

GLOBAL CUMULATIVE INSTALLED PHOTOVOLTAIC CAPACITY AND RESPECTIVE INTERNATIONAL TRADE FLOWS

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Motivation & Purpose of Work

The installed capacity of photovoltaic (PV) is rising steadily. Most PV is installed in highly electrified countries as on-grid applications. Further there are reams of small off-grid systems in rural areas of developing countries. Due to this, reliable installation rates for PV are available only for a limited number of countries. About 2,000 MWp cannot be allocated to any country.

An overview on installed PV for all countries in the world is provided, enhancing a better understanding of PV diffusion.

Detailed PV installation dataset is available for public dissemination (pls. provide business card).

Examination Method

Examination relying on public accessible data

- basic source: international customs database, monitored by 'Market Analysis and Research' section of the International Trade Centre (agency of UN's WTO) [1]
 - contains customs data of 188 countries worldwide since 2000 (total value of imported and exported products for each country per year)
 - products classified in several specific product numbers, so called HS Codes
 - HS Code group 854140 represents PV, i.a. solar cells, solar modules, etc.
 - it is valid, that 'imports A from B' = 'exports B to A'
 - possibility of cross-checking to increase data reliability
 - PV capacities per country calculated: 'import A' - 'exports A' + 'production A' = 'market A'
 - 20% of annual productions installed in the following year
- further sources: installation and production rates estimated by EPIA, IEA-PVPS, GIZ and Photon [2-6], as well as insights of local PV experts

Assumptions for the Analysis

[\$/Wp]	year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
average world price:	100%	5.17	4.96	4.36	4.13	4.24	4.55	5.07	4.57	4.38	2.53	2.05
countries >100MW/y	90%	4.66	4.47	3.92	3.72	3.82	4.09	4.56	4.11	3.94	2.28	1.85
countries >10MW/y	110%	5.69	5.46	4.79	4.55	4.67	5.00	5.57	5.02	4.82	2.78	2.26
countries >5MW/y	150%	7.76	7.44	6.54	6.20	6.36	6.82	7.60	6.85	6.57	3.79	3.08
countries <5MW/y	180%	9.31	8.93	7.84	7.44	7.63	8.19	9.12	8.22	7.89	4.55	3.70
countries <1MW/y	200%	10.35	9.93	8.71	8.27	8.48	9.10	10.13	9.14	8.76	5.06	4.11
Africa & Asia	220%	11.38	10.92	9.59	9.10	9.33	10.01	11.14	10.05	9.64	5.57	4.52
Europe & NA & LA	190%	9.83	9.43	8.28	7.86	8.06	8.64	9.62	8.68	8.33	4.81	3.90

Fig. 1: PV price for conversion of customs values into PV capacity [7]. Abbr. stand for: North (NA) and Latin America (LA).

- customs data include monetary value of the products
 - conversion to PV capacities is necessary
- price data refer to a worldwide annual average PV price [7]
- prices depend on countries' locations and market sizes
 - significant range of diverging between countries
 - classification of all countries that are nearly comparable in market size and economic conditions in five main groups (one of them having two subgroups)
 - price of each group multiplied by experienced ratio to average world price +10% for shipping and distributor margin

Global PV Installations

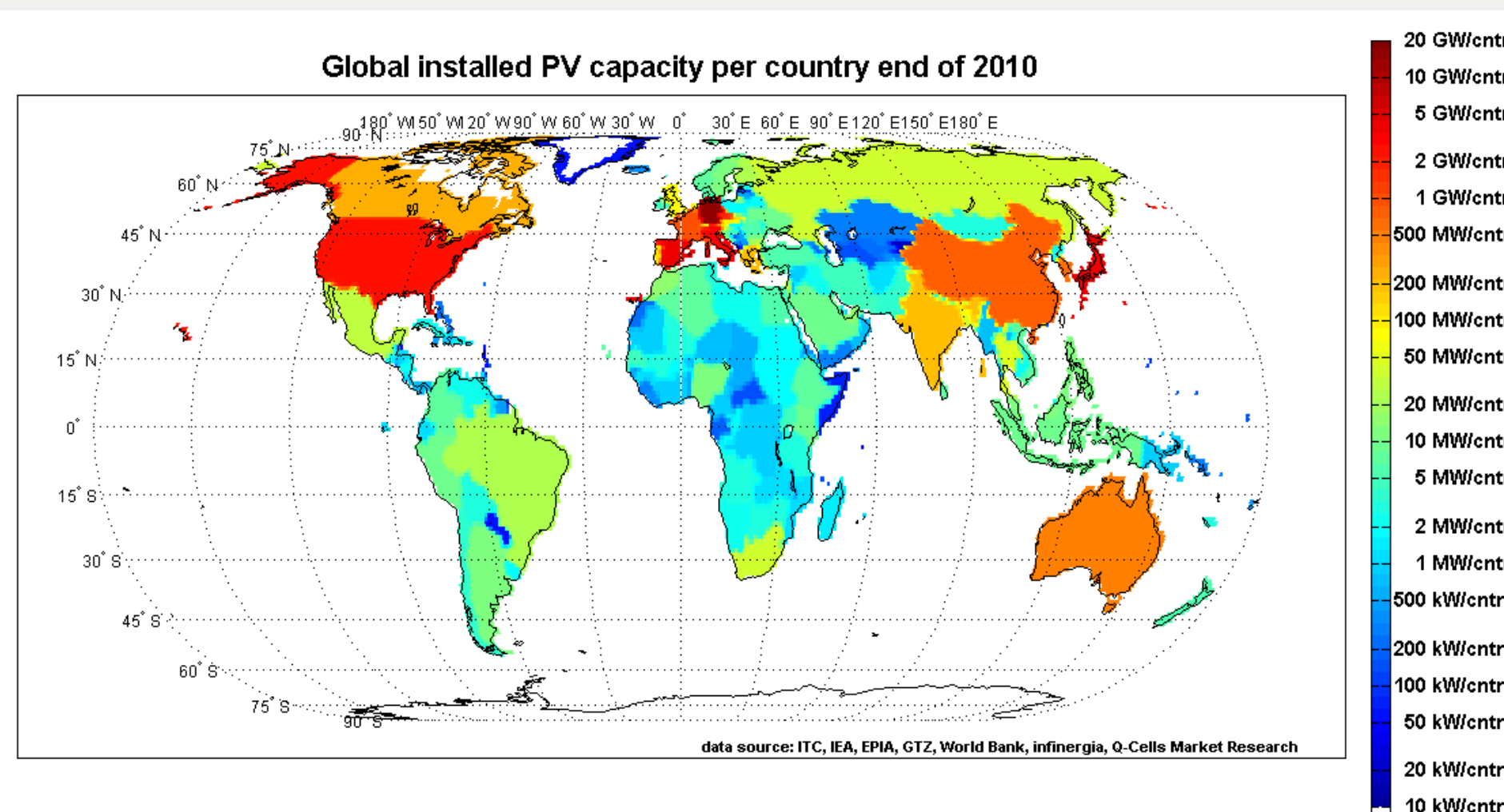


Fig. 2: Total installed PV capacity per country by end of 2010.

- world's total installed PV capacity allocated to 38,534 MWp in the end of 2010 on a per country basis
- further 487 MWp expected to be installed before 2000
- PV installations to be found in almost all countries
- seven largest markets comprise 87% of global PV installations
- plenty of developing countries with significant installed PV base, mainly representing high diffusion of small off-grid applications being used for electrification of remote areas
 - e.g. 5 MWp solar home systems with an average size of 50 Wp represent a solar power solution for 100,000 families

Regional Distribution of PV

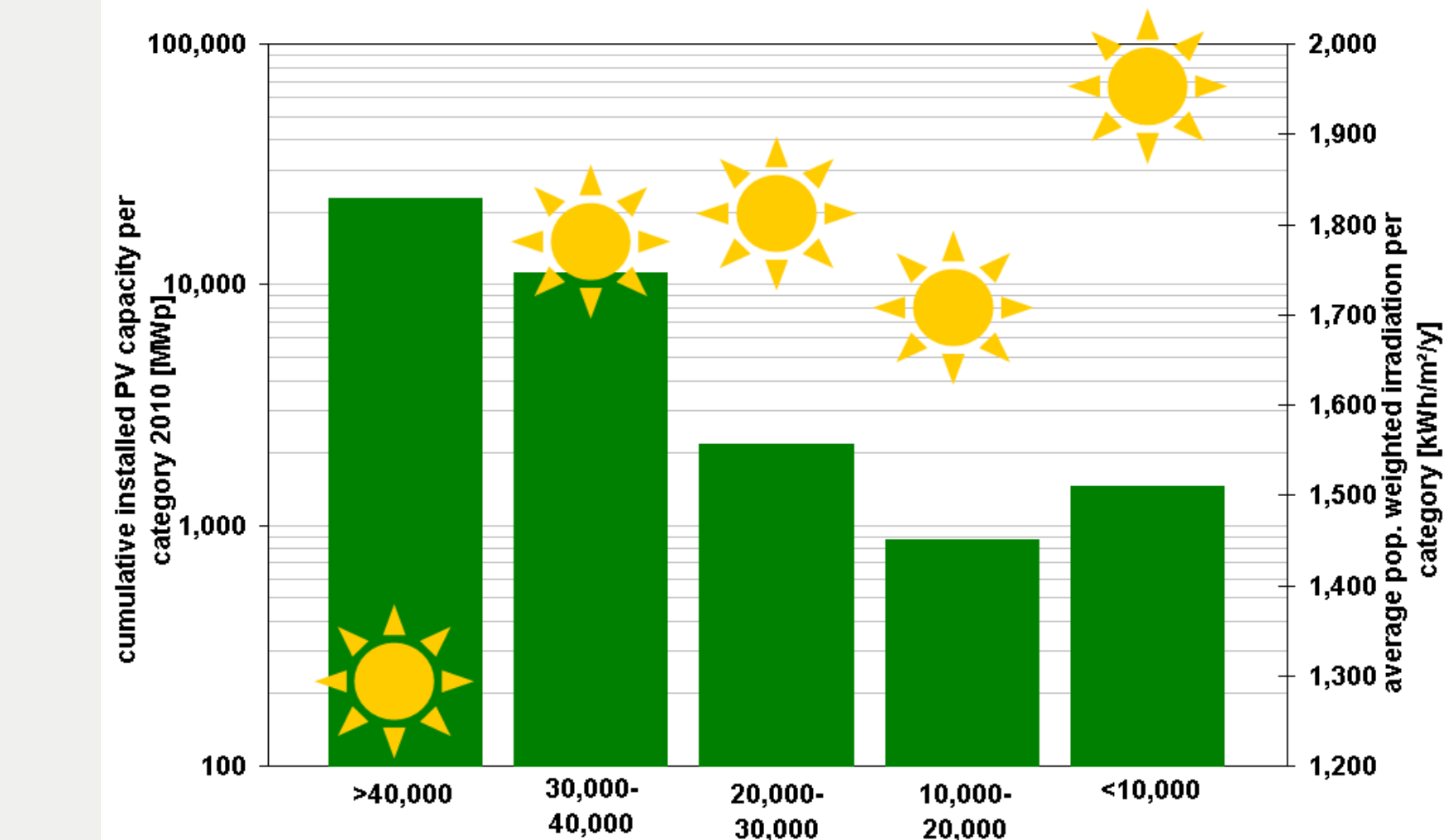


Fig. 3: Total global installed PV capacity by end of 2010 (left axis) and indication of the average population weighted irradiation [8] (right axis) depending on GDP/capita.

- nearly 90% of global installed PV in countries of GDP/capita >30,000 USD
- low income countries (GDP/capita <10,000 USD) claim 1,530 MWp in 135 countries
- majority of PV markets found in countries with moderate irradiation but high income; markets with high insolation mainly driven by PV off-grid applications

High Input in Off-Grid Countries

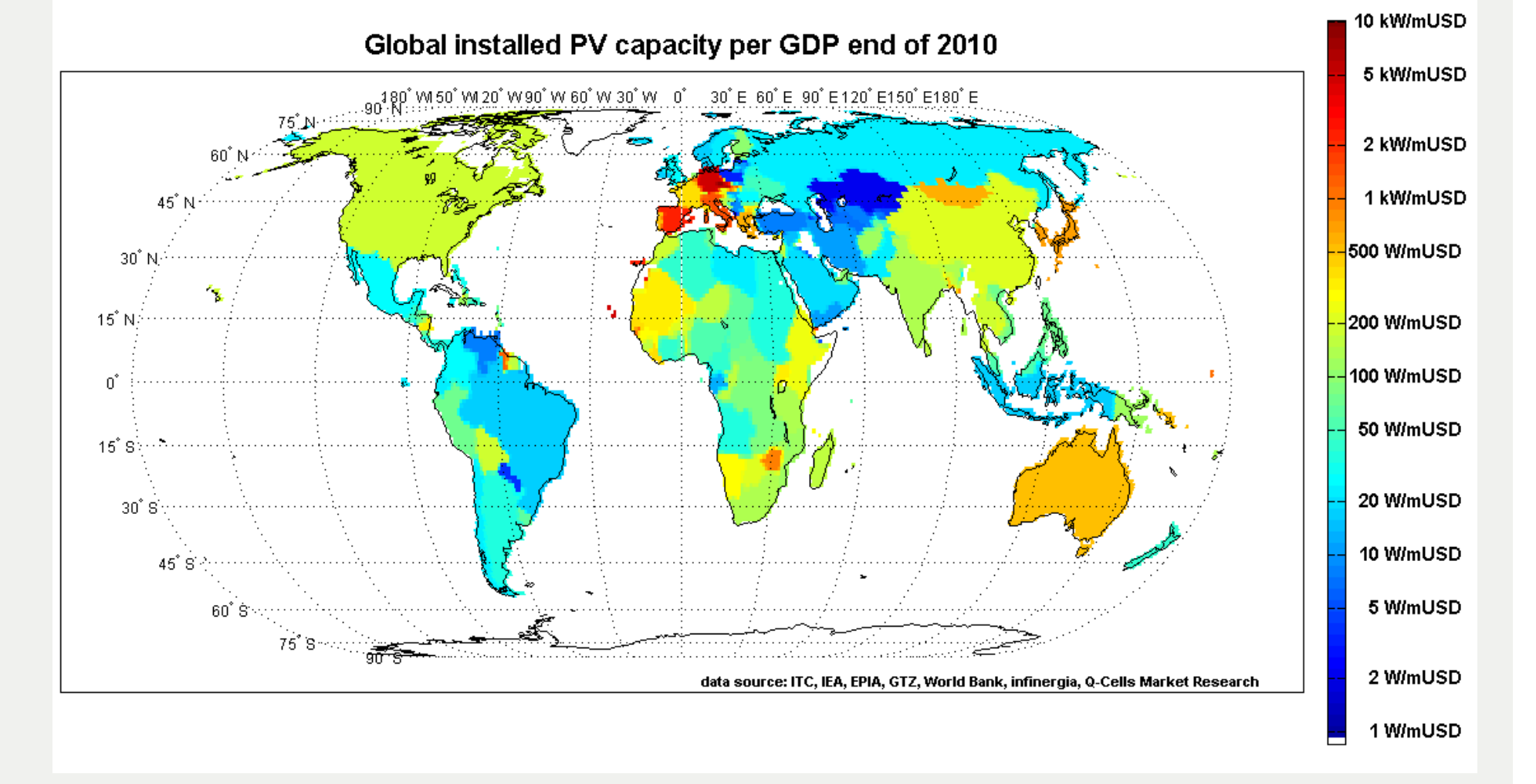


Fig. 4: Global overview on cumulative PV installations per million USD of GDP by end 2010.

- few countries invest considerable fractions of their economic power in PV (Germany, Spain, Czech Rep., Japan, Italy, etc.)
- several developing countries invest more of their GDP in PV than most of highly developed countries (e.g. the US)
 - recognizable in installed PV per economic power
 - off-grid PV markets mainly driven by fast amortization of PV systems in rural areas of developing countries [9]
 - those markets have no need for subsidies

PV Market Growth in 2010

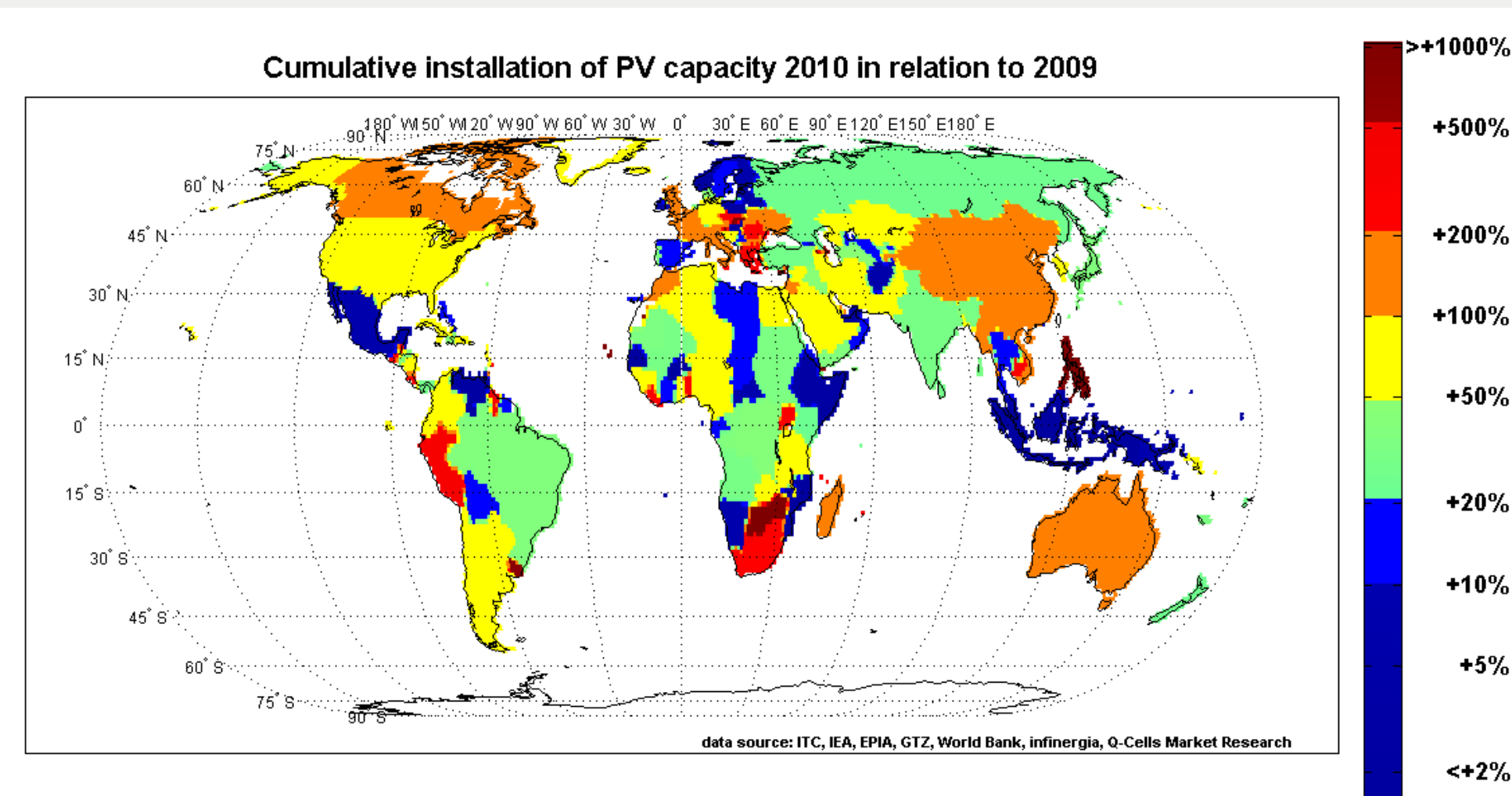


Fig. 6: Ratio of added PV capacity in 2010 to cumulative PV installations in 2009 by growth categories.

- few countries have reached huge growth rates in 2010
- several European PV markets have more than doubled (Czech Republic, Romania, Greece, Bulgaria, Italy, UK, France, Belgium), whereas German market grew by 78%, and others grew not more than 10% (e.g. Spain, Finland)
- East Asian PV markets show growth rates about 40%-50%
- South East Asian markets are boosted by growth rates higher than 100%, e.g. Australia, Philippines, China, Cambodia, Vietnam, Myanmar, Mongolia, Singapore)
- African markets grew substantially across the continent
- Americas are quite different
 - enormous growth by about 200% and higher, e.g. Uruguay, Guyana, Peru, Costa Rica and Canada
 - slow to zero growth, e.g. Venezuela, Mexico and Bolivia
- in total the majority of PV markets grew by more than 50% and in more than 50 countries the growth was higher than 100%

PV Markets

sample of markets' PV capacities by end of 2010:

country	PV [MWp]	country	PV [MWp]
Germany	17,210	Portugal	125
Spain	3,840	Austria	100
Japan	3,610	Switzerland	90
Italy	3,490	Netherlands	86
United States	2,520	United Kingdom	71
Czech Republic	1,950	Thailand	46
France	1,050	Israel	40
China	860	South Africa	39
Belgium	795	Slovenia	36
Rep. Korea	655	Russia	35
Australia	530	Bangladesh	35
Canada	240	Mexico	30
Greece	205	Luxembourg	30
India	180	Brazil	27
Slovakia	145	Finland	26

References

- ITC, 2011. Market Analysis Tool Product Map, Market Analysis and Research Section, ITC, Geneva, www.trademap.org/
- Hering G., 2011. Year of the tiger, Photon International, 2011(3), p. 186-218
- GTZ, 2009. Energy-policy Framework Conditions for Electricity Markets and Renewable Energies, GTZ Division Environment and Infrastructure, Berlin
- IEA-PVPS, 2011. Trends in Photovoltaic Applications, IEA-PVPS, Paris., prelim.
- EPIA, 2010. Unlocking the Sunbelt, Brussels
- EPIA, 2011. Global Market Outlook for Photovoltaics Until 2015, EPIA, Brussels
- Breyer Ch. et al., 2010. Research and Development Investments in PV - A limiting Factor for a fast PV Diffusion?, 25th EU PVSEC, Valencia
- Breyer Ch. and Schmid J., 2010. Population Density and Area Weighted Solar Irradiation, 25th EU PVSEC, Valencia
- Breyer Ch., Werner C., Rolland S., Adelman P., 2011. Off-Grid Photovoltaic Applications in Regions of Low Electrification: High Demand, Fast Financial Amortization and Large Market Potential, poster 5B.V.1.45
- Breyer Ch. et al., 2010. Fuel-Parity: New Very Large and Sustainable Market Segments for PV Systems, IEEE EnergyCon, Manama

Conclusion

- 38,534 MWp allocated to 190 countries
- not allocatable PV capacity ('Rest-of-World') has been reduced by about 1,000 MWp
- analysis of ITC customs data for the years 2001 - 2010 enables an allocation of 120 MWp in 88 countries of no other data source
- insights of local experts and examination of reports complement all other data
- 487 MWp assumed to be installed before 2001 being not allocatable by the customs approach
- further 512 MWp expected to be installed in 2001 - 2010 but cannot be allocated
- some countries invest high ratios of their economic power in PV
- off-grid PV markets have typically no need for subsidies but respective countries reached high share of PV in total power plant capacities
- the majority of countries in the world show a growth rate of more than 50% and 50 countries grew by more than 100% from 2009 to 2010

Detailed data for 190 countries available in Conference Paper. Please provide your business card for further information.