RLS Energy Network

9th REGIONAL LEADERS' SUMMIT

Energy Transition: Towards a Low Carbon Economy

RLS Energy Network: Internal working session

Monitoring on Renewable Energy in the RLS regions

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RLS Sciences & The Energy Network

RLS Energy Network

- RLS-Sciences had **four research and development themes** in 2016, which were carefully chosen to reflect the best potential for scientific cooperation between the seven RLS regions:

Energy

RLS-Energy focuses on energy innovation across the RLS regions, through key themes (renewable energy, energy efficiency, energy storage and conversion, waste-to-energy)

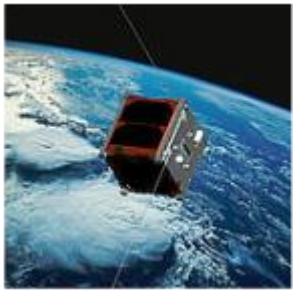
Digitization

RLS-Digitization is assessing the effects of digital integration through ''Beyond Industrie 4.0.''

Aerospace

RLS-Campus Aerospace is supporting the development of young aerospace researchers.

Small Satellites



RLS-Small Satellites is exploring new possibilities for Earth observation and telecommunications.

RLS Sciences & The Energy Network

- Within the framework of RLS, RLS-Sciences aims at generating and supporting **academic, scientific, and technological exchanges**, as well as **the initiation of multilateral research projects**.

- **GOALS:**

Internationalize Facilitate and support the development of international research partnerships between scientists in RLS regions
Innovate Create a framework with which researchers from RLS regions can develop new innovative ideas together
Invest Support RLS scientists by finding funding opportunities for their RLS projects

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Multilateral & Multilevel Governance

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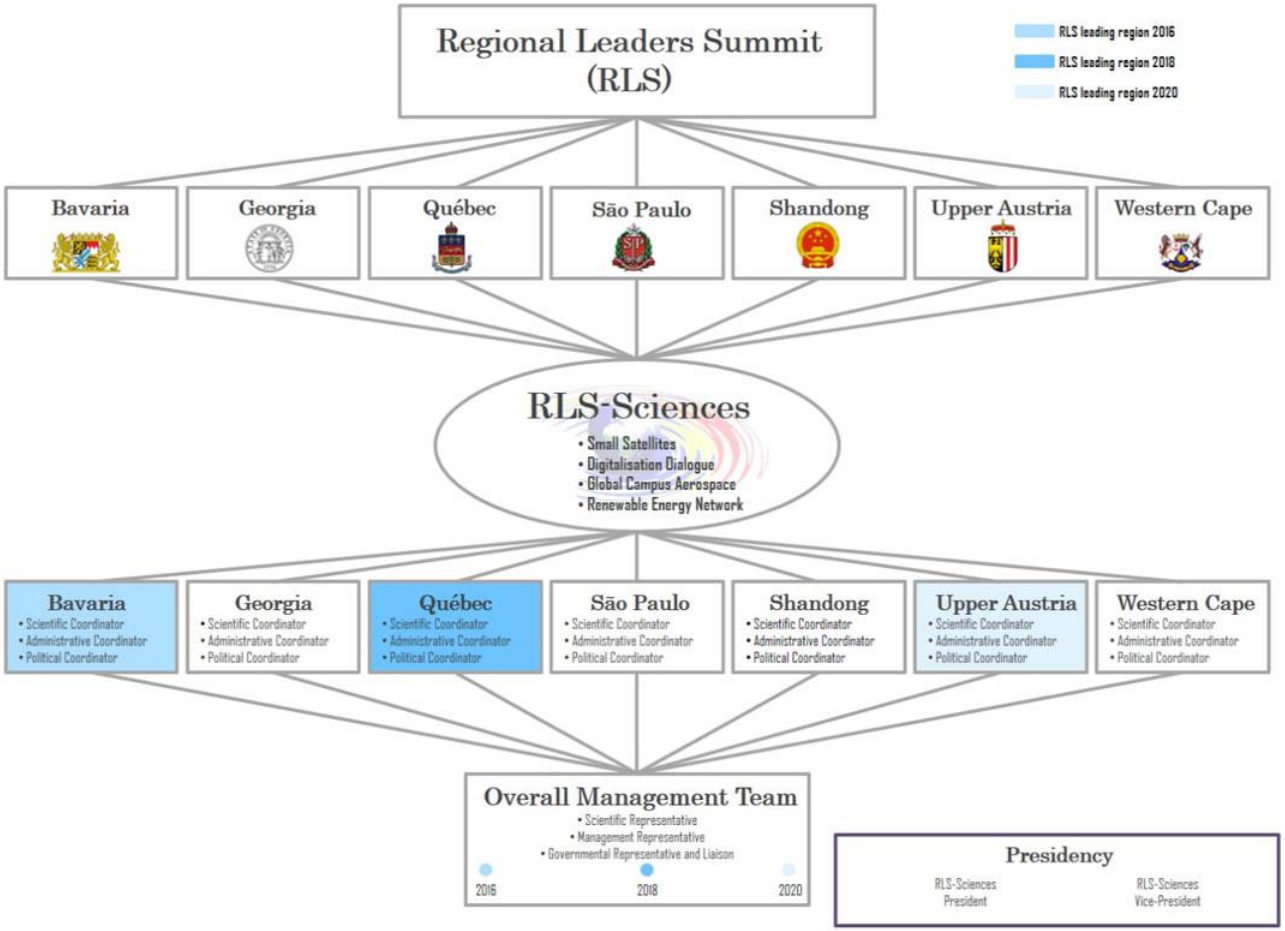


RLS Sciences & The Energy Network

Background & Objectives

RLS Energy Network

- The RLS Energy Network was initiated subsequent to the RLS meeting in São Paulo in 2012. It was agreed among the participants that renewable sources of energy require extensive research.

- The RLS Energy network is used as a means to bring together complementary strengths in energy research to be shared and further developed in a joint effort.

- The objective of the RLS Energy Network is to leverage the geographic and scientific potential of each region through cooperation in the following fields:
  - Renewable Energy
  - Storage & Conversion
  - Energy Efficiency
  - Waste to Energy

https://www.rls-energynetwork.org/

RLS Sciences & The Energy Network

RLS Energy Network

Activities

2002: Inaugural Regional Leaders Summit held in Munich

2012: Sixth Regional Leaders Summit, São Paulo (Energy)

The RLS Member States committed to intensify cooperation in research in renewable energy

2013: International Seminar on Biomass, Biogas and Energy Efficiency, São Paulo

The seminar identified and disseminated leading scholarly work on biomass, biogas and energy efficiency from RLS members.

2014: RLS- Energy Network meets in Western Cape

Members met for a workshop on second generation biofuels and to explore technical cooperation amongst the RLS members.

2015: RLS- Energy Network meets in Québec

Representatives of the Energy Network met to discuss network structure, network management, and next steps.

2016: RLS-Energy Network members present at iSEneC 2016 in Nuremberg

2017: RLS- Energy Network meets in Montréal

Members met to discuss clean energy, biomass and energy storage in the RLS regions.

2017: RLS- Energy Network presents to WindAc conference in Cape Town

The joint conference paper, ''The regional roles and benefits of wind power – a monitoring process for the partner regions Bavaria, Georgia, Upper Austria, Québec, São Paulo, Shandong and Western Cape'' was presented.

2017: 1st Upper Austrian RLS Energy Network Stakeholder workshop in Linz

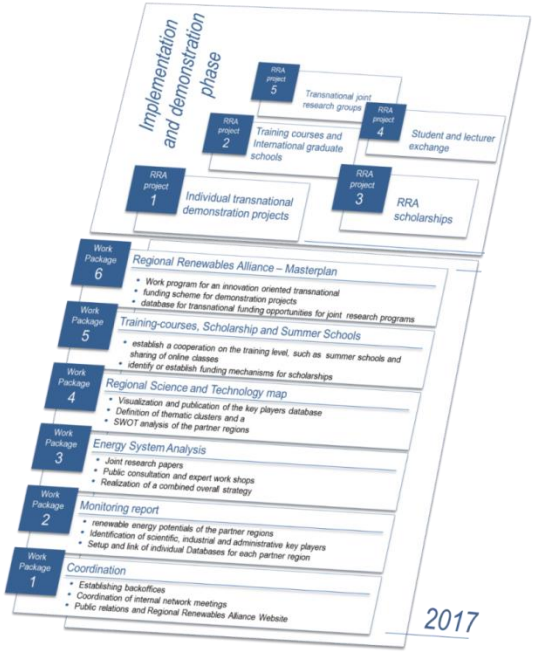
Scientists from Upper Austria and Bavaria introduced their research activities on Power-to-X, energy systems, energy storage and ICT ecosystems for energy savings on the household level to the stakeholders.

Regional Renewables Alliance – Joint Research Project

RLS Energy Network

Objective

To promote the global integration, storage and transportation of renewables energies



Preparatory phase

- Monitoring
- Energy System Analysis
- Technology Map
- Training & Exchange
- Master Plan

Implementation & Demonstration

Transcontinental demonstration projects that establish, test and evaluate new technologies

Regional Renewables Alliance – Joint Research Project

RLS Energy Network

Work Packages

The Regional Renewables Alliance jointly produced a **roadmap**, which lays out how they will work towards developing multilateral projects on renewable energies across the seven partner regions.


Roadmap
Joint Research and Innovation program

Regional Renewables Alliance
Part A – Overall approach

List of participants:

Participant No.	Participant organisation name	Country
1	Friedrich-Alexander-Universität Erlangen-Nuremberg	Bavaria
2	Energy Institute Linz at the Johannes Kepler University of Linz	Upper Austria
3	State University of Campinas (Unicamp), São Paulo	São Paulo
4	Fonds de recherche du Québec – Nature et technologies (FRQNT)	Québec
5	Shangdong University	Shangdong
6	Georgia tbd	Georgia
7	Stellenbosch University	Western Cape

Project Start: January 1st 2017
Project Duration: 2 years
Coordination:

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Work Package	
N° 1 **- in progress -**	**Coordination** 1.1 Establishing back offices 1.2 Coordination of network meetings 1.3 Public relations and Regional Renewable Alliance Website
N° 2 **- in progress -**	**Monitoring report** 2.1 Renewable energy potentials of the partner regions 2.2 Identification of scientific, industrial and administrative key players 2.3 Setup and link of individual databases for each partner region
N° 3	**Energy System Analysis** 3.1 Research papers 3.2 Public consultation and expert workshops 3.3 Development of overall strategy
N° 4	**Regional Science and Technology Map** 4.1 Visualization and publication of the key players database 4.2 Definition of thematic clusters 4.3 SWOT analysis of the partner regions
N° 5 **- in progress -**	**Training courses, Scholarships and Summer Schools** 5.1 Establish a cooperation on the training level 5.2 Identify or establish finding mechanisms for scholarships 5.3 Roll out scholarships
N° 6	**Regional Renewable Alliance - Masterplan** 6.1 Work program for transnational funding scheme 6.2 Database for transnational funding opportunities 6.3 Definition Masterplan

Monitoring on Renewable Energy in the RLS regions

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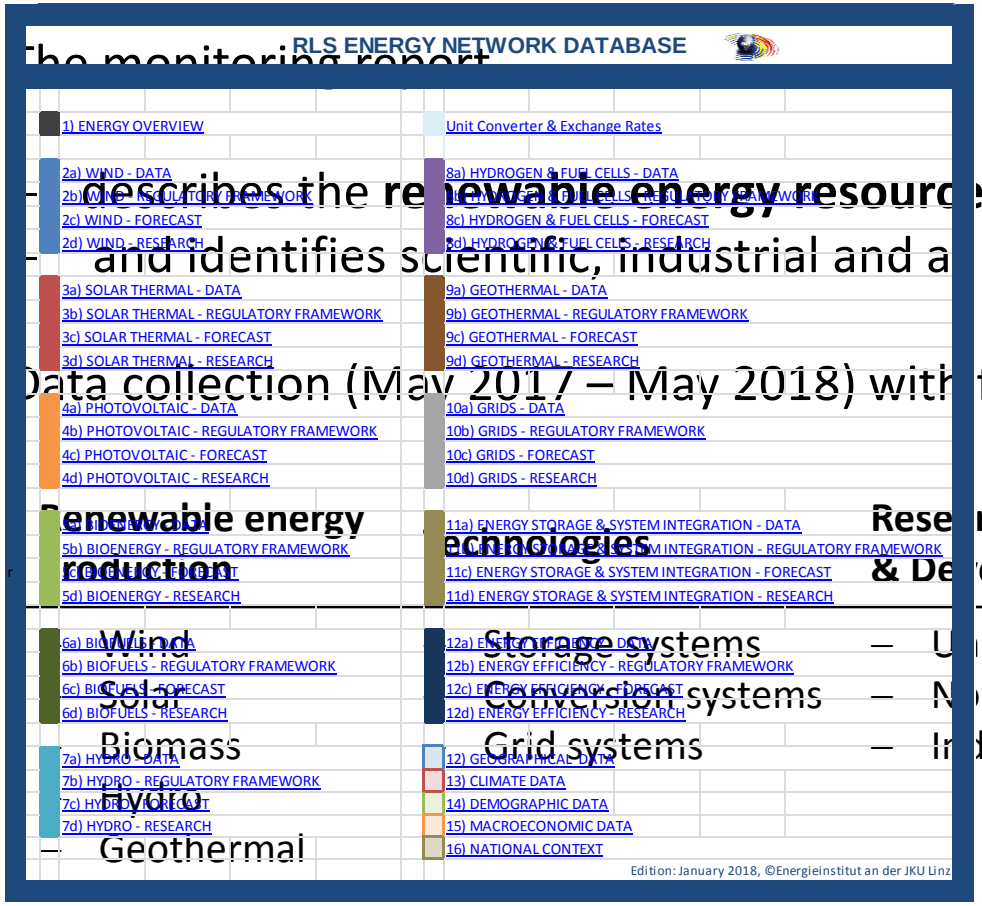
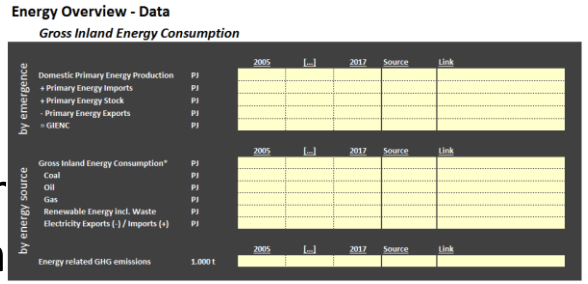
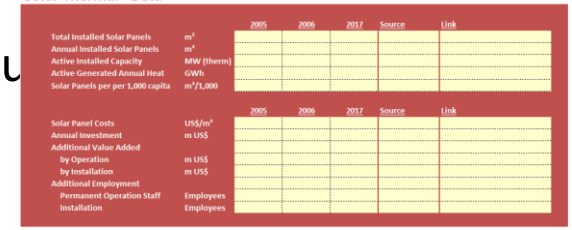
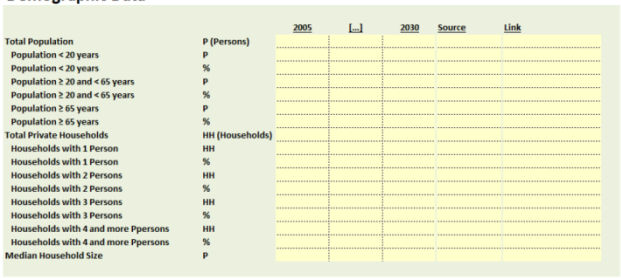
Methodology









- The monitoring report
  - describes the renewable energy resources and
  - and identifies scientific, industrial and a min
- Data collection (May 2017 – May 2018) with focu

Renewable energy production

- Wind
- Solar
- Biomass
- Hydro
- Geothermal

Technologies

- Storage systems
- Conversion systems
- Grid systems

Research & Development

- Universi
- Non-uni
- Industry

Policy frameworks

promotion actions

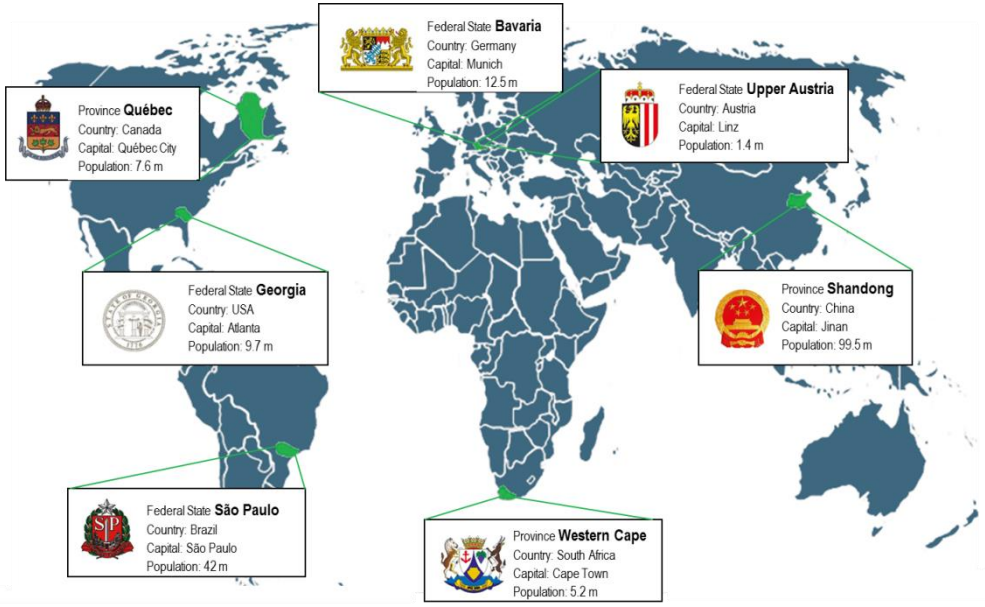
Monitoring on Renewable Energy in the RLS regions

RLS Energy Network

Methodology

ENERGIE INSTITUT an der Johannes Kepler Universität Linz
JOHANNES KEPLER UNIVERSITÄT LINZ
UNIVERSITY OF APPLIED SCIENCES UPPER AUSTRIA
LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN
FAU FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG
TUM TECHNISCHE UNIVERSITÄT MÜNCHEN
HOCHSCHULE LANDSHUT TECHNOLOGIEZENTRUM ENERGIE
Bayerische Forschungsallianz
UNIVERSITÉ DE SHERBROOKE
Fonds de recherche Nature et technologies Québec
中国科学院 CHINESE ACADEMY OF SCIENCES
山东大学 SHANDONG UNIVERSITY
UNICAMP
UNIVERSITEIT STELLENBOSCH UNIVERSITY
CENTRE FOR RENEWABLE & SUSTAINABLE ENERGY STUDIES
GreenCape Supporting the business of green

Multilateral and multilevel cooperation for data collection



Monitoring on Renewable Energy in the RLS regions

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Summary

- The collection of data and information reveals that the RLS partner regions represent all main renewable energy sources and have already established large capacities at remarkable growth rates in the past.
- The RLS regions integrate **wind**, **solar**, **biomass**, **hydro** and **geothermal** resources into their regional energy system and utilize them for **electricity**, **heat** and **fuel production**.
- It also provides insights into new and developing technologies, i.e. **advanced storage**, **fuel cells** and **grid systems**.
- Several RLS governments face national regulation for renewable energy and implemented **targets**, **voluntary actions** and **incentive programs** .
- **Research & Development** activities with regard to renewable energy take a significant part in the transformation of the RLS regions' energy systems.

Monitoring on Renewable Energy in the RLS regions

RLS Energy Network

Regional key facts

These indicators help to categorize the role of renewable energies with geographic, climatic and socio-economic key factors of the RLS partner regions.

Geographical Data

		2005	[...]	2017	Source
Total Area	km²				
Permanently Inhabited Area	km²				
Total Population	P (Persons)				
Inhabitants per Total Area	P / km²				
Inhabitants per Permanently Inhabited Area	P / km²				

Macroeconomic Data

		2005	[...]	2017	Source	Link
Exchange Rate US$ / €	US$ / €					
Gross Regional Product (current prices)	M US$					
Primary Sector	US$					
Primary Sector	%					
Secondary Sector	US$					
Secondary Sector	%					
Tertiary Sector	US$					
Tertiary Sector	%					
Inflation Rate	%					
Consumption of Private Households	US$					
Investment	US$					
Disposable Income	US$					
Exports	US$					
Imports	US$					
Employment	P (Persons)					
Primary Sector	P					
Primary Sector	%					
Secondary Sector	P					
Secondary Sector	%					
Tertiary Sector	P					
Tertiary Sector	%					

Climate Data

		2005	[...]	2017
Mean Air Temperature	°C			
Rainfall	liter / m²			
Days with Rainfall (> 0.1 liter / m²)	days			
Sunshine	hours			

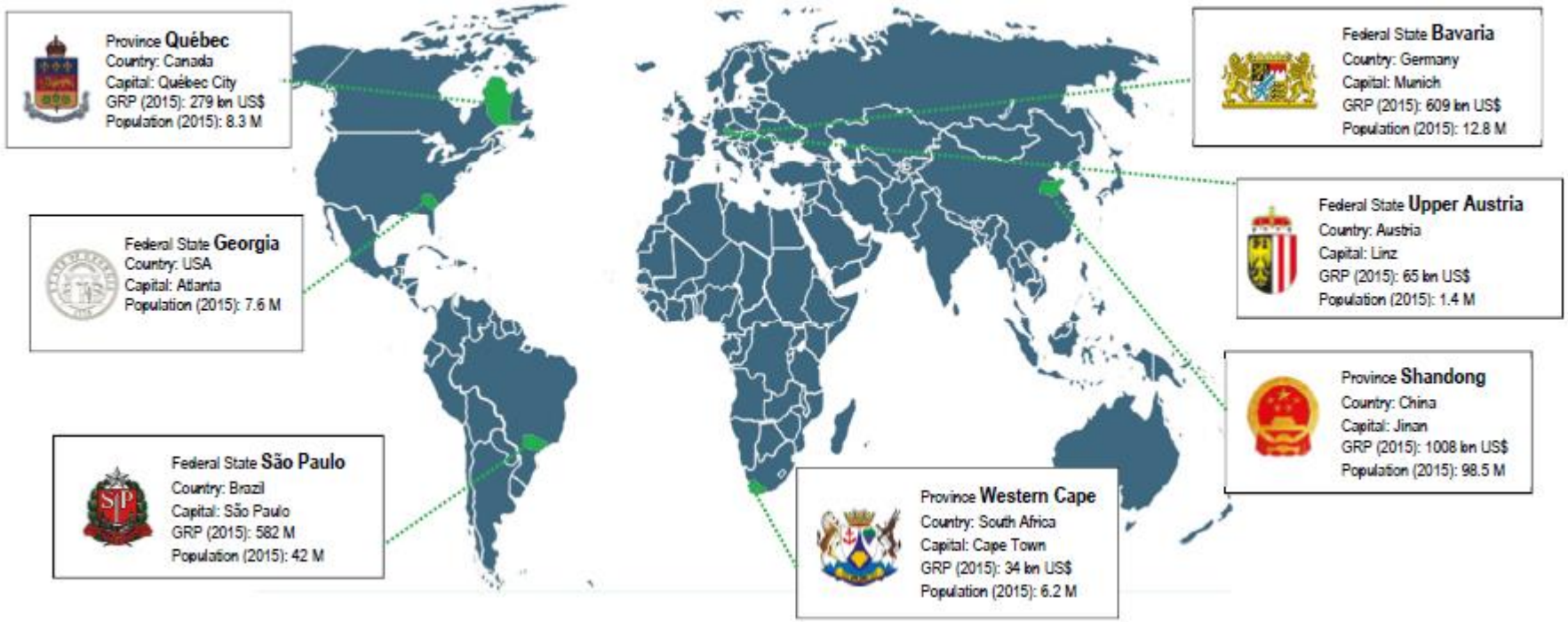
Demographic Data

		2005	[...]	2030	Source	Link
Total Population	P (Persons)					
Population < 20 years	P					
Population < 20 years	%					
Population ≥ 20 and < 65 years	P					
Population ≥ 20 and < 65 years	%					
Population ≥ 65 years	P					
Population ≥ 65 years	%					
Total Private Households	HH (Households)					
Households with 1 Person	HH					
Households with 1 Person	%					
Households with 2 Persons	HH					
Households with 2 Persons	%					
Households with 3 Persons	HH					
Households with 3 Persons	%					
Households with 4 and more Ppersons	HH					
Households with 4 and more Ppersons	%					
Median Household Size	P					

Monitoring on Renewable Energy in the RLS regions

RLS Energy Network

Regional key facts



The RLS regions are located on 4 continents and are geographically, climatically, demographically and economically diverse.

Monitoring on Renewable Energy in the RLS regions

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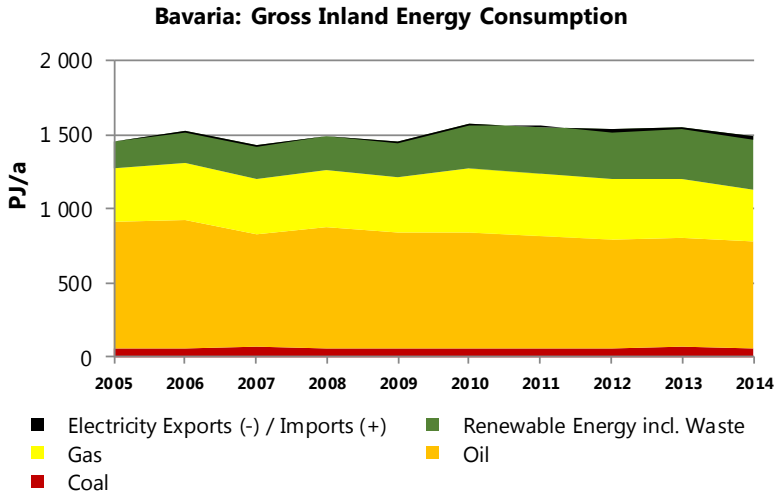
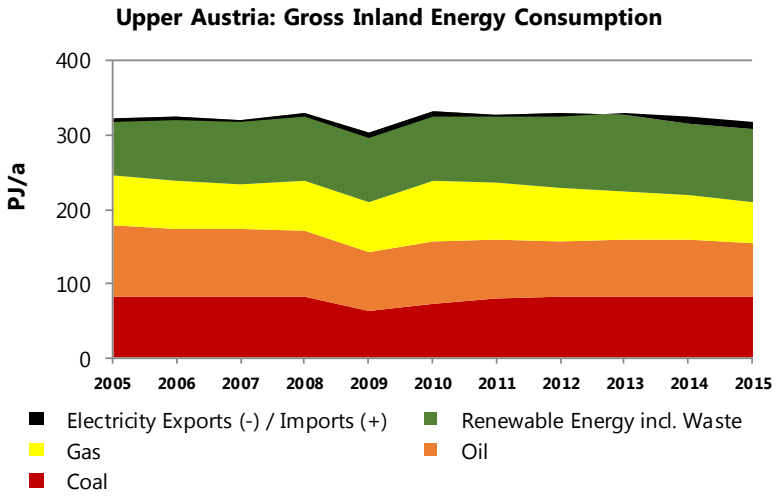
Renewable energies' status on the regional level

Gross inland energy consumption - exemplary results

The gross inland energy consumption corresponds to the amount of energy used to cover the domestic demand (boundary is the regional border). It is defined as the sum of the domestic primary energy production, primary energy imports and primary energy stocks minus primary energy exports.





Source: Monitoring Report on Renewable Energy in the RLS regions

Monitoring on Renewable Energy in the RLS regions

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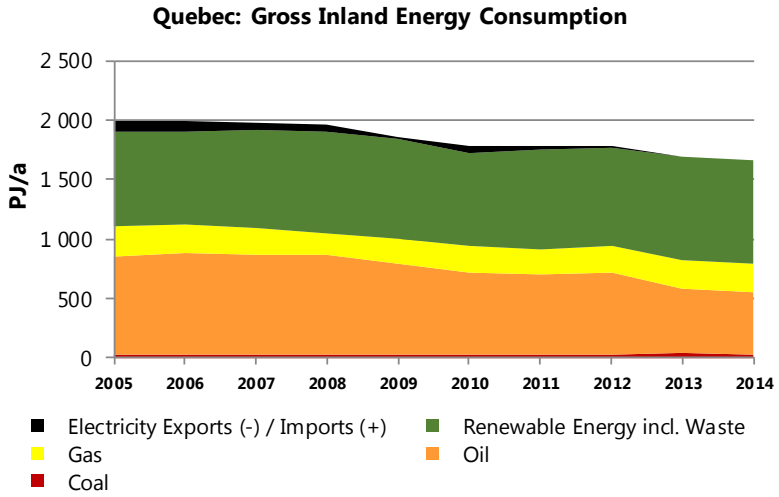
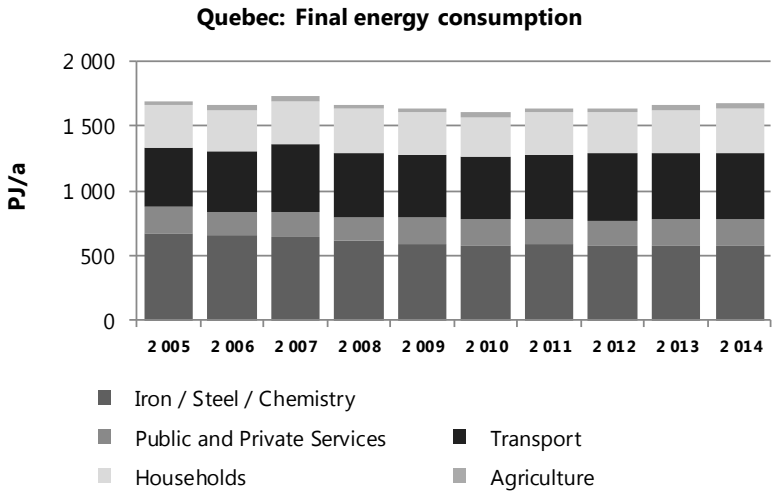
Renewable energies' status on the regional level

Gross inland energy consumption / Final energy consumption - exemplary results

Accounting for non-energy consumption, transformation losses, transport losses and the consumption of the sector energy leads to the final energy consumption.





Source: Monitoring Report on Renewable Energy in the RLS regions

Monitoring on Renewable Energy in the RLS regions

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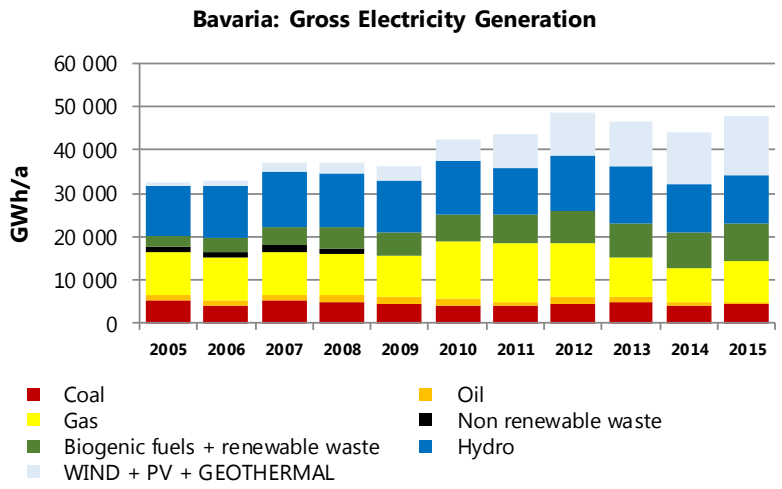
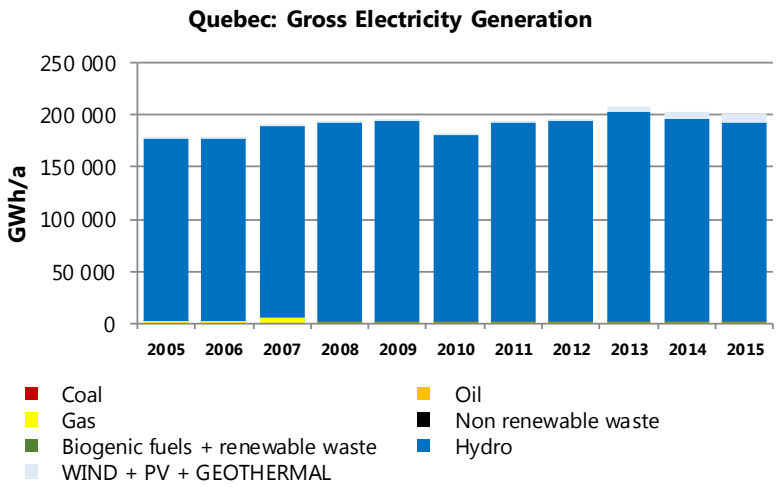
Renewable energies' status on the regional level

Gross electricity generation - exemplary results





Source: Monitoring Report on Renewable Energy in the RLS regions

Monitoring on Renewable Energy in the RLS regions

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Renewable energies' in detail: Solar Thermal Energy

Bavaria		2012	2013	2014	2015	2016
Total Installed Solar Panels	m^2	5,401,200	5,667,400	5,889,400	6,068,100	6,295,500
Annual Installed Solar Panels	m^2	331,200	266,200	222,000	178,700	227,400
Active Generated Annual Heat	GWh	2,260	2,230	2,668	2,561	2,556
Solar Panels per 1,000 capita	m^2/1,000	431	450	464	472	487
Shandong		**2012**	**2013**	**2014**	**2015**	**2016**
Total Installed Solar Panels	m^2	-	-	-	100,000,000	130,000,000
Upper Austria		**2012**	**2013**	**2014**	**2015**	**2016**
Total Installed Solar Panels	m^2	1,266,000	1,309,000	1,339,000	1,369,000	1,429,000
Annual Installed Solar Panels	m^2	51,000	43,000	30,000	30,000	25,000
Active Installed Capacity	MW_{therm}	890	920	940	960	920
Active Generated Annual Heat	GWh	440	450	455	460	500
Solar Panels per 1,000 capita	m^2/1,000	900	920	890	900	1,000

Source: Monitoring Report on Renewable Energy in the RLS regions

Exemplary results

- In the regions **Bavaria**, **Shandong** and **Upper Austria** approximately **138 million m² solar thermal collectors** were installed in **2016**.
- Nowadays about 1 m² solar panels per inhabitant were installed in Upper Austria. Because of this, **Upper Austria** belongs to one of the **world's leading solar thermal regions**.

Monitoring on Renewable Energy in the RLS regions

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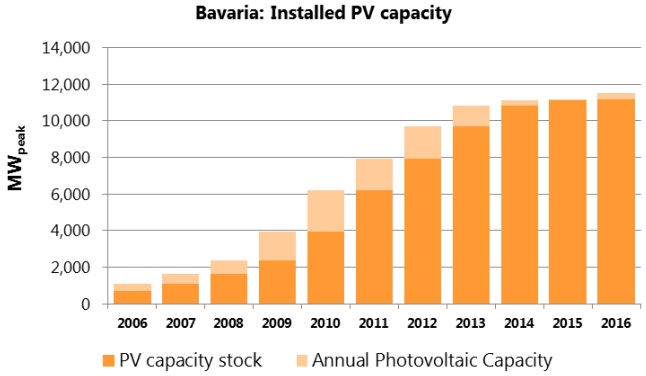
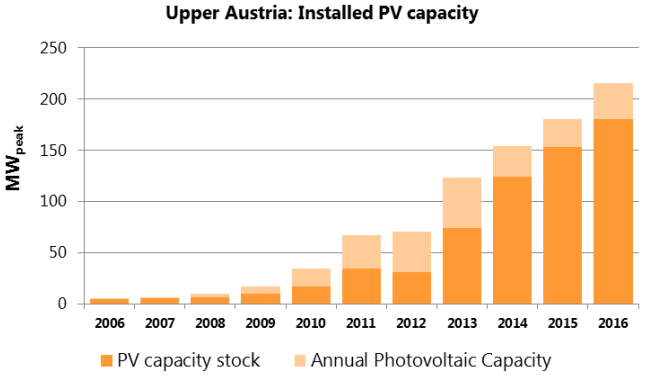
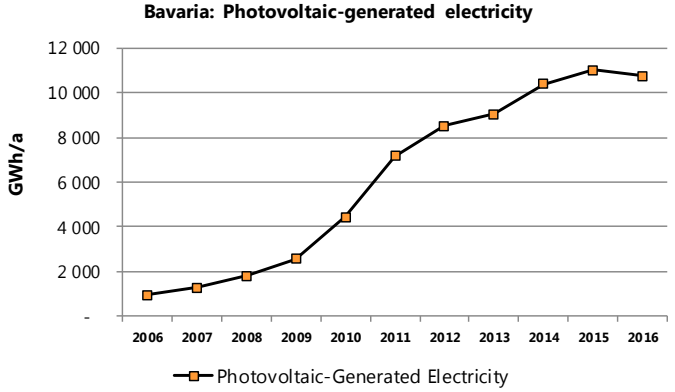
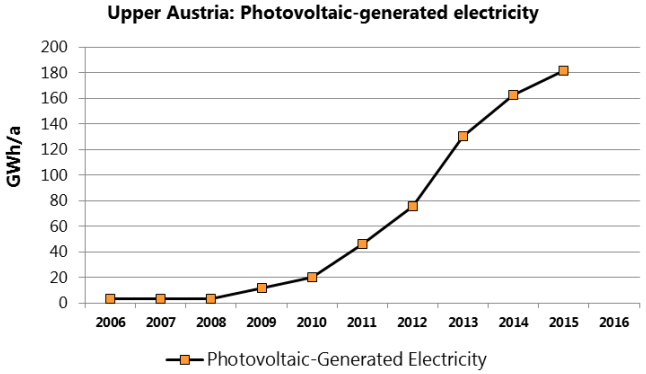
Renewable energies' in detail: Photovoltaic Power

Photovoltaic power capacities and generated electricity - exemplary results









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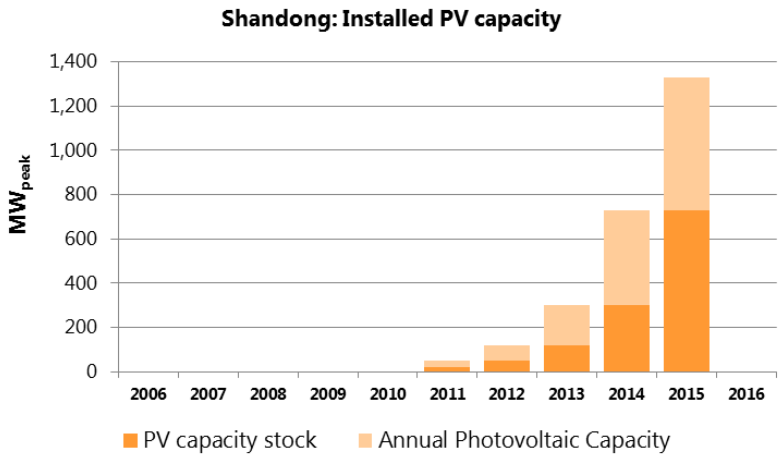
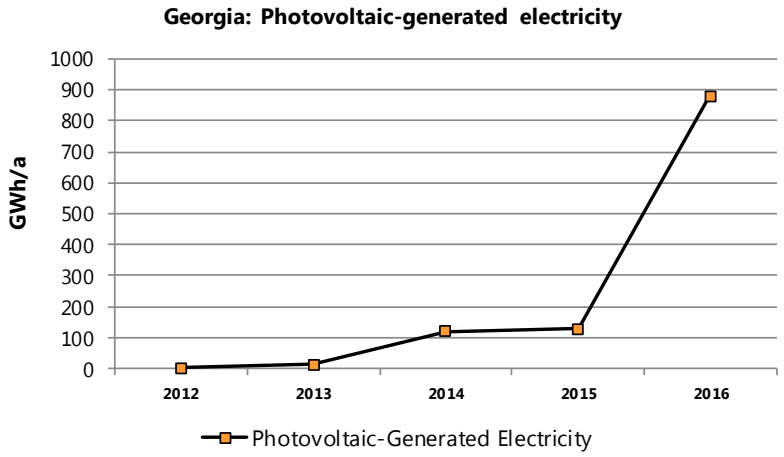
Renewable energies' in detail: Photovoltaic Power

Photovoltaic power capacities and generated electricity - exemplary results





Source: Monitoring Report on Renewable Energy in the RLS regions

Monitoring on Renewable Energy in the RLS regions

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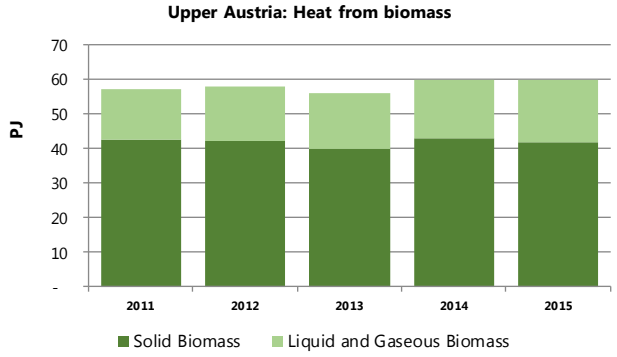
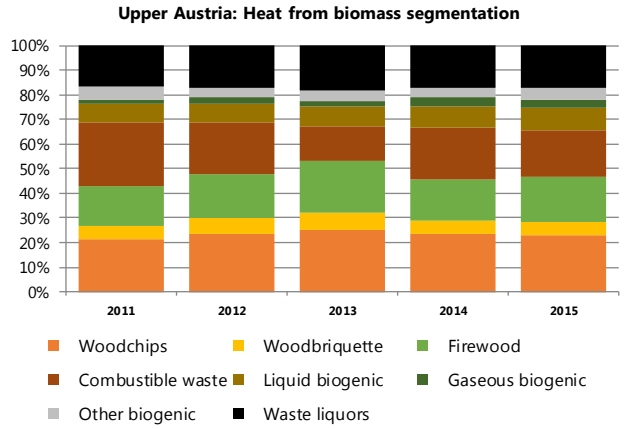
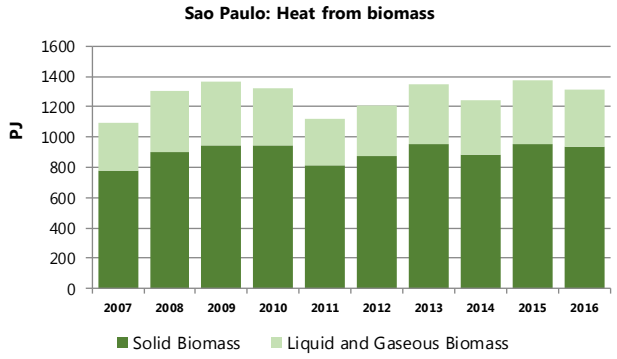
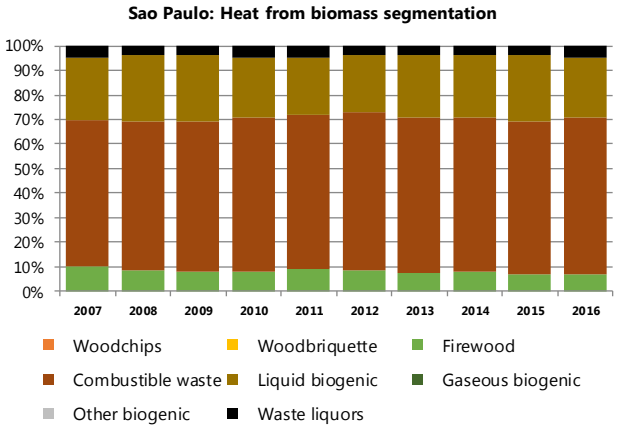
Renewable energies' in detail: Bioenergy

Heat from biomass - exemplary results









Source: Monitoring Report on Renewable Energy in the RLS regions

Monitoring on Renewable Energy in the RLS regions

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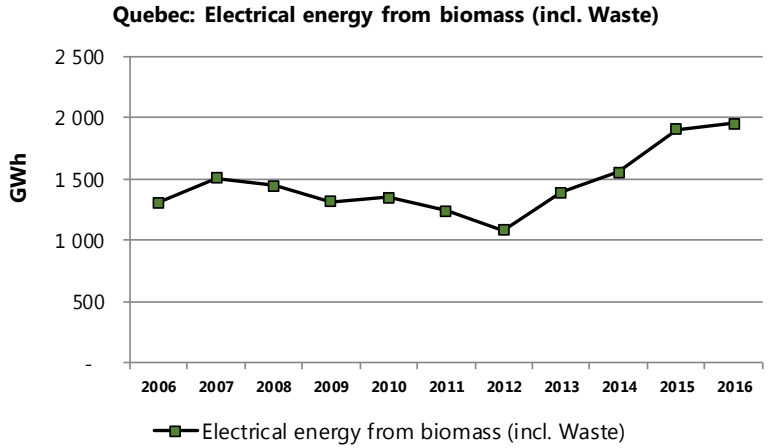
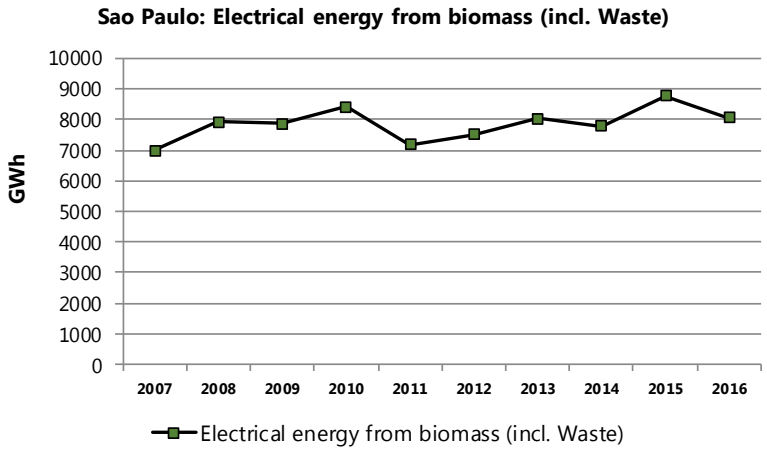
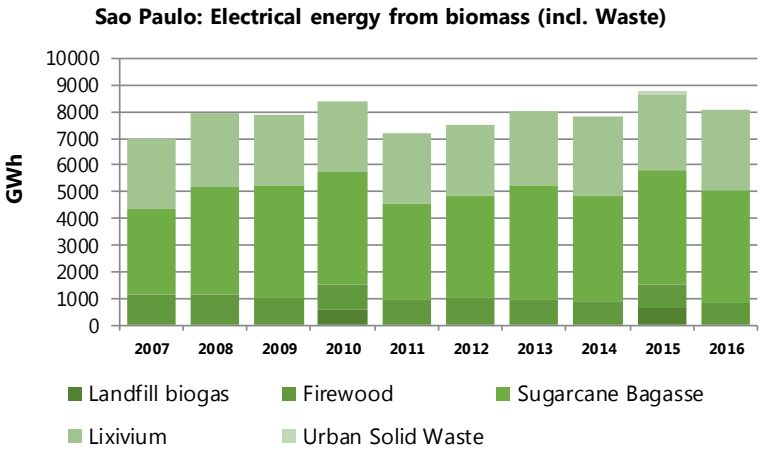
Renewable energies' in detail: Bioenergy

Electricity from biomass - exemplary results







Source: Monitoring Report on Renewable Energy in the RLS regions

Monitoring on Renewable Energy in the RLS regions

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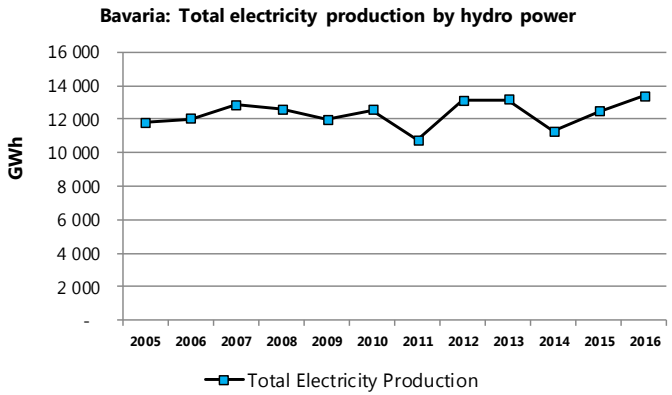
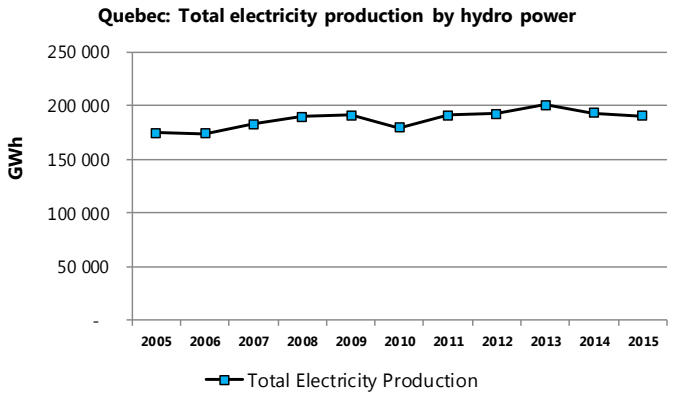
Renewable energies' in detail: Hydro power

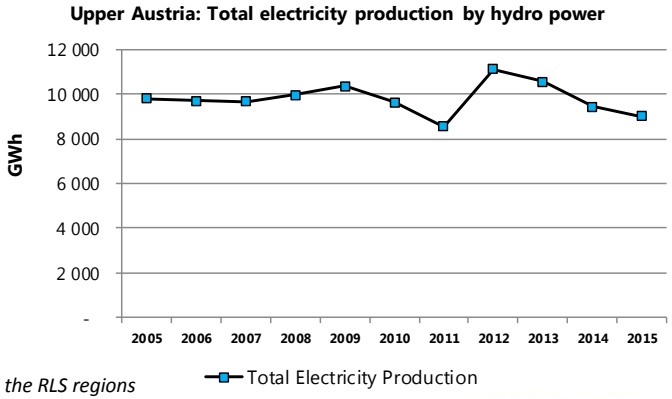
Electricity production by hydro power- exemplary results





In São Paulo are 48 large hydropower plants existing, which produced 62,280 GWh in 2017.

For the future an increase of hydro power is planned, by 2020 about 70,080 GWh and by 2030 approximately 73,093 GWh of electricity shall be generated.



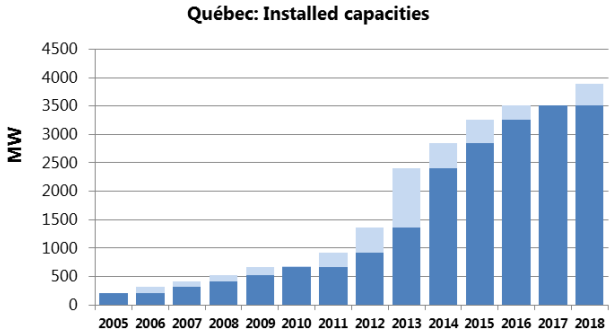
Source: Monitoring Report on Renewable Energy in the RLS regions

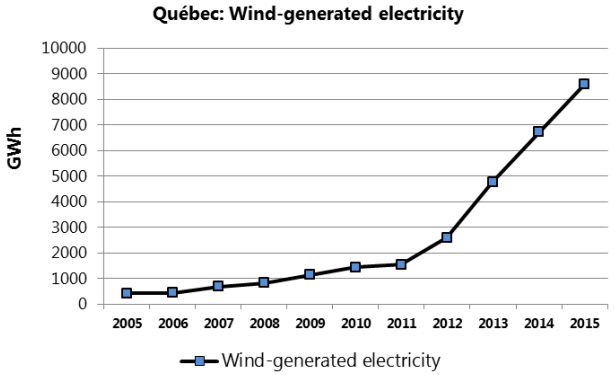
Monitoring on Renewable Energy in the RLS regions

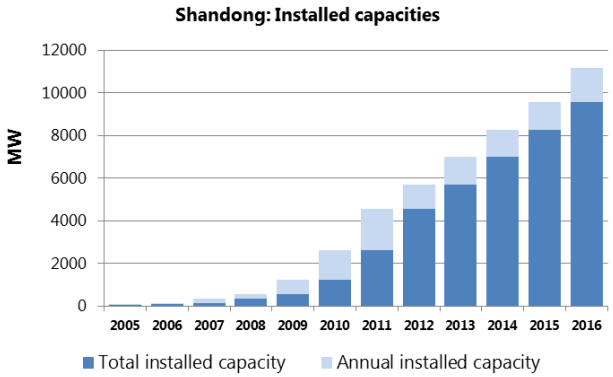
RLS Energy Network

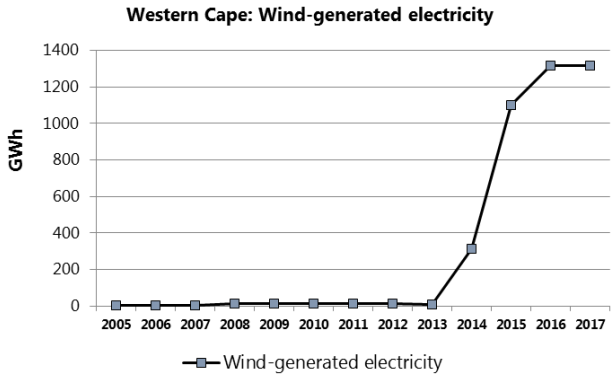
Renewable energies' in detail: Wind

Installed wind power capacities and wind-generated electricity - exemplary results









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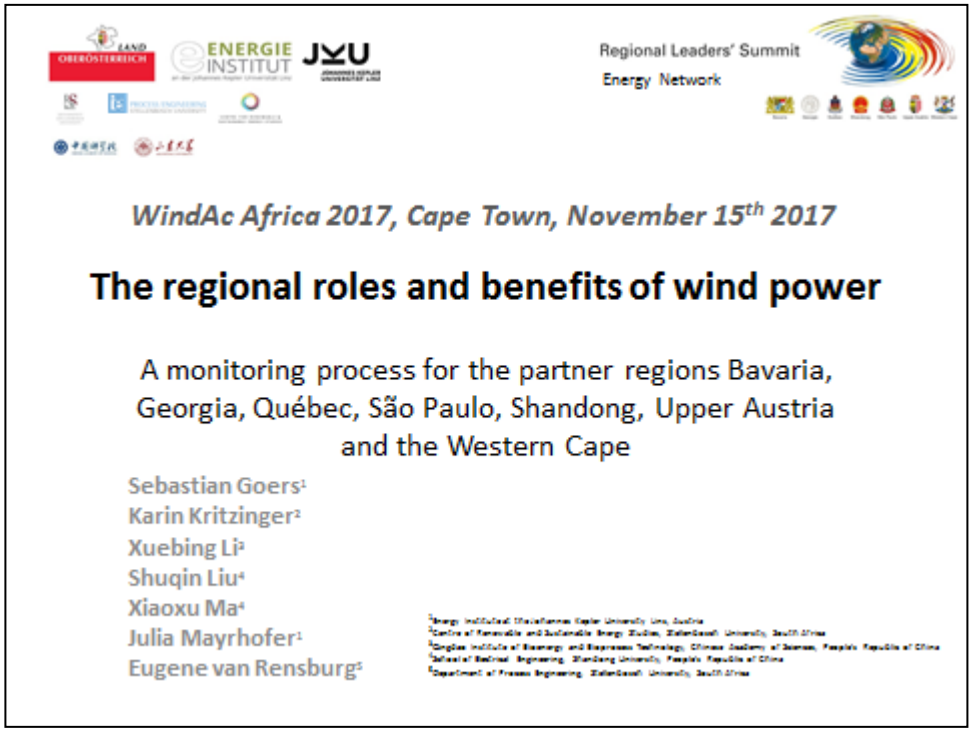
Renewable energies' in detail: Wind

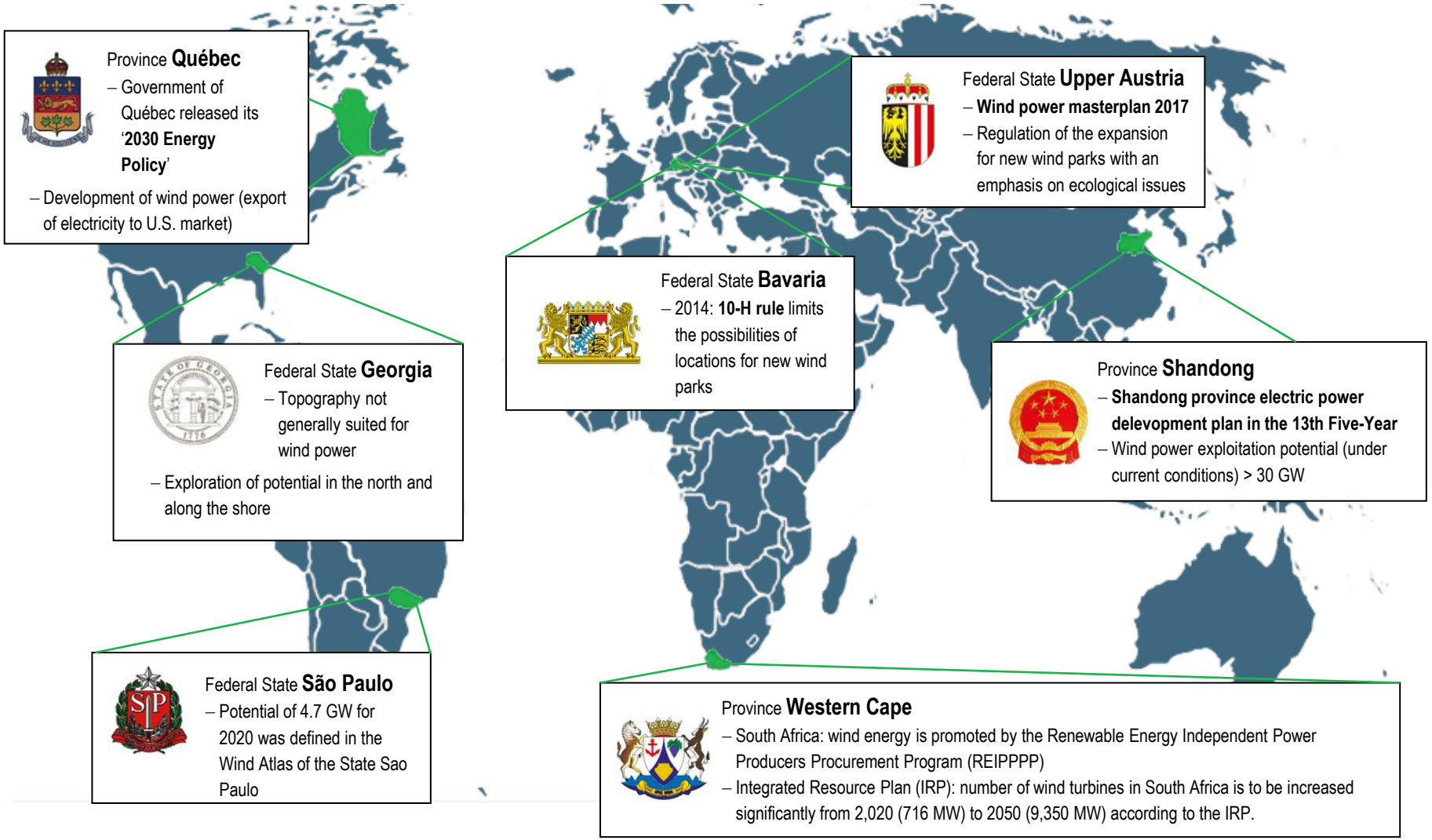


- Status quo
- Potentials
- Regulatory Framework
- R & D

Wind power in the RLS regions

Regional policy frameworks and targets

Several RLS regions have targets for increasing the amount of renewable energy or low-carbon energy in the electrical generation mix. These targets are based in legislation and appear in roadmap documents. Some RLS regions have specific goals or targets for renewable energy generally and wind energy in particular.



Wind power in the RLS regions

Installed capacities

- A **total installed wind power capacity** of about **18,955 MW** is in operation in the RLS regions Bavaria, Québec, Shandong, Upper Austria and the Western Cape by the end of 2015.

Table 1: Total installed wind capacity in selected RLS partner regions in 2015

RLS region	Total wind capacity in 2015 (MW)
Bavaria	1,862
Québec	3,510
Shandong	13,100
Upper Austria	47
Western Cape	436

Note: For the regions of Georgia and São Paulo, no detailed data is publically available for wind power or wind energy does not play a decisive role in the domestic energy system so far.

Wind power in the RLS regions

Key impacts of wind energy implementation

- Wind power development directly affects the employment and income of the industry, mainly during the construction phase of a wind power project, but also during its operational phase. Indirectly, wind power construction and operation expenses may create demand for goods and services in the **regional economy**.
- Wind power plays a significant role in curbing **emissions** that would otherwise be generated from conventional sources.

Table: Employment effects (rounded) of wind energy in selected RLS regions in 2015

RLS region	Estimated jobs
Bavaria	11,800
Québec	5,000
Upper Austria	350
The Western Cape	2,400

Table: CO_2 reduction by wind energy by displacing fossil fuel power plants in selected RLS regions

RLS region	CO_2 reduction
Shandong	21,500,000 t *(in 2008)*
Upper Austria	60,000 t *(in 2015)*
The Western Cape	1,200,000 t *(in 2017)*

Wind power in the RLS regions

Research & development activities

- R&D programs took a significant part in making wind energy technology more cost-competitive and consistent. **Research programs, in combination with demonstration activities implemented by the industry**, supported the role of wind generation as a significant contributor to respond to challenges of growing energy demand and to mitigate against climate change.
- Within the RLS partner regions several research and development activities in the field of wind energy are taking place.

Shandong

Wind power research

- Technology research center of Shandong University: Technological Research (i.e. magnetic suspension vertical axis wind turbine)

Wind power related businesses

- Shandong Rui the Electric Appliance Co. Ltd. / Shandong Zhongtai New Energy Group Co. Ltd./ Shandong Zhongche Wind Power Co. Ltd./ Shandong Datang International wind power / Shandong Jupiter wind Composite Materials Co Ltd.

Upper Austria

Academic and applied wind power research

- Energy Institute at Johannes Kepler University of Linz
  - Storage of wind power
  - Macroeconomic effects
  - Social acceptance issues

Supplies and service companies

- Planning office
- Wind turbines technology suppliers

The Western Cape

Educational issues / environmental assessment / development

- Stellenbosch University incl. **CRSES** & **Department of Process Engineering**
- **SARETEC** – accredited qualification for wind turbine service technicians
- Sector Development Agency **GreenCape**
- Interdisciplinary assessment
  - Council for Scientific and Industrial Research (**CSIR**)
  - the Energy Research Centre (**ERC**) at the University of Cape Town (**UCT**)
  - the South African National Energy Development Institute (**SANEDI**)
  - the South African Renewable Energy Business Incubator (**SAREBI**)

Companies engaged with wind power

- Kestrel

Government of the Western Cape

- Sustainable energy database

Monitoring on Renewable Energy in the RLS regions

RLS Energy Network

Value-added for RLS regions

- **Comparability**

  of the partner regions' energy systems through harmonized indicators

- **Gain of information**

  on renewable energy resources, technologies and key players

- **Evidence-based data**

  highlighting the potential for further action and its relevance

- **Use of data by interested companies and organizations**

- **Basis for targeted research and development investments**

Monitoring on Renewable Energy in the RLS regions

RLS Energy Network

Input for the roadmap

Work package 3

Energy system analysis

Energy systems and grids / Industrial energy systems / Conversion and storage systems / Buildings and urban systems / Transition processes, social innovations / Transportation and mobility systems

- Research papers
- Expert workshops

Work package 4

Regional science and technology map

- Visualization of the key player database
- Definition of thematic clusters
- SWOT analysis of the partner regions

Thank you for your attention!

RLS Energy Network

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