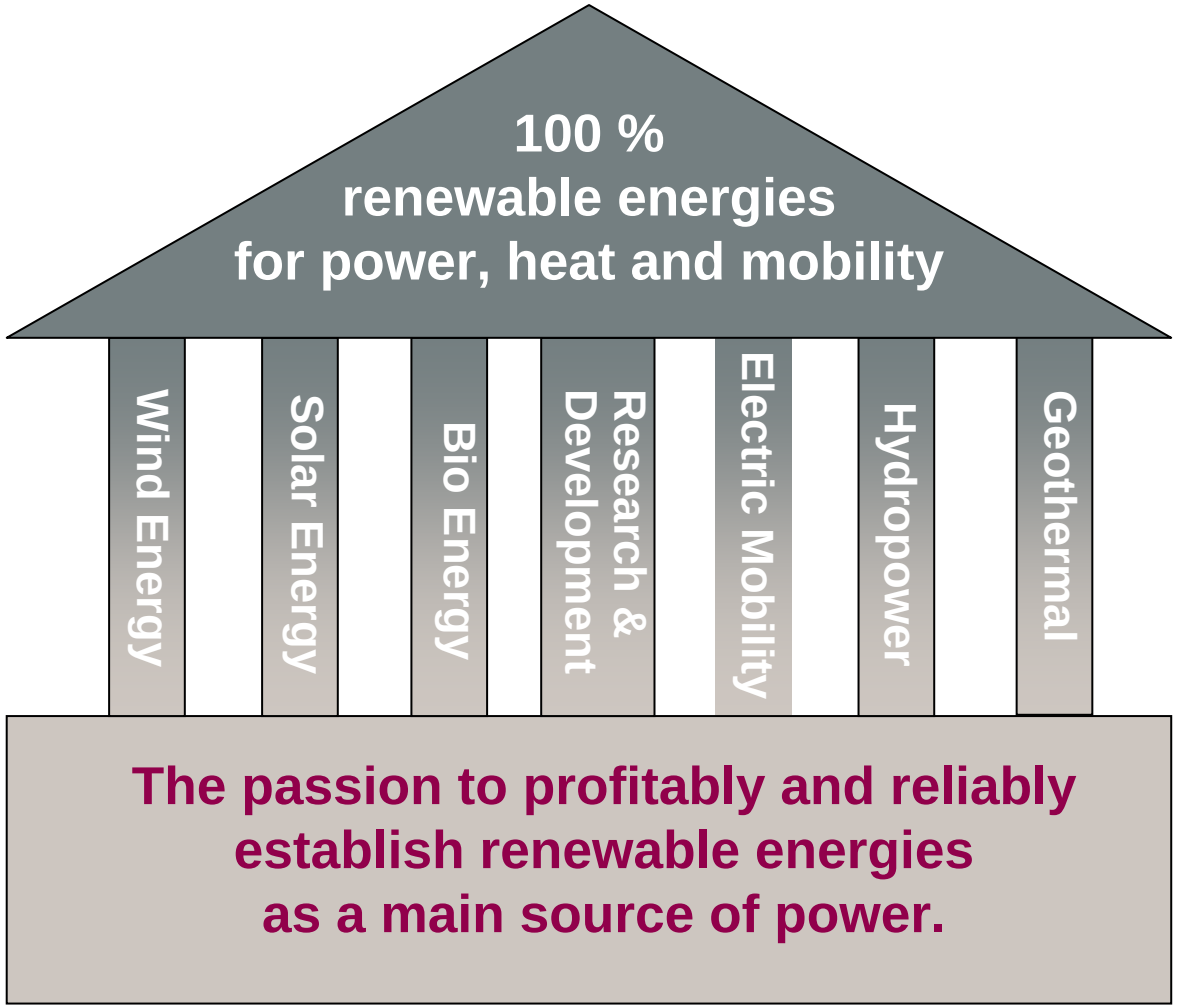
Solar Power:
Photovoltaic Systems for a Variety of Applications

Christian Hinsch
Director Corporate Communications
juwi Holding AG

Contents


We make it
happen

1.1 Our vision



1.1 Our services

Goal-oriented integration

- Consulting
- Acquisitions & Site Selection
- Planning
- Development
- Financing & sales
- Implementation
- Commercial & technical management

The sum of all parts:
people, nature, technology

juwi is your partner during every phase of project development.

1.2 juwi at a glance

established: 1996
workforce: approx. 800 employees
revenues: approx. 600 mil. € (in 2009)

Headquartes in Wörrstadt (Germany)

Project Development of Renewable Energy Plants

Planning – Realisation – Financing – Operation

Wind Power

- approx. 400 wind turbines
- approx. 600 megawatts

50-MW wind farm in Costa Rica

Photovoltaic Systems

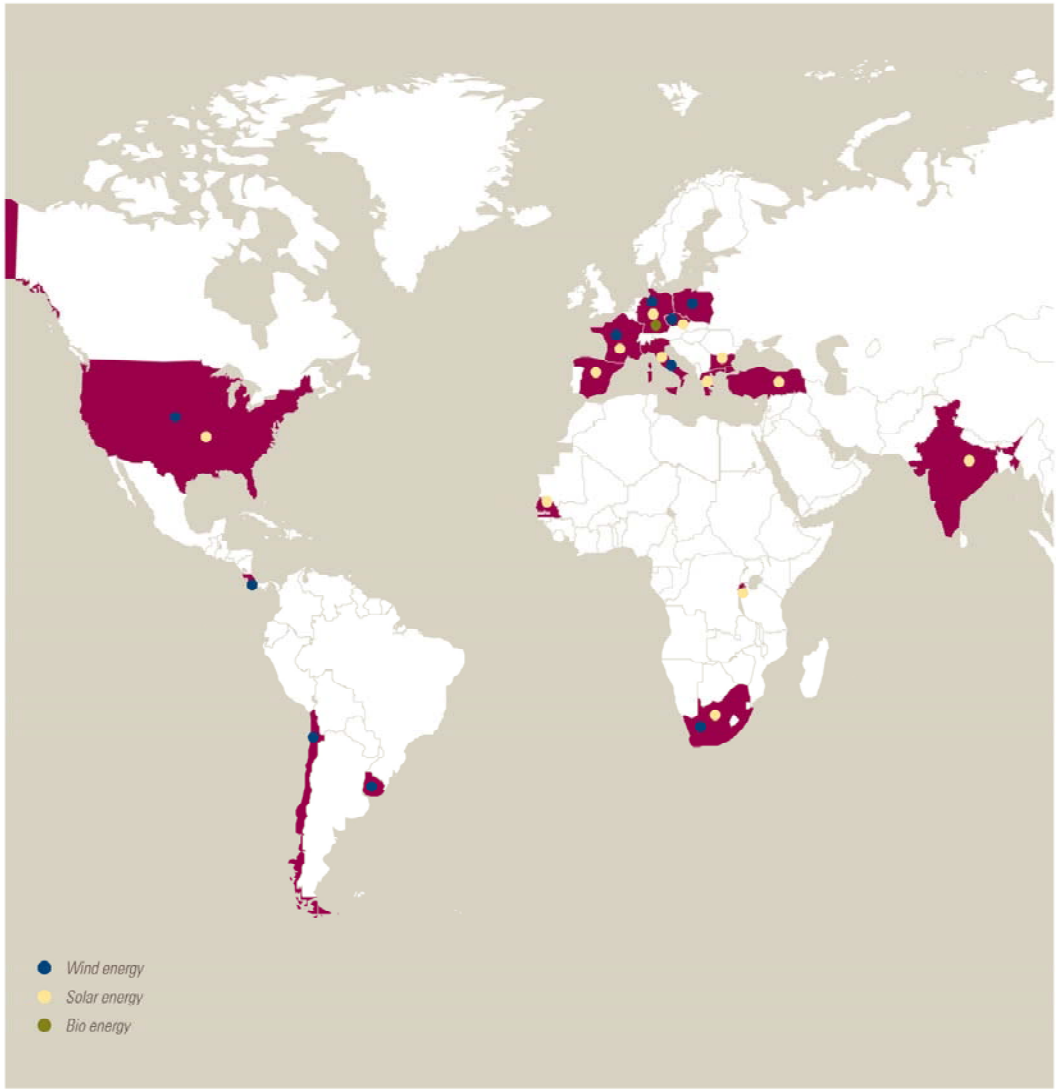
- approx. 1,200 installations
- approx. 400 megawatts

53-MW solar farm in Lieberose

Bioenergy

- 4 Biogas Installations
- Wood Pellets Production

1.2 Offices, projects and new markets



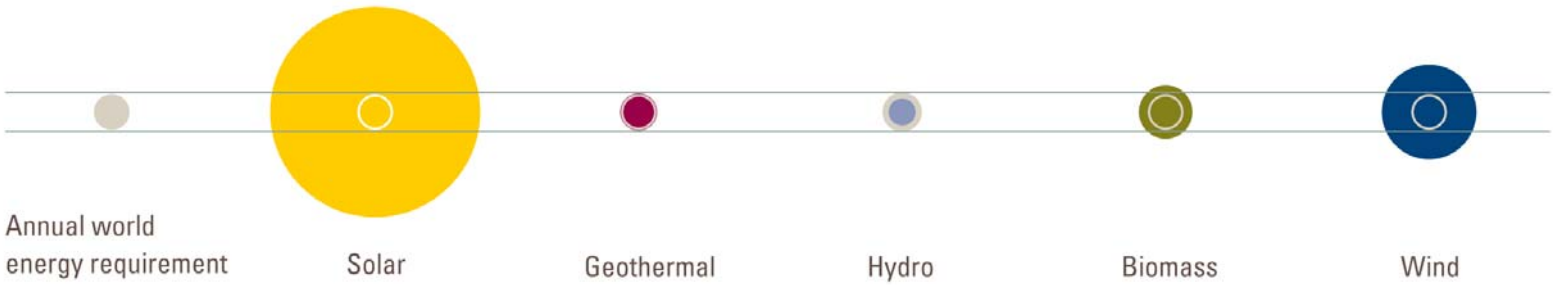
- **Approx. 800 employees worldwide:**
  - Germany:
    Wörrstadt, Brandis, Berlin
  - Western & Southern Europe:
    France, Italy, Spain, Greece
  - Eastern Europe:
    Czech Republic, Poland
  - United States
  - Costa Rica


Different
kind of
energies

2.0 Renewable Energies in General

Potential of renewable energies

- The annual supply of renewable energy sources significantly surpasses the world's energy needs.
- It is conceivable that the world's energy demand could be met by renewable energy sources within the next 40 years.



2.0 Renewable Energies in General

Re-thinking 2050: 100% Renewables for Europe

Renewable Electricity Installed Capacity (GW)

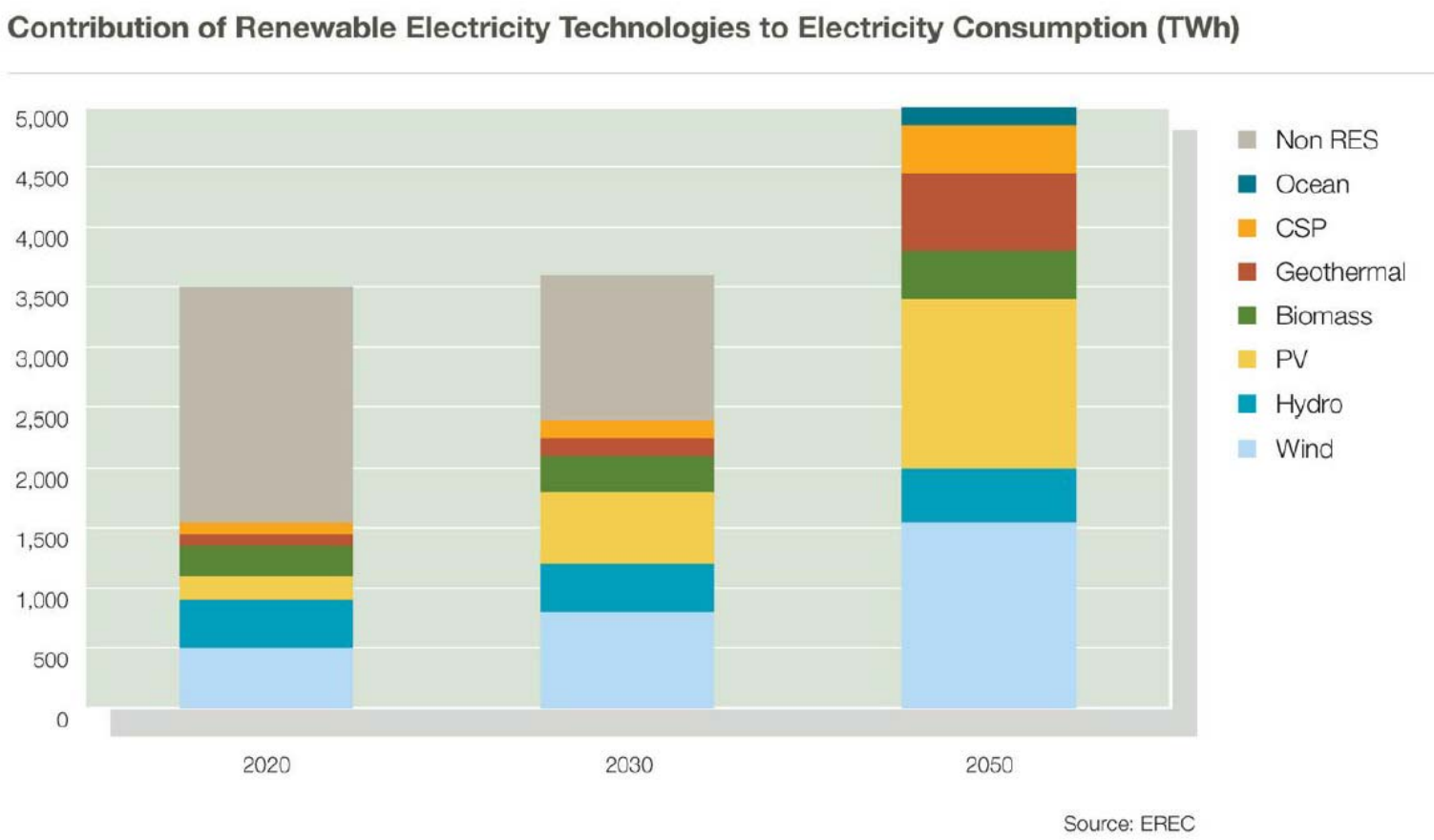
	2007	2020	2030	2050
Wind	56	180	288.5	462
Hydro[1]	102	120	148	194
PV	4.9	150	397	962
Biomass	20.5	50	58	100
Geothermal	1.4	4	21.7	77
CSP	0.011	15	43.4	96
Ocean	-	2.5	8.6	65
Total RES-E capacity (GW)	185	521.5	965.2	1,956

Source: EREC

1 The capacity of pumped storage plants is not included

2.0 Renewable Energies in General

Re-thinking 2050: 100% Renewables for Europe



2.1.1 Wind energy – General Aspects

Facts & figures (worldwide)*:

- Installed capacity: > 160,000 megawatts
- Leading markets:
  USA: 35,159 MW
  Germany: 25,777 MW
  China: 25,104 MW
- Prospects (2014): > 400,000 megawatts

Wind farm in Guanacaste, Costa Rica

Advantages / Disadvantages:

- high energy yield per area (+)
- low production costs (+)

- change of landscape (-)
- volatile production (-)

Wind farm in Brittany, France

***: source Global Wind Energy Council (GWEC)**

2.1.2 Solar energy – General Aspects

Facts & figures (worldwide)*:

- Installed capacity: > 22,000 megawatts
- Leading markets:

  Germany: 10,000 MW

  Spain: 3,600 MW

  Japan: 2,600 MW

  USA: 2,100 MW

  Italy: 1,200 MW
- Prospects (2014): > 30,000 megawatts

Advantages / Disadvantages:

- high energy yield per area (+)
- Good correlation between production / consumption (+)
- high production costs (-)
- volatile production (-)

Free-field installation / former military area in Brandenburg, Germany

Solar soccer stadium in Verona, Italy

***: source Solar Energy Industries Association (SEIA)**

2.1.3. Other Renewables – General Aspects

Sources:

- Bioenergy
- Hydropower
- Geothermal Energy
- Ocean Energy (waves…)
- Something new to come…

Energy cabin at juwi‘s headquarters in Wörrstadt

Advantages / Disadvantages:

- constant production (+)
- good correlation between production / consumption (+)
- low production costs (+)

- bioenergy: low energy yield per area (-)
- hydropower: limited potential (-)

Biogas power plant in Bischheim, Germany

2.2 The Energy Mix - more Regional Value

Profits for communities:

- Climate protection & sustainability
- Income from leasing land
- Income from tax revenues
- New employment for local companies
- Attractive to tourists
- Environmentally-improved image

Facts & figures

Morbach Energy Landscape:

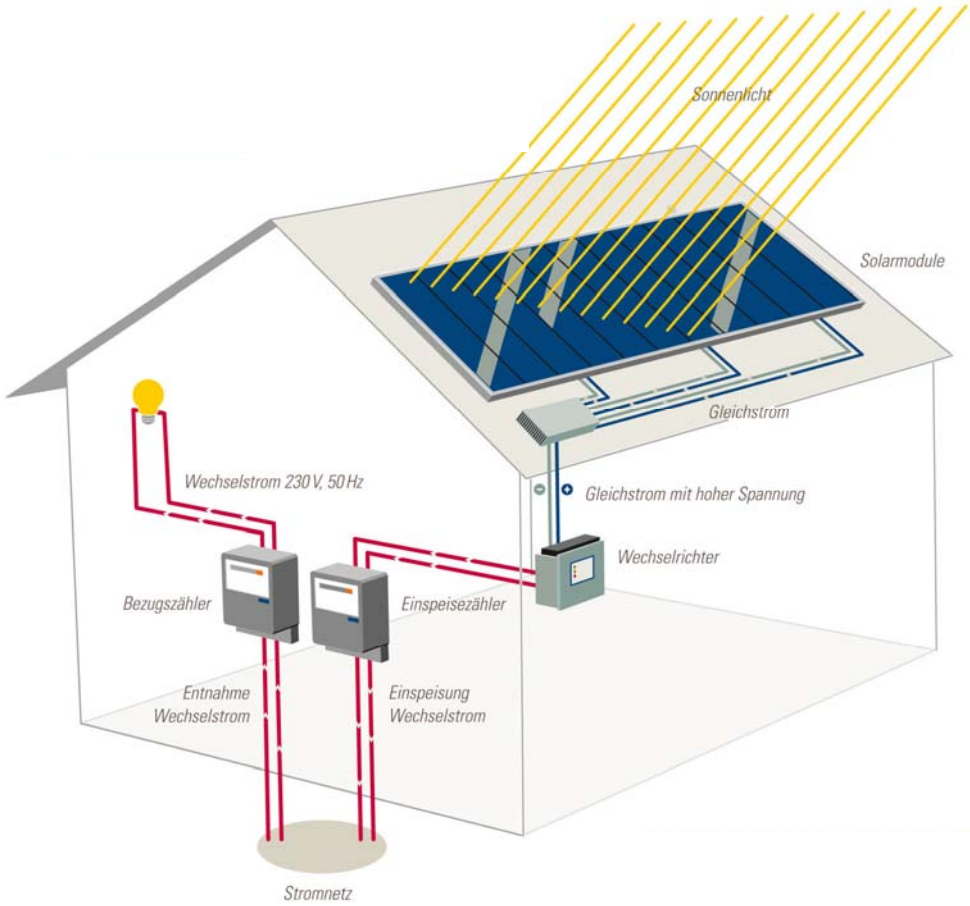
- 14 wind turbines (two megawatts each)
- Free-field PV systems (> 1,000 kW)
- Biogas power plant (500 kW)
- Wood pellet production facility
- Wood-based heating plant
- More than 20,000 visitors

Wind, solar and bio energy at
the Morbach Energy Landscape (Germany)

Instead of spending money importing raw materials, jobs can be created in the region.


Photovoltaic
Applications

3.0 How is a PV system working?



Quelle: Agentur für Erneuerbare Energien

3.1 Building Integrated PV-Systems

juwi headquarters and carports in Wörrstadt, Germany:
260 kWp (modules supplied by various manufacturers)

3.1 Building Integrated PV-Systems

**Carports at juwi's headquarters in Wörrstadt, Germany:
48 kWp (modules supplied by various manufacturers)**

3.1 Building Integrated PV-Systems

Soccer Stadium 1. FSV Mainz 05, Germany:
240.8 kWp (modules supplied by Sharp & S.E. Project)

3.1 Building Integrated PV-Systems

Market hall in South Tyrol, Italy:
520 kWp (modules supplied by First Solar)

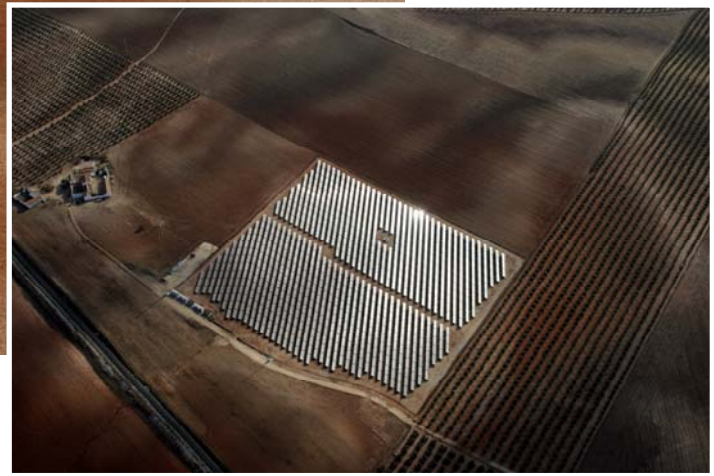
3.1 Building Integrated PV-Systems

Logistic Center in Muggensturm, Germany:
1,800 kWp (modules supplied by First Solar)

3.2 Free-field PV-Installations

Mont Jali in Kigali, Rwanda:
250 kWp (modules supplied by First Solar)

3.2 Free-field PV-Installations



El Cura, Malaga region, Spain:
2,000 kWp (modules supplied by First Solar)

3.2 Free-field PV-Installations

Agricultural site in Mehring, Germany:
3,450 kWp (modules supplied by First Solar)

3.2 Free-field PV-Installations

Agricultural Site in Rapale, Corse (France):
7,700 kWp (modules supplied by First Solar)

3.2 Free-field PV-Installations

Former airfield in Brandis/Waldpolenz, Saxony:
40,000 kWp (modules supplied by First Solar)

3.2 Free-field PV-Installations

Former airfield in Lieberose, Brandenburg:
52,790 kWp (modules supplied by First Solar)

3.2 Free-field PV-Installations

Former airfield in Lieberose, Brandenburg:
52,790 kWp (modules supplied by First Solar)

3.3 Offgrid PV Systems

Power for the lightning system of a hospital in Peru
5.7 kWp + battery storage system

3.3 Offgrid PV Systems

Power for a local hospital station in Senegal
3.96 kWp + battery storage system


On the way
to grid parity

4.0 Feed-in tariffs (Germany)

	Feed-in tariff (2010) €-cents / kWh	Feed-in tariff (2009) €-cents / kWh
Free-field	28.43	31.94
Small roof (< 30 kWp)	39.14	43.01
Medium roof (30-1,000 kWp)	35.23 - 37.23	39.58 - 40.91
Larger roof (>1,000 kWp)	29.37	33.00

- **Higher price than the consumer is paying for electricity (22 ct./kWh) but: consumer prices are rising – solar power becomes cheaper!**

4.1 Building Technology

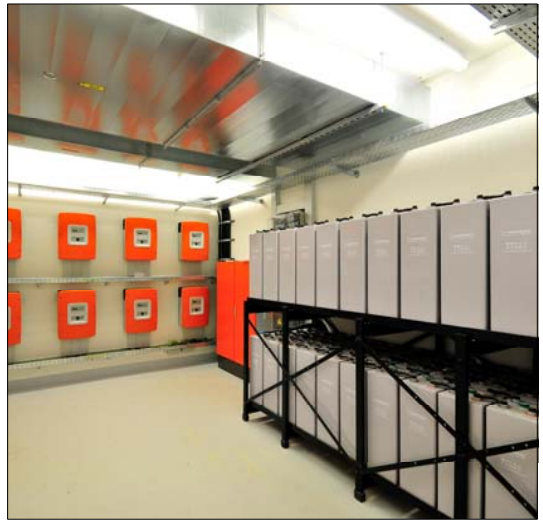
Combination of Energy Technologies:

- PV-Systems at the building (fassade, roof)
- PV-Systems close to the building (e.g. carports)
- Storage Technology (e.g. batteries)
- Energy Saving & Efficiency (e.g. light & power management)

4.1 juwi‘s headquarters in Wörrstadt

Electricity Production

Total area	ca. 2.500 m²
Total capacity	ca. 260 kW_{peak}
Annual enegy yield	ca. 250,000 kWh/a

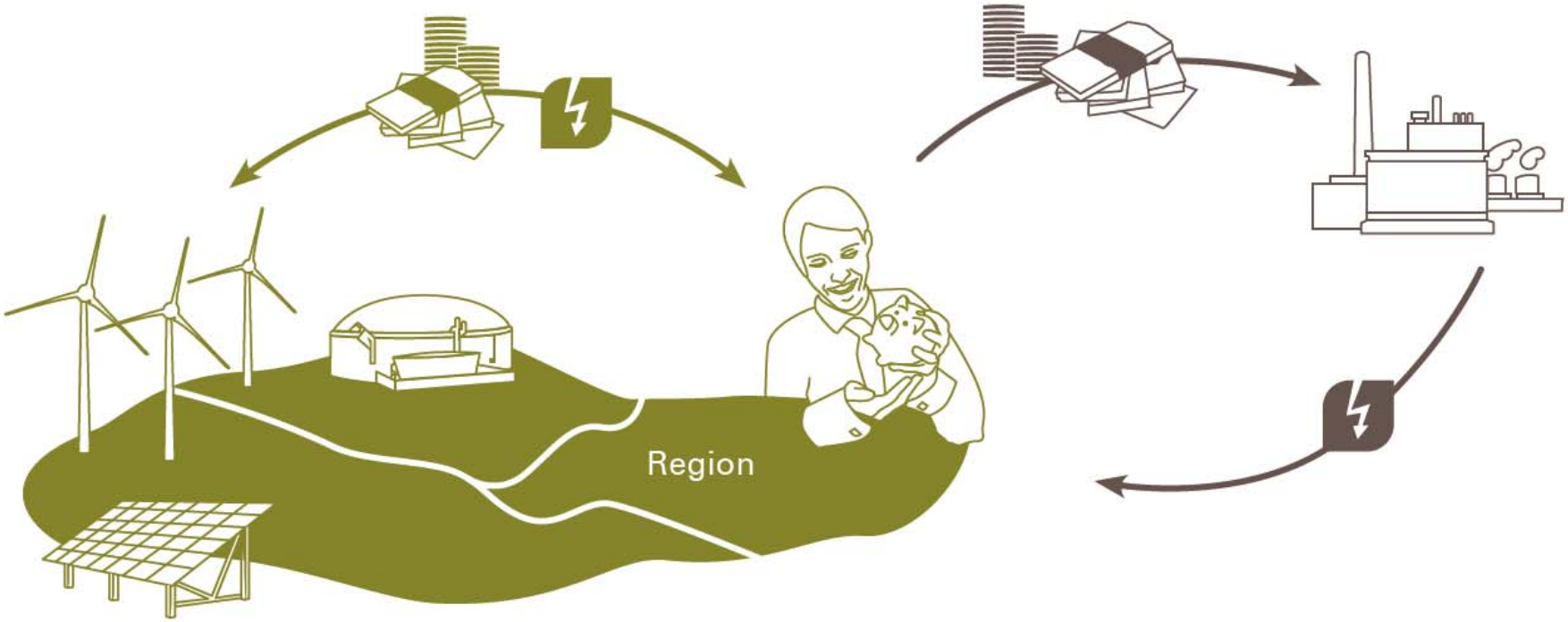


Dining Hall with PV in the Windows

Kindergarten „juwelchen“

4.2 Combined Renewable Power Plants

- Bringing more value to the regions



4.2 Combined Renewable Power Plants

- Combination
  of renewable energy sources:
  - Wind turbines
  - PV Power Systems
  - Bioenergy
  - Hydropower
  - Geothermal Power Stations
- Advantages:
  - Clean electricity
  - Stable energy prices
  - High security of supply
  - Income from land lease
  - Income from tax revenues
  - Tourism
  - Green Image

4.2 Combined Renewable Power Plants

How could this power stations look like?

A combined renewable power plant can secure a purely clean energy supply of communities and industries.

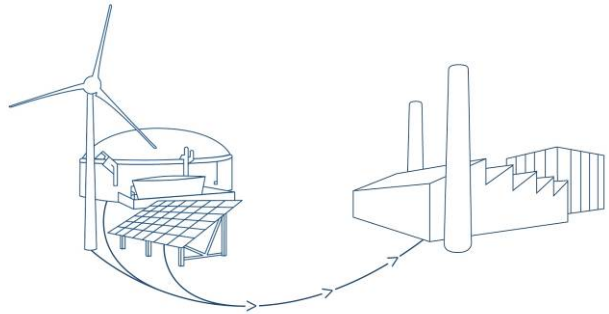
Main components:

- **large share of wind energy**
- **using large PV power systems as a complementary energy source for wind power**
- **using the flexibily of bioenergy**

A large share of „free“ energies – like wind and solar - secures more independency from any kind of resources!

4.2 Combined Renewable Power Plants

Example of a CRPP: 9 GWh / a



Mixture of the CRPP

6 GWh/a Wind power

2 GWh/a free-field solar

1 GWh/a bioenergy

Feed-tariffs*	2010	2013	Degression/a
Wind	8 ct/kWh	7,76 ct/kWh	-1%
PV	28,43 ct/kWh	18,21 ct/kWh	-9%
bioenergy	20 ct/kWh	20 ct/kWh	
Combined energy mix	13,87 ct/kWh	11,44 ct/kWh	

* without taxes

4.2 Will there be enough space?

- Example: federal state of Rhineland-Palatinate

100% clean energy by 2030

40% Wind power

15-20% Solar power

15-20% Bio energy

15-20% Geothermal power

5% Hydropower

4.2 Will there be enough space?

- 17.5% of Solar power = 4,500 megawatts of PV

100% clean energy by 2030

- private homes (1,400 ha)
- factory roofs (3,900 ha)
- free-field applications (3,900 ha)

Sum: 9,200 ha = 3% of the area for settlement and traffic

Thanks for your attention

Contact:
Christian Hinsch
juwi Holding AG
Energie-Allee 1
55286 Wörrstadt
Tel. +49. (0)6732. 96 57-1201
Fax. +49. (0)6732. 96 57-7001
info@juwi.de
www.juwi.de