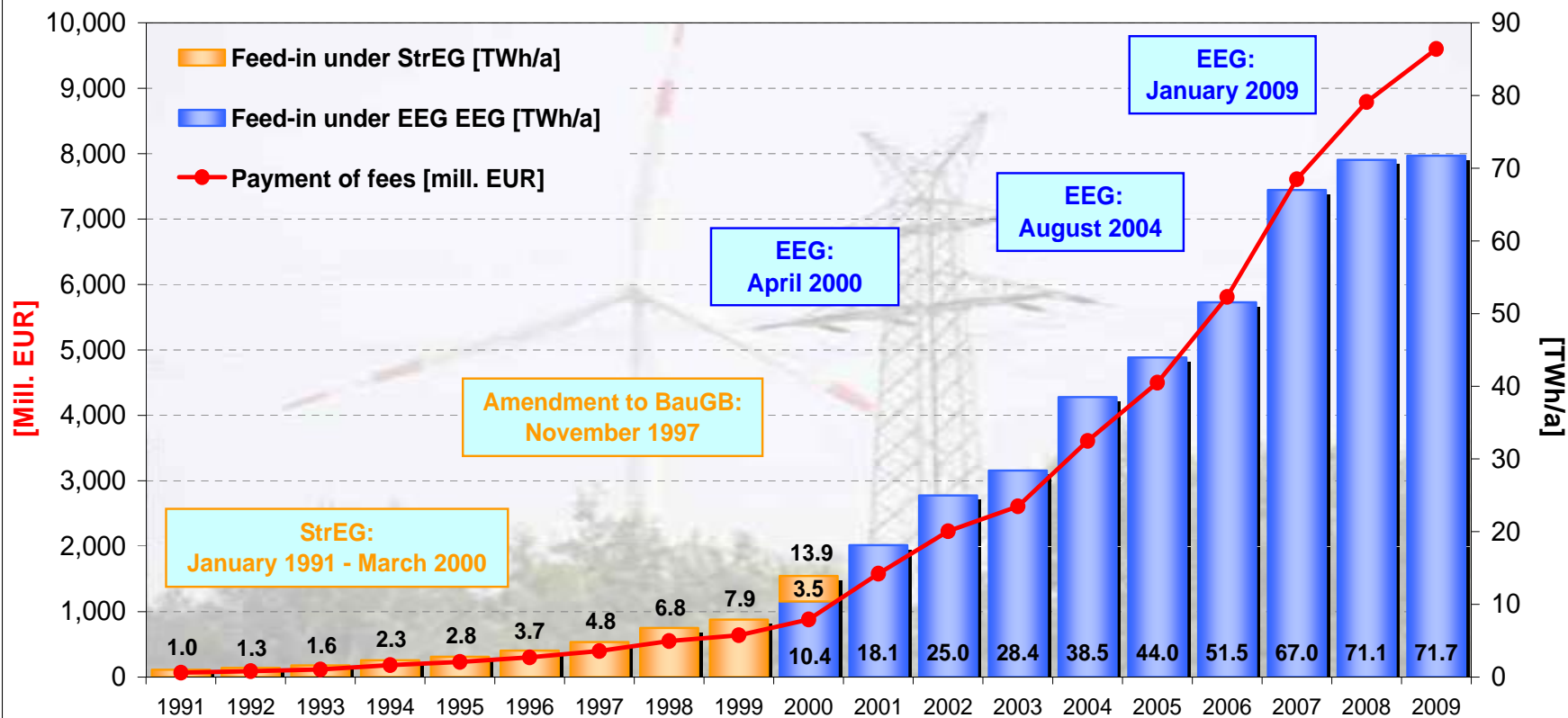
## Key to success :

- The tariff is set at the **point of connection** to the grid.
- The level of the tariff is **guaranteed for 20 years**  
> planning security + attractive investment in solar electricity systems.
- The cost of the feed-in tariff is **supported by all electricity users**  
> it does not rely on State budgets
- The **simplicity** of the feed-in tariff concept and its low administrative costs  
> it is a highly effective and efficient tool



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## Feed-in and payment under the Electricity Feed Act (StrEG) and the Renewable Energy Sources Act (EEG) in Germany 1991 - 2009

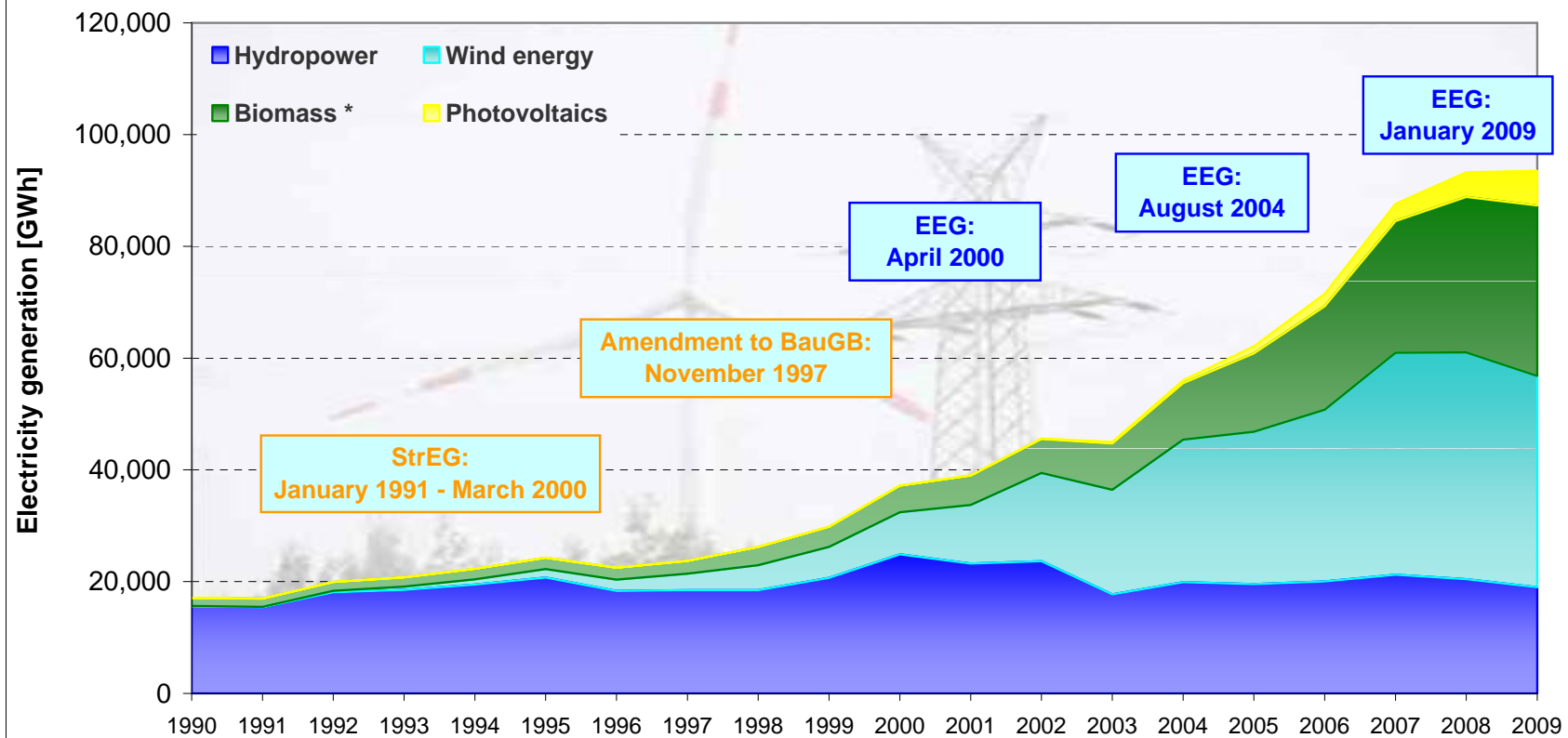


StrEG: Act on the Sale of Electricity to the Grid; BauGB: Construction Code; EEG: Renewable Energy Sources Act;  
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); Image: BMU / Christoph Edelhoff; all figures provisional



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## Development of electricity generation from renewable energy sources in Germany 1990 - 2009

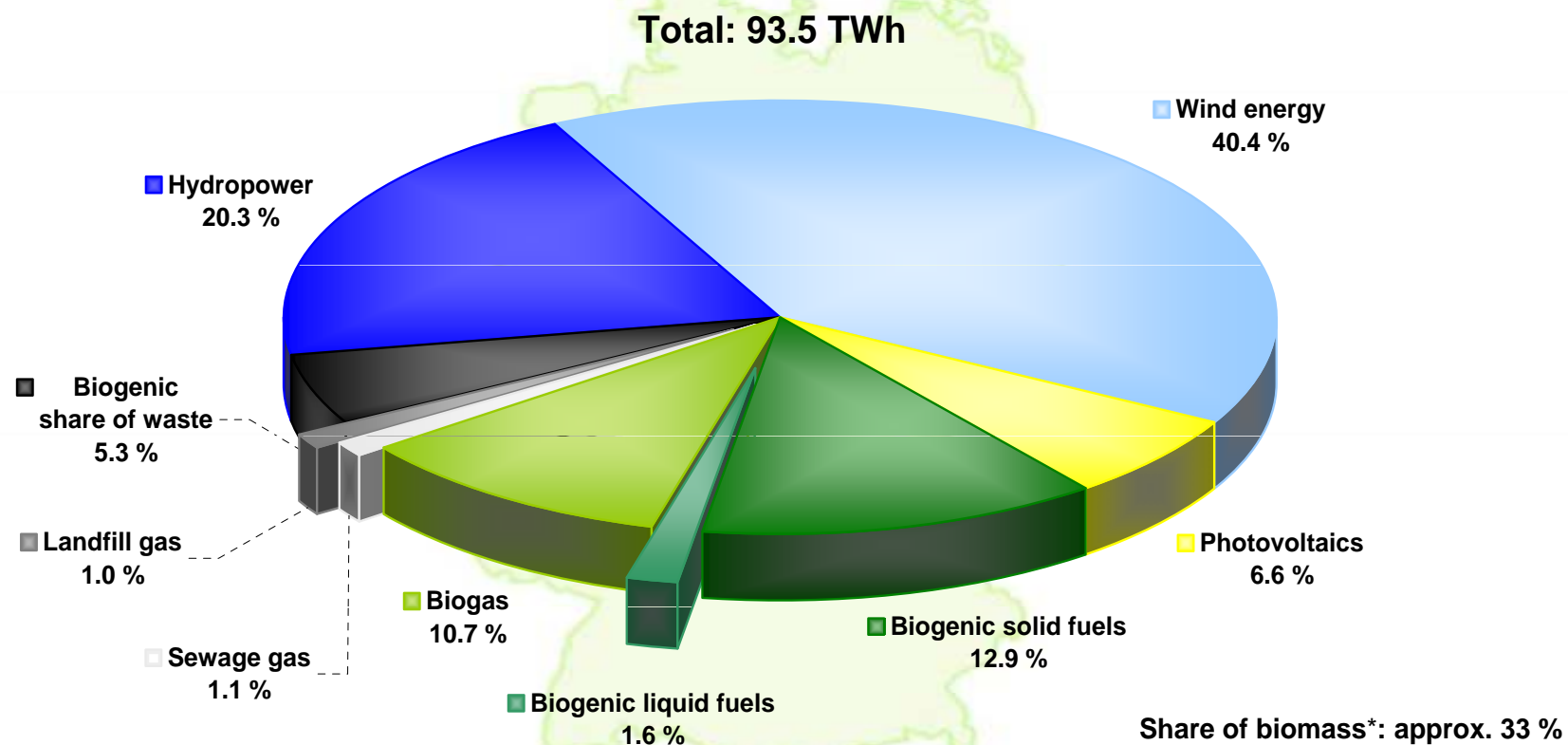


\* Solid, liquid, gaseous biomass, biogenic share of waste, landfill and sewage gas;

Electricity from geothermal energy is not presented due to the negligible quantities of electricity produced; StrEG: Act on the Sale of Electricity to the Grid; BauGB: Construction Code; EEG: Renewable Energy Sources Act; Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); Image: BMU / Christoph Edelhoff; all figures provisional



## Structure of electricity supply from renewable energy sources in Germany 2009

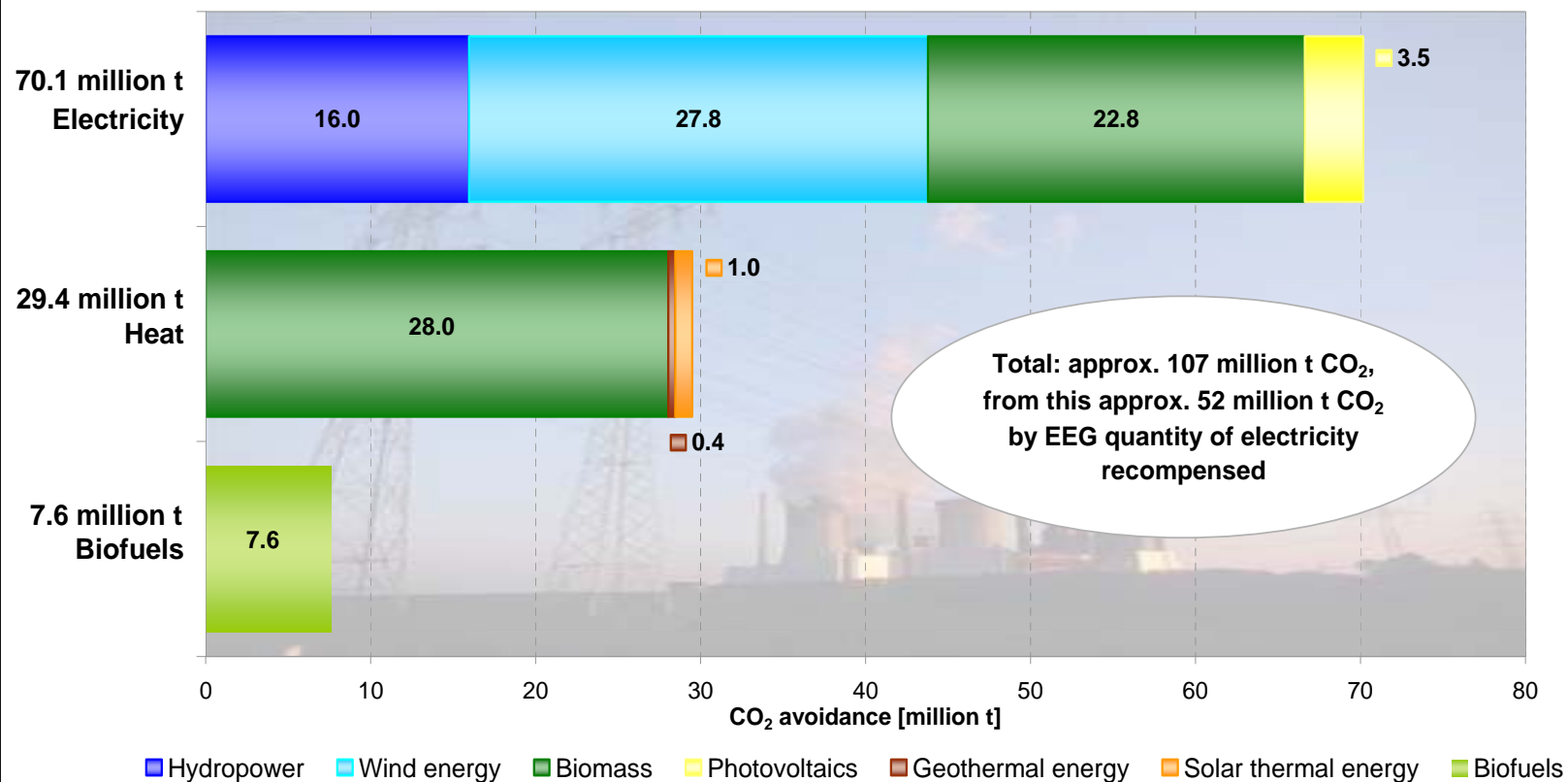


\* Solid, liquid, gaseous biomass, biogenic share of waste, landfill and sewage gas; Deviations in the totals are due to rounding;  
Source: BMU-KI III 1 according to Working Group on Renewable Energies-Statistics (AGEE-Stat); all figures provisional



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## Total CO<sub>2</sub> avoidance via the use of renewable energy sources in Germany 2009

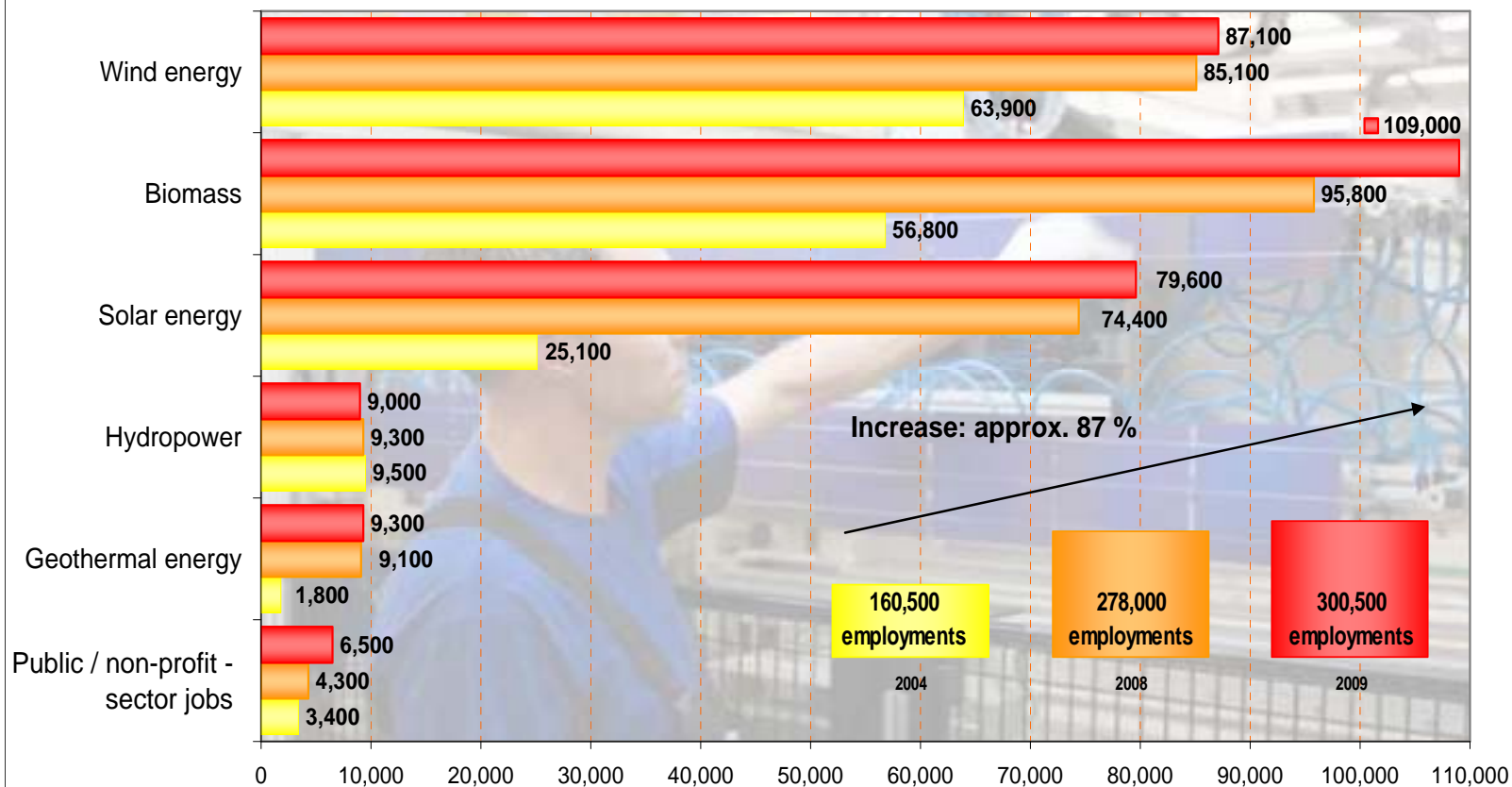


EEG: Renewable Energy Sources Act; Deviations in the totals are due to rounding;  
Source: UBA according to Working Group on Renewable Energies-Statistics (AGEE-Stat); Image: H. G. Oed; all figures provisional



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## Jobs in the renewable energy sector in Germany 2004, 2008 und 2009



Figures for 2008 and 2009 are provisional estimate;

Source: BMU-KI III Projekt "Gross employment from renewable energy in Germany in the year 2009, a first estimate"; Image: BMU / Christoph Busse / transit

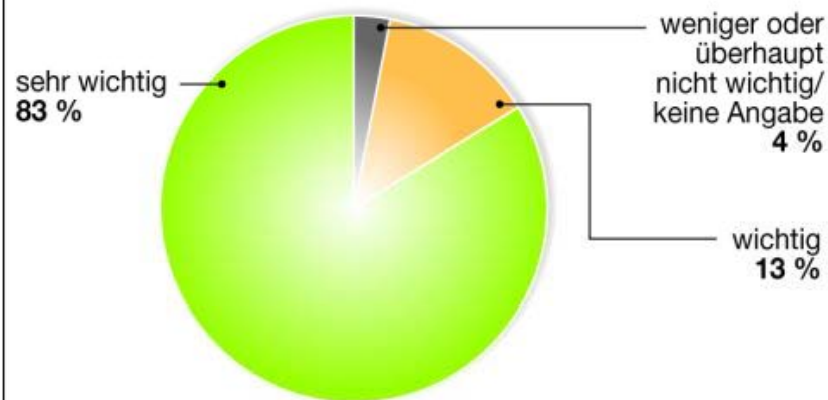


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## 3.3 Public acceptance

**96 Prozent der Deutschen befürworten den verstärkten Ausbau der Erneuerbaren Energien**

**Erneuerbare Energien stärker zu nutzen bzw. auszubauen ist ...**



Quelle: FORSA 11/2007

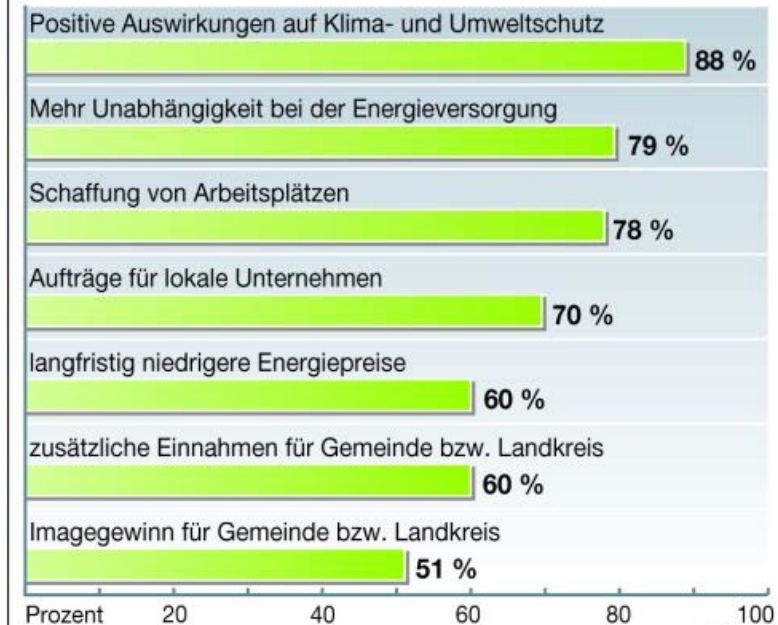
[www.unendlich-viel-energie.de](http://www.unendlich-viel-energie.de)



96 percent of Germans support the increased development of renewable energies.

**Die Vorteile Erneuerbarer Energien sind den Menschen bewusst**

**Als wichtigste Vorteile Erneuerbarer Energien nennen die Deutschen...**



Mehrfachnennung möglich

Quelle: FORSA 11/2007

[www.unendlich-viel-energie.de](http://www.unendlich-viel-energie.de)



The Germans are aware of the benefits of the renewable energies.



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## 4. Regional context

### 4.1 Problems of the municipalities

- Political majorities
- Municipal budgets
- Higher administrations / authorities > Veto
- Lack of competence
- Unclear ownership structure
- Time frame





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## 4.2 Possibilities of action

### > direct influence:

- Urban land use planning and land consolidation planning / building law
- Construction and operation of own PV systems
- Solar Roof Exchange Market/ register

### > indirect influence

- Citizens advice on technical issues and support programs
- Local promotion / aid
- Local Public Relations





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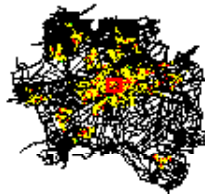
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1 : 1500



## Solarstadt Kaiserslautern



- Dachflächen zur solaren Nu
- Luftbilder 2008
- Stadtgrundkarte
- Solardachkataster



ok  
A B C D E F G H I J K L M  
N O P Q R S T U V W X Y Z



### Dachflächen zur solaren Nutzung

- gut geeignet
- geeignet
- nicht geeignet
- nicht auswertbar

#### Weiterführende Informationen erhalten sie bei:

Herr Dr. Stefan Kremer  
Direktor des Referates Umweltschutz  
Telefon: 0631 365-1150  
stefan.kremer@kaiserslautern.de

Frau Bettina Dech-Pschorn  
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Telefon: 0631 365-2788  
umweltberatung@kaiserslautern.de



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## 4.3 Financing

Several ways for local governments:

- The **municipality invests and operates** the facilities under its own responsibility  
> **local operating company** is founded or **the public utilities** provide the work
- **A contractor** could build and operate the PV-array for the municipality  
>The municipality then pays the energy from those facilities.
- **Citizens join forces** to establish an operating company and finance the project through corresponding proportions.



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## 4.3 Financing

Several ways for local governments:

- **Planning and operating companies** take care for
  - > planning, construction, financing and management
  - > Community creates the legal requirements in the area of planning and permit.
- **Professional investors** buy PV projects and offer their customers the shares as a capital investment of an investment fund.



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## 4.4 Advantages for the municipalities

- Solar energy is free
- Produces no noise
- Minimal maintenance required to keep the system running
- Modular systems can be quickly installed and easily expanded
- Climate protection
- Financial income (Feed-In Tariff, tax)
- Image improvement
- Generate local jobs
- New perspectives for the rural areas



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## 4.5 Best Practices





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# Fritz Walter Stadium, Kaiserslautern

- World's largest solar installation on a stadium roof
- May 2010, on roof solar power plant
- 1.38 MWp, 1.156 kWh/year
- 5.800 polycrystalline LiteOn Solarmodules
- Annual electricity needs of about 450 households
- Saving 856 tons carbon dioxide
- Investor and operator is the Korean LiteOn-Group
- 5 Mio. Euros Investment
- Installed by the local partner  
SOLAR ENERGIEDACH GmbH, Sembach





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# Solar Park Municipality Wörrstadt

- Electrical power: 5.6 MWp
- Current annual income: about 5.6 million kWh
- Location (Province): Rhineland-Palatinate
- Dec. 2008 put into operation
- 77.000 modules, First Solar (thin-film modules)
- module area: 55.360 m<sup>2</sup>
- Project development: juwi Holding AG,  
Germany





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**Thank you for your attention.**

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