Decentralised or Centralised Solutions for the Alps?

Strategic Reflections in the
Framework of the Austrian Energy Strategy

The Austrian Position and Remarks to the Workshop-Paper

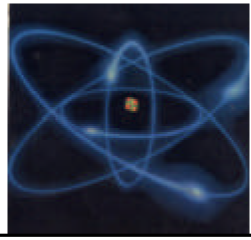
Gerhard Faninger
Alpen-Adria Universität Klagenfurt
Energy Economic Group, TU Wien

Energy Platform Workshop 2
Energy vs. Environment
- Interest Conflicts and the Acceptance for
Energy Production in the Alps
24 - 25 October 2013
Lucerne, Switzerland

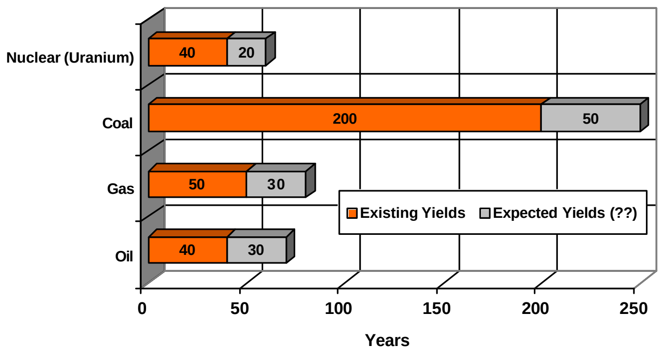
Chapter 1:
Awareness to Establish a New Energy-System

There is a growing interest of Public and Policy for the transformation of the present Energy Supply to a future-oriented „Sustainable Energy System“:

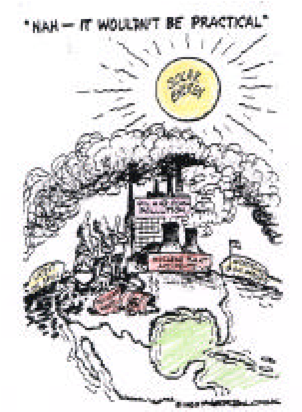
(1)The present worldwide Energysystem is not ready for a long-term Energy Security:
Fossil and nuclear sources are limited!



Availability of Fossil and Nuclear (Fission) Sources



Environmental Impacts



(2) The impacts of fossil and nuclear fuels to the environment and habitat are serious:

Potential for fast climate change

- **by greenhousegas-emissions,**
- **nuclear power plants accidents and nuclear waste deposite.**

Has Nuclear Power a future ??

Nuclear Power Accidents
and
the unsolved problem to handle the
Nuclear Waste
will have consequences for the further deployment of Nuclear Energy Power.

Nuclear Power Accidents (1)

Fukishima, Japan: 11. March 2011

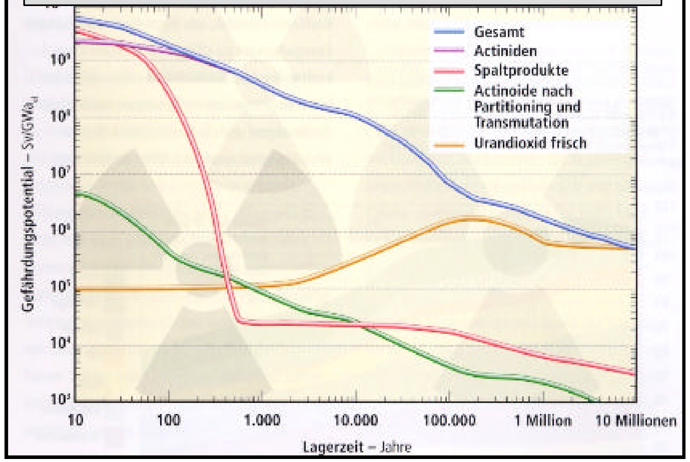
Nuclear Power Accidents (2)

Tschernobyl, Ukraine: 26 April 1986

Disposal of Nuclear Waste

- Today, about 9 500 ton Nuclear Waste per year is produced.
- Nuclear waste includes radioactive elements with a lifetime more than 100 000 years.
- The finite and longtime disposal of nuclear waste could not be solved up to now and therefore nuclear waste disposal includes a high danger potential for future generations.

Danger Potential of Nuclear Waste



Prolongation of Oil-Reserves with New Technologies?

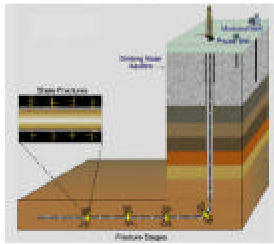
Oil-sand Extraction

The environmental impact caused by ***oil sand extraction*** is serious. Greenhouse gas emission from oil sand crude is 12% higher than from regular crude. Damage of land use, remarkable impacts to environment and habitat, high production costs, are arguments, **not to prolong the world wide oil-reserves for some years by extracting of oil sands.**

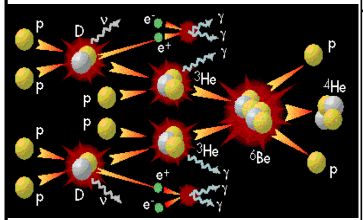
Prolongation of Gas-Reserves with New Technologies?

Hydraulic Fracturing

Unconventional Gas Production with ***Hydraulic Fracturing*** may play a role in ensuring the security of global energy supply for years to come. **But the chemical additives in the fracturing fluid have a negative impact to groundwater – with the technology of today.**



Option „Nuclear Fusion“



The Nuclear Fusion Process
is realized in the SUN,
but is not available
on EARTH - up to now -
for Electricity Production.

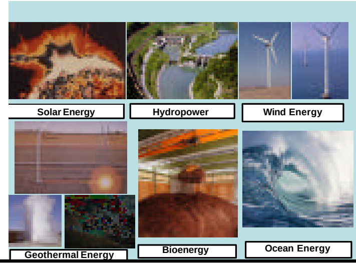
If Nuclear Fusion
will be possible,
than it would take
more decades
to come on the market.

Not before 2100!

Option „Renewables“

The only way to a longterm available Energy System would be the transformation of fossil and nuclear energy sources to Renewable Energy Sources and Technologies:

Renewables **are the only future eventually energy sources if fusion fails and coal remains dirty!**



Renewable Energy Comes in Many Forms

- Electricity generated from solar, wind, biomass, geothermal, hydropower, and ocean resources.
- Heat generated from solar thermal, geothermal and biomass resources.
- Biofuels and hydrogen obtained from renewable resources.

Renewable Energy is energy that is derived from natural processes that are replenished constantly

In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth.

Included in the definition of renewable energy sources, *Renewables* is energy generated from solar, wind, biomass, geothermal, hydropower and ocean resources, and bio fuels and hydrogen derived from renewable resources.

Commercial markets for Renewables are today:
Hydropower, Bioenergy, Solar Heating and Cooling,
Solar Thermal Power Plants, Photovoltaic,
Wind Energy and Geothermal Energy.

Renewables & Sustainability

The Brundtland Commission on Environment and Development (WCED, 1987) gave the following definition *:

„Sustainable development is development that meets the needs of the present without compromising the ability for future generations to meet their own needs.“

Today, Sustainability is considered as goal for future economic development: **Substitution of limited energy sources by Renewables, including three domains over a long term period: society, environment, economy.**

The topic of sustainability is part of the public consciousness.

* *The Brundtland Commision was chaired by Norwegian Prime Minister Gro Harlem Brundtland, and its report „Our Common Future“, published in 1987, was widely known as the Brundtland Report.*

"Renewable" does not mean Inexhaustible and Sustainable

- **Only providing the balance between the plant growth and biomass use, the Biomass is renewable and therefore sustainable and helps combat climate change.**
- **In reality bioenergy products are not strictly "renewable", because energy is needed for production and transport of fire wood, barks and wood chips.**
- **The harnessing of *Renewables* relies on material resources which are finite and non-renewable. In other words they have their limits and their environmental consequences.**
- **The input of non-renewable energy sources will be considered by the Primary Energy Factor.**

Benefits from *Renewables* generally include some combination of the following:

- **Energy security**: reduced dependence on foreign energy imports.
- **Environment**: mitigating global climate change, regional acid rain, local air pollution, and indoor air pollution.
- **Employment**: technology development, manufacturing, installation and maintenance services.
- **Technological development and competitiveness**: rise of new domestic industrial bases.
- **Rural development**: improved energy services and income-generation opportunities.
- **Reliability**: greater energy availability and/or reliability in areas where service from electric power grids may be intermittent or unreliable.

Renewables are capable supplying most of worlds energy needs and have the potential to support global economic development.

Renewable Energy Technologies have made considerable progress over the last few decades.

- Through technology development - much carried out through international collaboration - many Renewables options have reached levels of maturity that allow broad market deployment, while others are finding cost effective applications in expanding niche markets.
- The significant increase over the last few years of emerging technologies such as wind, solar both thermal and electric (photovoltaic, PV), as well as modern bioenergy plants, is concentrated in countries, which are leaders in R&D spending.

Renewables add to the diversity of the energy supply portfolio, and reduce the risk of energy price fluctuations, as well as constraints on supply.

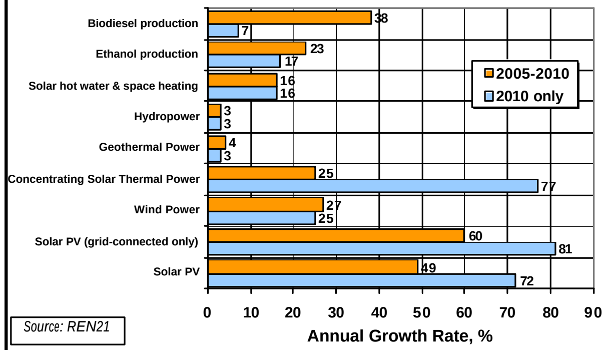
- Distributed Renewables provide options to consumers not otherwise available.
- And Renewables are the most environmentally benign of the options available in current and near-term markets.
- Also, Renewables are the only future eventually energy sources if fusion fails and coal remains dirty.

Renewable Energy Market

The Development of the Worldwide Renewables Energy Market - and especially in Europe - is positive and promising and the energy production costs are decreasing.

Today, some of the new Renewable Energy Technologies are compentative with traditional Energy Technologies.

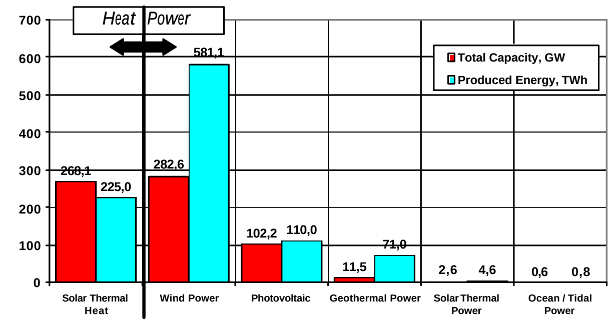
Average Annual Growth Rate of Global Renewable Energy Capacity and Biofuel Production, 2005 - 2010

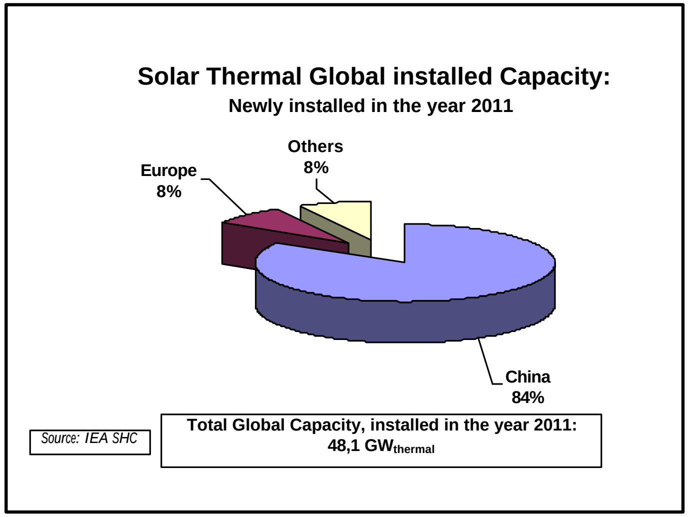


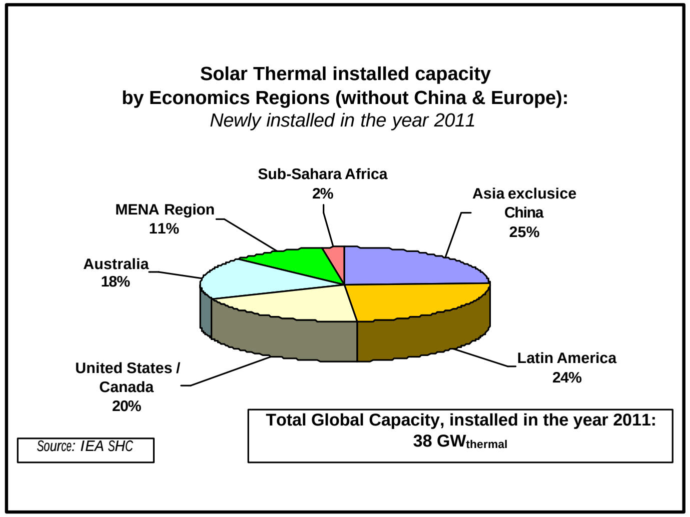
The Future of Renewables

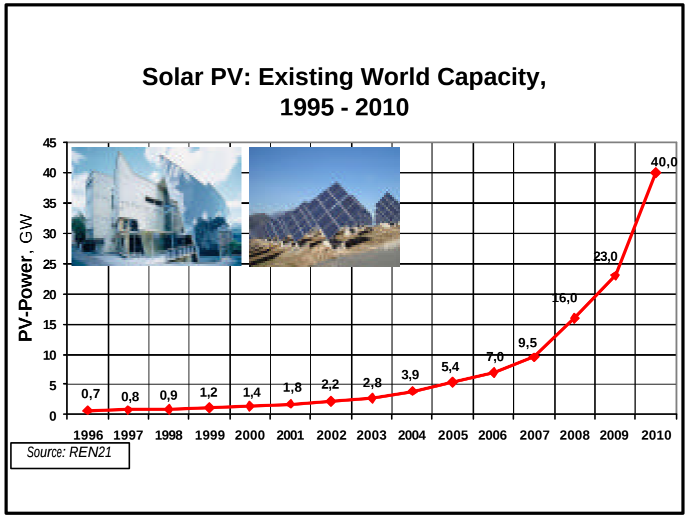
The present Market Deployment of Renewables is very positive.

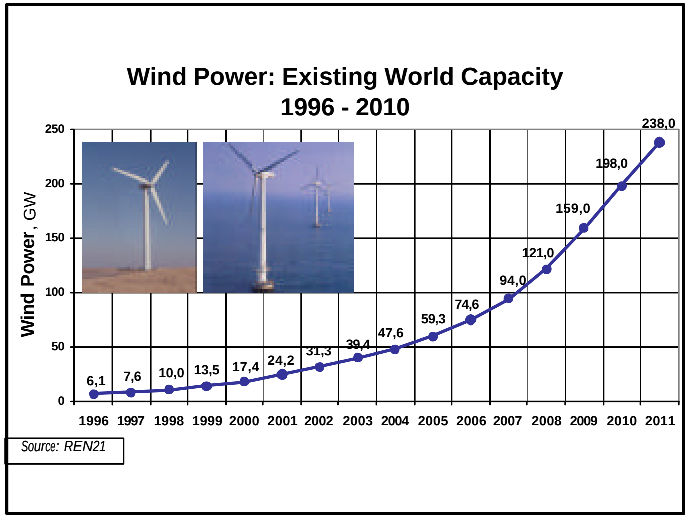
Total Capacity in Operation (GW_{el} and GW_{th}) and Produced Energy (TWh_{el}/a and TWh_{th}/a), 2012



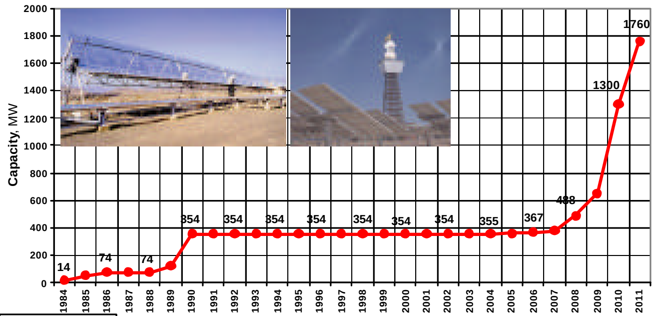

Solar Thermal Global installed Capacity:
Newly installed in the year 2011
Others 8%
Europe 8%
China 84%
Source: IEA SHC
Total Global Capacity, installed in the year 2011: 48,1 GWthermal


Solar Thermal installed capacity
by Economics Regions (without China & Europe):
Newly installed in the year 2011
Sub-Sahara Africa 2%
MENA Region 11%
Asia exclusive China 25%
Australia 18%
United States / Canada 20%
Latin America 24%
Source: IEA SHC
Total Global Capacity, installed in the year 2011: 38 GWthermal


Solar PV: Existing World Capacity,
1995 - 2010
PV-Power, GW
0 5 10 15 20 25 30 35 40 45
0,7 0,8 0,9 1,2 1,4 1,8 2,2 2,8 3,9 5,4 7,0 9,5 16,0 23,0 40,0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Source: REN21

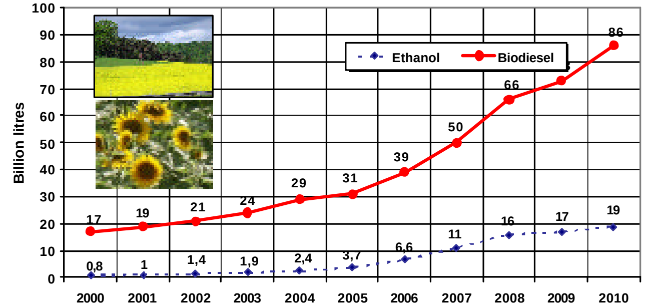

Wind Power: Existing World Capacity
1996 - 2010
Wind Power, GW
0 50 100 150 200 250
6,1 7,6 10,0 13,5 17,4 24,2 31,3 39,4 47,6 59,3 74,6 94,0 121,0 159,0 198,0 238,0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Source: REN21

Concentrating Solar Thermal Power Global Capacity: 1984 - 2011



Source: REN21

Global Ethanol and Biodiesel Production, 2000 - 2010



Source: REN21

The Role of Energy Policy to Promote Renewables Deployment

- Renewable energy technology solutions have a crucial role to play in addressing today's energy challenges. Ensuring dependable supplies of affordable Renewables technologies is essential.
- Expanded use of Renewables, in combination with increased energy efficiency as well as rational energy use in all sectors of energy consumers can reduce dependence on imported fossil fuels, thus enhancing energy security.
- Increased use of Renewables and greater efficiency can help reduce greenhouse gas emissions.
- Commitment on the part of policy and industry is necessary to stimulate demand and significantly increase use of emerging Renewables technologies.

Growing Political Consensus to Promote Renewable Energy Technologies

- There is a strong and growing political consensus to promote the development of *Renewables*.
- E.g., all IEA Member States have established, or are planning, measures to increase share of *Renewables* in their energy markets.
- The *Directive* adopted by the European Union as a Member of IEA - is an example of this political will: the target is to increase the share of *Renewables* – as an average for all EU-Member countries – in energy consumption/energy supply from its present level of 6% to 12% in 2010 and 20% in 2020.
- *Renewables* are also high on the agenda of developing countries, and expanded renewable energy deployment is one of the key goals of the World Bank.

EU-Goals for Energy Supply in EU-Member States 2000 ? 2020

Improvement of Energy-Efficiency →	+ 20%
Improved contribution of Renewables to Energy Supply →	+ 20%
Reduction of Energy-related CO_2-Emission →	- 20%

20 / 20 / 20

ENERGIENEUDENKEN

„Das Weltenergiesystem steht an einem Scheideweg. Die derzeitigen weltweiten Trends von Energieversorgung und Energieverbrauch sind eindeutig nicht zukunftsfähig. Es braucht nichts Geringeres als eine Energierevolution".

Internationale Energieagentur, IEA/OECD

Energiestrategie Österreich

The Role of Renewables in Future Energy Supply

• Renewable energy sources *(Renewables)* will have to play a central role in moving the world onto a more secure, reliable and sustainable energy path.

• The potential is unquestionably large, but how quickly their contribution to meeting the world's energy needs grows hinges critically on the strength of government support to stimulate technological advances and make *Renewables* cost competitive with other – mainly fossil and nuclear - energy sources.

• Some of Renewable energy technologies are on the market, some under development and some in the demonstration phase.

• Bio-energy (solid, liquid and gaseous) and Solar Energy (thermal and electric) are key options within all energy sectors.

• Due to their continually improving performance and cost, and given growing recognition of their environmental, economic and social benefits ***Renewables* will grow increasingly competitive with traditional energy technologies**.

Renewable Energy Industry

• Across most technologies, renewable energy industries saw continued growth in equipment manufacturing, sales, and installation during 2011.

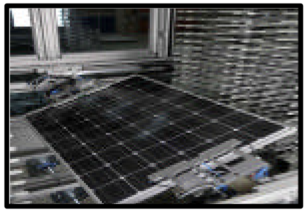
• Solar PV and onshore wind power experienced dramatic price reductions during the course of the year resulting from declining costs due to economies of scale, technology advances, and other factors, but also due to reductions or uncertainties in policy support.

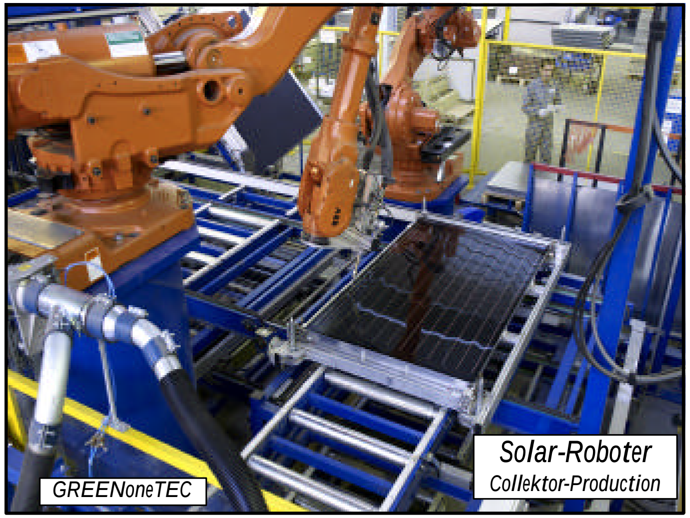
• At the same time, some renewable energy industries - particularly solar PV manufacturing - have been challenged by these falling prices, declining policy support, the international financial crisis, and tensions in international trade.

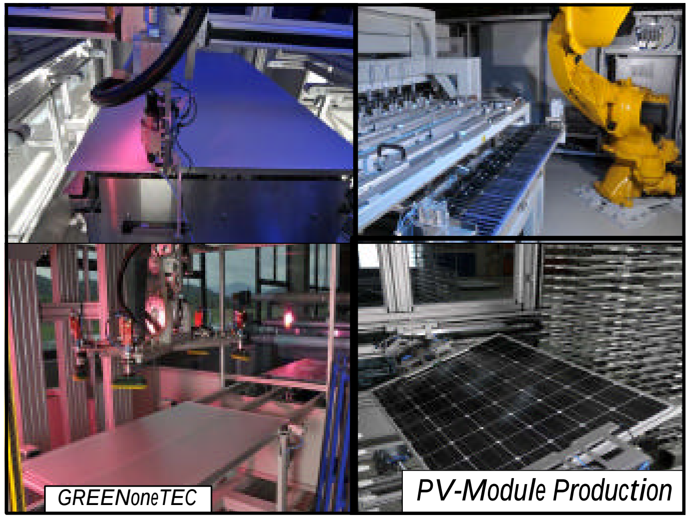
Production of PV-Modules

Cost-reduction of PV-Modules within Automatisation

KIOTO-Photovoltaic







Chapter 2:
Energy Situation in Austria

The Energy Situation in Austria is characterised by:

- **Increasing share of Renewable Energy Sources on Total Primary Energy Supply as well as End-use Consumption.**
- **Trend for reduction of Energy Consumption.**

The share of Renewables on Total Primary Energy Supply is of about 34,3% and on End-use Consumption of about 44,9%.

Statistik Austria 2012

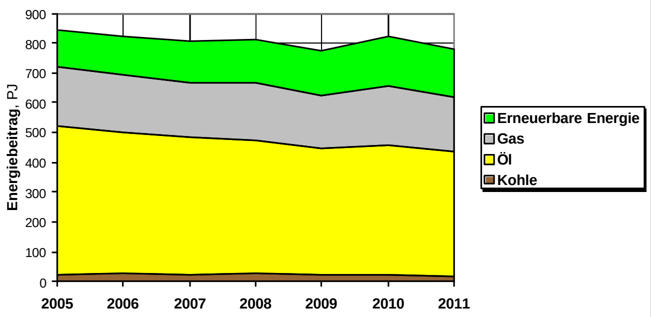
Energiebilanz Österreich, PJ: 2005 - 2011

Jahr	2005	2006	2007	2008	2009	2010	2011
Brutto-Inlandsverbrauch	1.458	1.453	1.434	1.444	1.370	1.476	1.427
Energetischer Endverbrauch	1.118	1.109	1.098	1.112	1.062	1.135	1.089
Inländische Erzeugung von Rohenergie	423	429	459	477	491	519	489

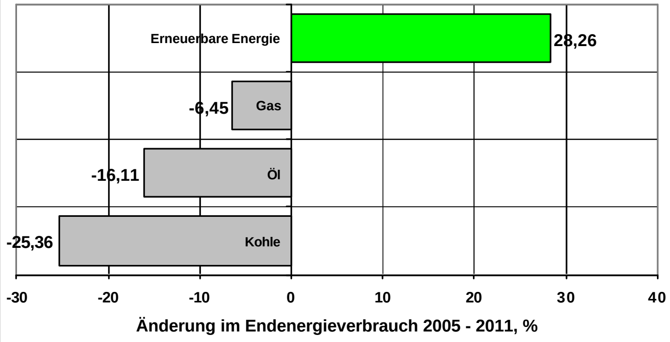
Energiebilanz Österreich, Jahresänderungen in %/Jahr

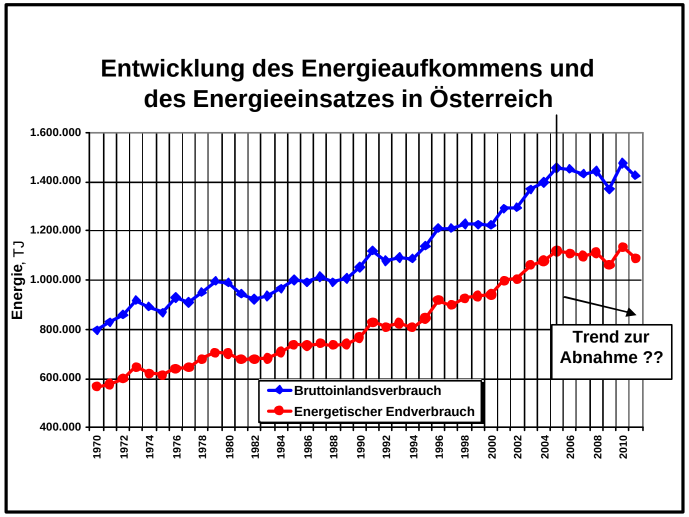
Periode	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2005/2011
Brutto-Inlandsverbrauch	-0,34	-1,29	0,74	-5,12	7,70	-3,29	-2,07
Energetischer Endverbrauch	-0,79	-1,07	1,32	-4,50	6,83	-4,01	-2,60
Inländische Erzeugung von Rohenergie	1,36	7,06	3,88	2,93	5,85	-5,83	15,66

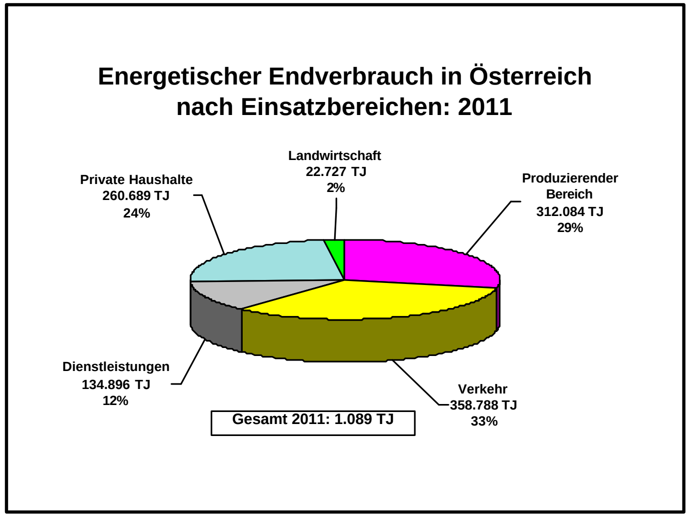
Entwicklung des energetischen Endverbrauches in Österreich nach Energieträgern

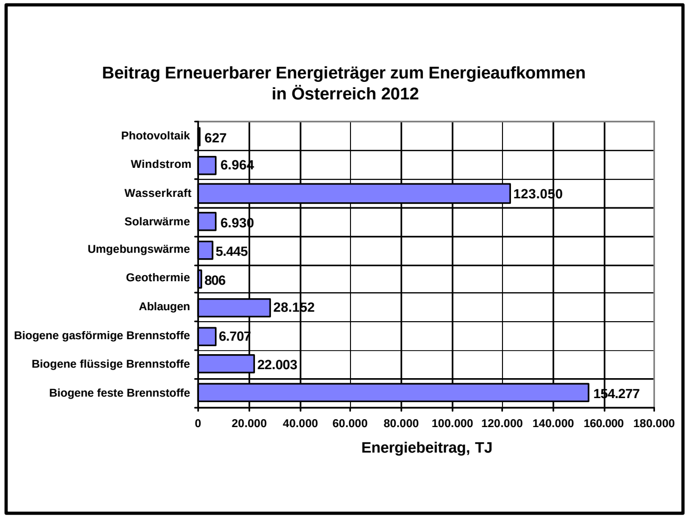


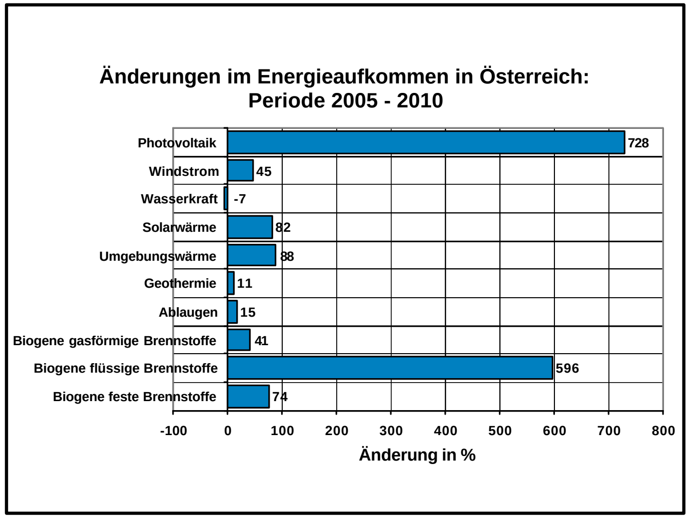
Änderungen der Energieträger am energetischen Endverbrauch in Österreich in der Periode 2005 - 2011

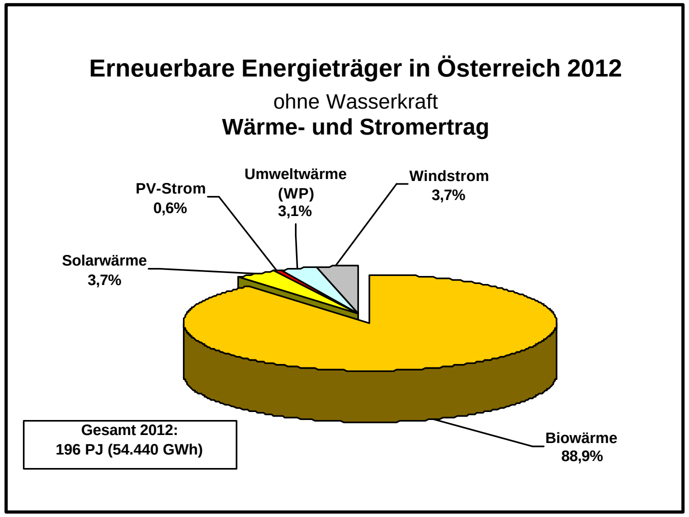


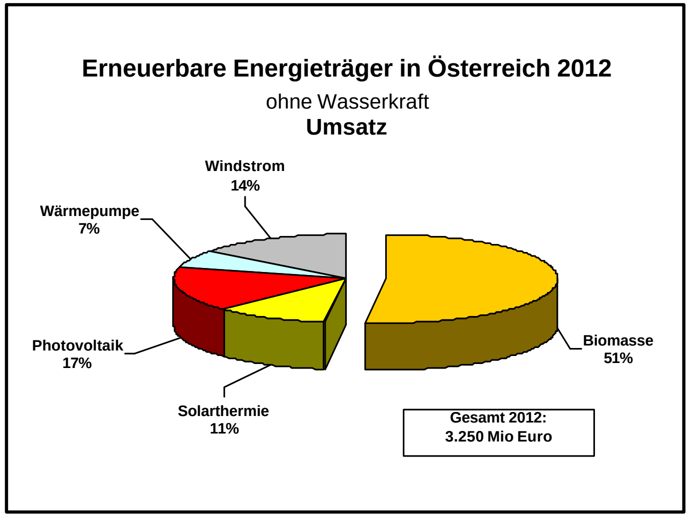

Entwicklung des Energieaufkommens und des Energieeinsatzes in Österreich
Energie, TJ
1.600.000
1.400.000
1.200.000
1.000.000
800.000
600.000
400.000
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Trend zur Abnahme ??
Bruttoinlandsverbrauch
Energetischer Endverbrauch

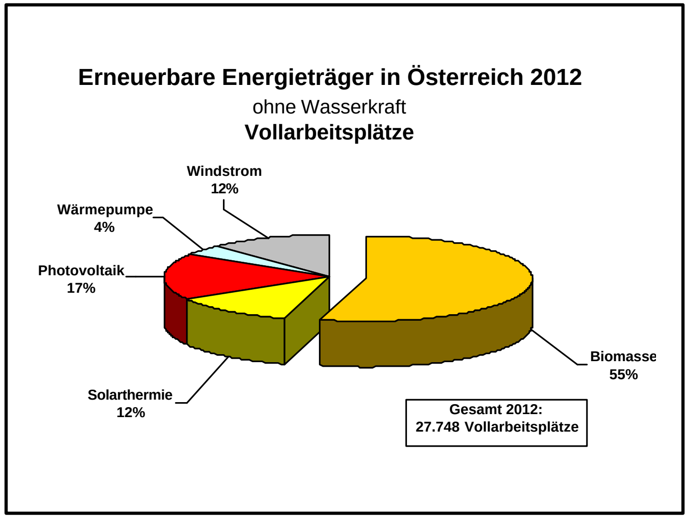

Energetischer Endverbrauch in Österreich nach Einsatzbereichen: 2011
Landwirtschaft 22.727 TJ 2%
Private Haushalte 260.689 TJ 24%
Produzierender Bereich 312.084 TJ 29%
Dienstleistungen 134.896 TJ 12%
Verkehr 358.788 TJ 33%
Gesamt 2011: 1.089 TJ

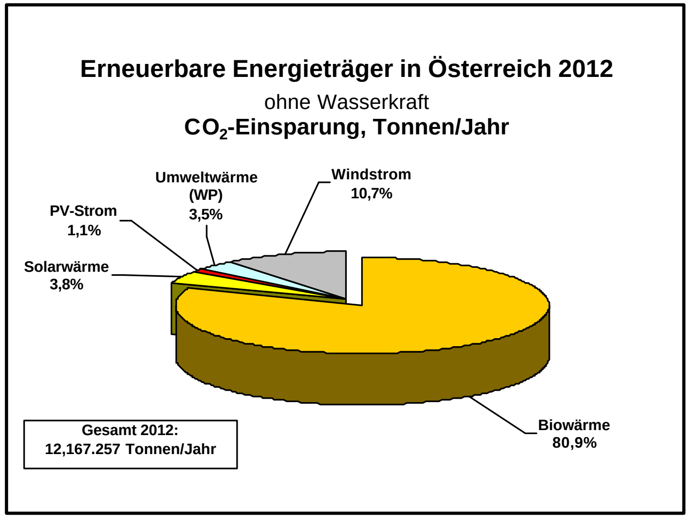

Beitrag Erneuerbarer Energieträger zum Energieaufkommen in Österreich 2012
Photovoltaik 627
Windstrom 6.964
Wasserkraft 123.050
Solarwärme 6.930
Umgebungswärme 5.445
Geothermie 806
Ablaugen 28.152
Biogene gasförmige Brennstoffe 6.707
Biogene flüssige Brennstoffe 22.003
Biogene feste Brennstoffe 154.277
0
20.000
40.000
60.000
80.000
100.000
120.000
140.000
160.000
180.000
Energiebeitrag, TJ


Änderungen im Energieaufkommen in Österreich: Periode 2005 - 2010
Photovoltaik 728
Windstrom 45
Wasserkraft -7
Solarwärme 82
Umgebungswärme 88
Geothermie 11
Ablaugen 15
Biogene gasförmige Brennstoffe 41
Biogene flüssige Brennstoffe 596
Biogene feste Brennstoffe 74
-100
0
100
200
300
400
500
600
700
800
Änderung in %

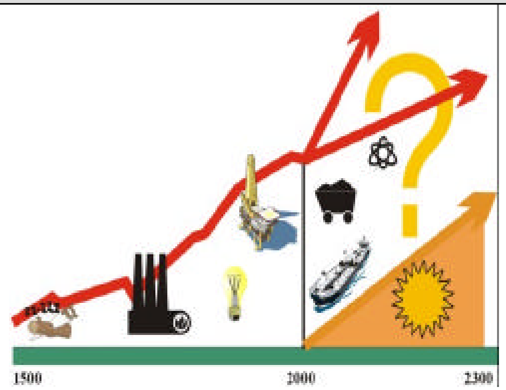

Erneuerbare Energieträger in Österreich 2012
ohne Wasserkraft
Wärme- und Stromertrag
PV-Strom 0,6%
Umweltwärme (WP) 3,1%
Windstrom 3,7%
Solarwärme 3,7%
Biowärme 88,9%
Gesamt 2012:
196 PJ (54.440 GWh)


Erneuerbare Energieträger in Österreich 2012
ohne Wasserkraft
Umsatz
Windstrom 14%
Wärmepumpe 7%
Photovoltaik 17%
Solarthermie 11%
Biomasse 51%
Gesamt 2012:
3.250 Mio Euro


Erneuerbare Energieträger in Österreich 2012
ohne Wasserkraft
Vollarbeitsplätze
Windstrom 12%
Wärmepumpe 4%
Photovoltaik 17%
Solarthermie 12%
Biomasse 55%
Gesamt 2012:
27.748 Vollarbeitsplätze


Erneuerbare Energieträger in Österreich 2012
ohne Wasserkraft
CO_2-Einsparung, Tonnen/Jahr
Umweltwärme (WP) 3,5%
Windstrom 10,7%
PV-Strom 1,1%
Solarwärme 3,8%
Biowärme 80,9%
Gesamt 2012:
12,167.257 Tonnen/Jahr

Chapter 3: Energy Forecasts



Energy Forecasts

• Long-term scenarios are generally simplified. Estimates for the future energy systems generally involve forecasting current trends into the future creating the best possible images of the future. The main question what may be realisable is not answered.

• **But prospective energy scenarios are not only meant to give the best prediction of the future but also to initiate debate or even promote visions.**

• Energy scenarios often concentrate on the future of fossil fuels and nuclear energy, including longer-term prospects of producing oil from tar sands and extracting natural gas trapped in hydrate beneath the ocean.

• But fossil fuels and nuclear energy both face environmental challenges – fossil fuels because of their contribution to emissions of greenhouse gases, and nuclear power because of the problem of long-term storage for nuclear waste.

• Energy scenarios for the establishment of a “sustainable” energy system focus on the long-term vision of energy production systems based on renewable sources and more efficient energy-use technologies, as well as the use of hydrogen or other synthetic fuels of energy carriers.

• Also coal may be a part of future sustainable energy system, if way could be found to use coal more efficiently and to remove and store the CO_2 produced when burned.

• The uncertain nature of energy forecasting is a main barrier for initiatives on global and national level to organise future energy systems. A key uncertainty is the point in time at which growth in the demand for oil and gas will extend growth in production capacity. There exist really no clear idea how much oil and gas can be recovered, and at what prices.

• Also the pace at which new energy technologies will be introduced on the market is a big source of uncertainty. Examples in the past show that new energy technologies often succeed only with the help of specific policies and incentives set up to establish new markets and promote technical innovation.

• Even future energy systems is hard to foresee, there is no doubt about the global growth of energy consumption, the necessity for more decentralised and dispersed energy sources and systems in Europe and other larger regions. This means that larger contribution of *Renewables* in the global and European energy mix is necessary.

Estimates of Possible Useful Potential of Renewable Energy Sources

• Some renewable energy technologies have good potential for growth, namely solar thermal, biomass fuels, wind power, geothermal and solar photovoltaic.

• Estimating the potential for energy production from Renewable energy sources is complex. Main reasons for this are both the versatility of Renewables in meeting so many different end-uses and geographic distribution of renewable sources.

• Important limitations to expanding the use of technical potentials of renewable sources are economics as well as the geographic distribution of the resource.

Potential of Renewable Energy Sources

- Theoretically Potential

ß

- Technically possible Potential

ß

- Realistically possible Potential

ß

- Economically useful Potential

Important Criteria's:
Ecomomic, Social and Political Framework

- Price trends for coal, oil and gas are important for planning future energy systems, but are less predicable. Important is the willingness for the transition from fossil fuels to Renewables.
- Large-scale market introduction of new technologies (i.e. wind-power, solar-power, bio-fuel production) will have an influence/impact to the environment as well to public acceptance.
- These facts have to be considered on the basis of "sustainability", considering energetic, economic, environmental and social aspects. R&D is needed to find adequate solutions.

- **The energy system of tomorrow will be a result of technological innovation and various social, economic and environmental changes.**

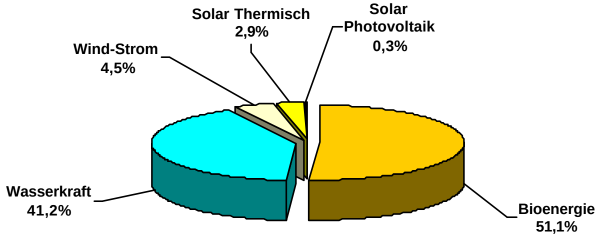
The Austrian Energy Strategy
Towards a „Sustainable Energy System"

Short-term: 2020
Decision by Government

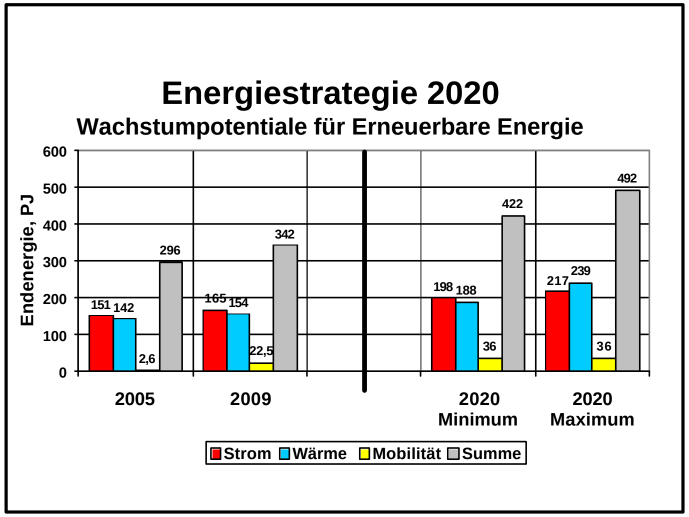
Mid-term: 2030
Forecast by Government

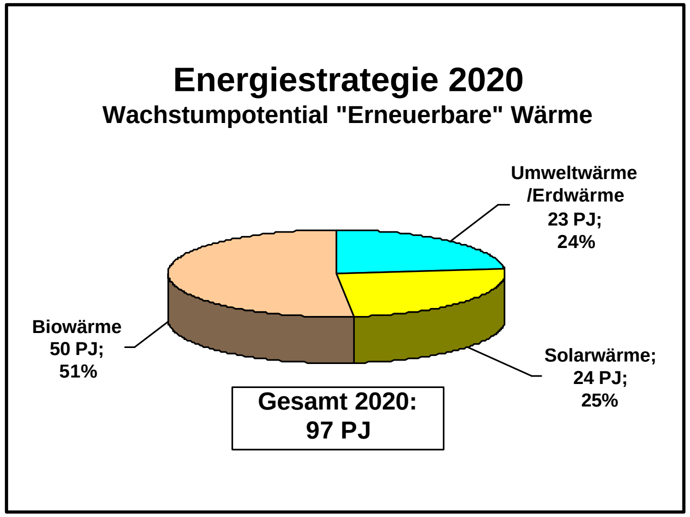
Long-term: 2050
Evaluation by Research Institutes,
co-ordinated by the Austrian Ministry for Technology

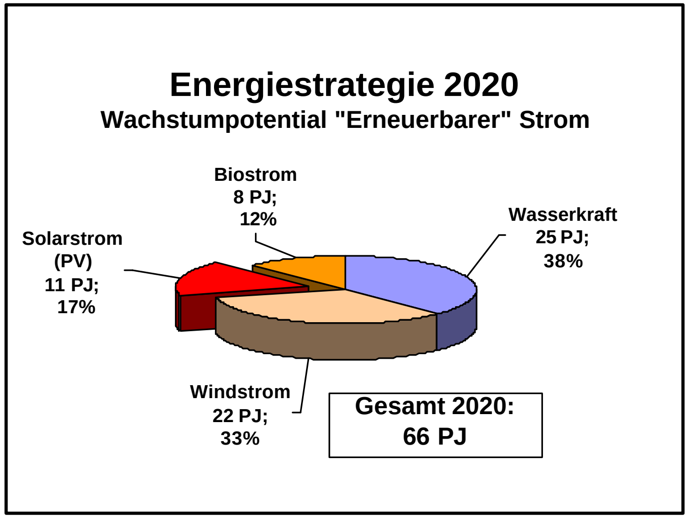
Aktionsplan Erneuerbare Energie für Österreich 2020

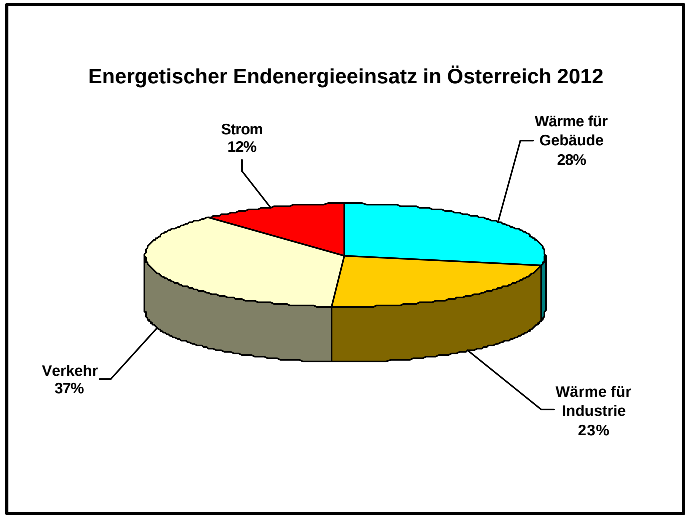


Der Aktionsplan "Erneuerbare Energie für Österreich" sieht vor, dass bis 2020 mindestens 9,2 Mio t Erdöleinheiten über erneuerbare Energieträger abzudecken sind. Biowärme hat die besten Chancen, wesentlich zu den nationalen und europäischen Zielen beizutragen.


Energiestrategie 2020
Wachstumpotentiale für Erneuerbare Energie
Endenergie, PJ
600
500
400
300
200
100
0
151
142
2,6
296
165
154
22,5
342
198
188
36
422
217
239
36
492
2005
2009
2020 Minimum
2020 Maximum
Strom
Wärme
Mobilität
Summe


Energiestrategie 2020
Wachstumpotential "Erneuerbare" Wärme
Umweltwärme /Erdwärme 23 PJ; 24%
Biowärme 50 PJ; 51%
Solarwärme; 24 PJ; 25%
Gesamt 2020: 97 PJ


Energiestrategie 2020
Wachstumpotential "Erneuerbarer" Strom
Biostrom 8 PJ; 12%
Wasserkraft 25 PJ; 38%
Solarstrom (PV) 11 PJ; 17%
Windstrom 22 PJ; 33%
Gesamt 2020: 66 PJ


Energetischer Endenergieeinsatz in Österreich 2012
Strom 12%
Wärme für Gebäude 28%
Verkehr 37%
Wärme für Industrie 23%

Chapter 4: Long-term Energy Strategy for Austria

Goal for a longterm available and secure Energy System:

***Sustainable Energy System*:**

Substitution of fossil and nuclear energy sources with renewable energy sources

with special attention of

energetic, ecological, economic and social aspects.

Towards a Future Sustainable Energy System: Tasks to be done

Improvement of Energy-Efficiency by Energy-Production and Energy-Consumption
Longterm, the Energy Services should be covered with the half of present energy supply.

Fast Market Deployment of efficient, emission-free, economic and social acceptable Renewable Energy Technologies

Further Research, Development and Demonstration in the sectors of Energy-Efficiency and New Renewable Energy Sources and Technologies

Strategy for the Transformation of our present Energy System

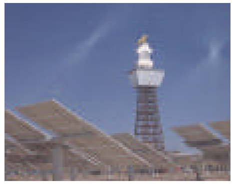
Today exist different options for centralised future Energy Systems:

- **Developing of central Energy Production and Distribution Systems , e.g. Electricity from Desert,**
- **Development of a worldwide Solar Hydrogen Economy,**
- **Utilisation of Ocean Power.**

These concepts needs high international investments as well as international cooperation – with a high risk concerning energy security.

More changes for realisation will have a strategy with decentralised Energy Production and Distribution on national basis, using existing Renewables on site.

Solar Electricity from the Desert



Solarthermal Powerplants
– Tower- and Parabolic Collector-Concept -
since 1981 under development and allready available for the market.

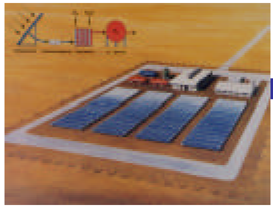
European „Solar DESERTEC“ in the planning phase.

Goal: 15% contribution to the European Electricity Consumption 2050 - with solar electricity, produced in Sahara.

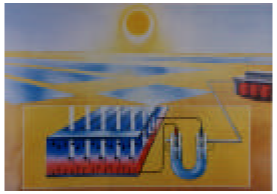
Estimated Investment Costs: 400 Billion Euro.

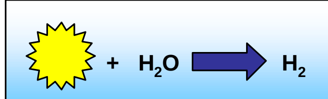
Potentially Investors: Large firms in Europe

Solare Wasserstofferzeugung mit PV-Strom



Elektrolyse mit Solarstrom





Requirements for Central Energy Systems

Energy Carriers:
Ready for Transport and Store

ß

Infrastructure:
Grid and Pipelines

Requirements for Decentralised Energy Systems

Energy Carriers:
Available on Site

ß

Infrastructure:
Small Production Units
Decentralised Boilers, Micro-District Heating, Building-intergrated Solar Photovoltaic

The Energy System of Tomorrow

Production

ß

Grid

ß

Distribution ← **Production**

ß

Consumer ← **Production**

Heat and Electricity from Solar, Biomass, PV, Wind

Combination of centralised and decentralised Energy System within energetic and economic optimised Energy Management

Renewables and Social Acceptance

- Decentralised Energy Systems with Bioenergy, Solar Energy and Wind Power are characterised by economic, environmental and social impacts in the region.
- The use of regional energy sources support the economic development in the region, but some changes in the landscape will happen.
- Building integrated solar thermal and solar photovoltaic installations are favourised instead of free installations.
- Regulations by communities for planning and organisation of regional Energy Supply and Energy Consumption should garantue the efficient operation.

Renewable Energy Sources, Technologies, and Energy Services

- Heat Production
- Electricity Production
- Bio-Fuel Production

Renewable Energy Sources, Technologies, Energy Service

Heating & Cooling
Low-Temperature Heat

Solar Thermal Systems
Flat plate collector,
Evacuated tube collector,
CPC collector

Heat Pump Systems
Heat Sources: Ground, Water, Air (Ambient Heat)

Biomass Systems
Wood log, Wood chips, Pellets

Solar Drying,
Pool Heating,
Hot Water,
Space Heating,
Cooling & Air-Conditioning,
District Heating

Renewable Energy Sources, Technologies, Energy Service

Process Heat
Middle-Temperature Heat

The majority of the energy used by commercial and industrial companies is below 250°C, such as cleaning, drying, sterilization and pasteurization, heating of productions halls.

Solar Thermal Systems
Advanced flat plate collector, Evacuated tube collector

Solar collectors used in *industrial and commercial processes* can reach energy savings of 75% to 80% with payback periods under five years.

Continued development of high performance collectors and system components will improve the cost effectiveness of higher temperature applications.

Renewable Energy Sources, Technologies, Energy Service

Process Heat
Middle-Temperature Heat

The majority of the energy used by commercial and industrial companies is below 250 °C, such as cleaning, drying, sterilization and pasteurization, heating of productions halls.

Solar Thermal Systems
Advanced flat plate collector, Evacuated tube collector

Biomass Systems
Wood log, Wood chips, Pellets

Solar collectors used in *industrial and commercial processes* can reach energy savings of 75% to 80% with payback periods under five years.

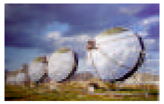
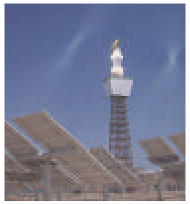
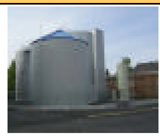
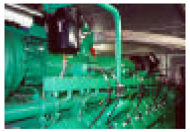
Continued development of high performance collectors and system components will improve the cost effectiveness of higher temperature applications.

Renewable Energy Sources, Technologies, Energy Service

Process Heat
High-Temperature Heat (over 500 °C)

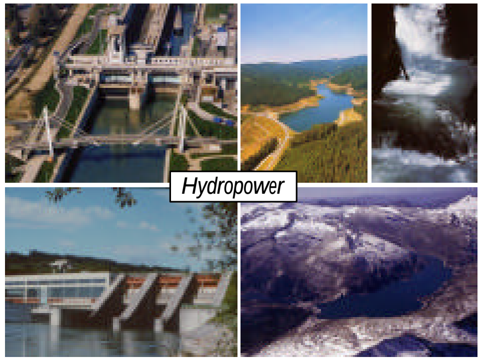
Solar Thermal Systems
Concentrating collectors
(only in regions with high direct solar radiation)

Bioenergy
Biogas
(Alternative to natural gas)

Renewable Energy Sources, Technologies, Energy Service

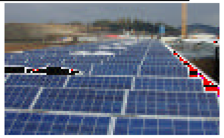
Electricity Production (1)



Renewable Energy Sources, Technologies, Energy Service

Electricity Production (2)

Solar Energy
Solar Electric Power Plants
Photovoltaic Systems



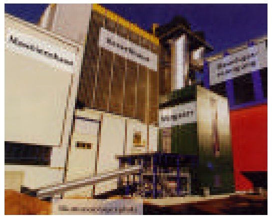
Stand-alone PV-Systems in Alpine Regions

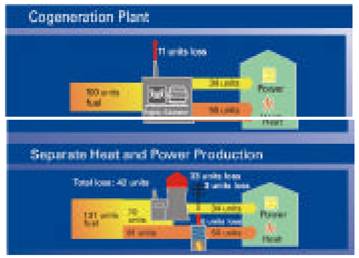
Renewable Energy Sources, Technologies, Energy Service

Electricity Production (3)

Bioenergy
Biomass Cogeneration Plants

Comparison between Cogeneration Plant and Separate Heat and Power Production





Renewable Energy Sources, Technologies, Energy Service

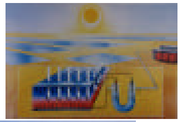
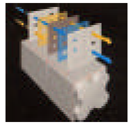
Electricity Production (4)


Wind Power


Renewable Energy Sources, Technologies, Energy Service

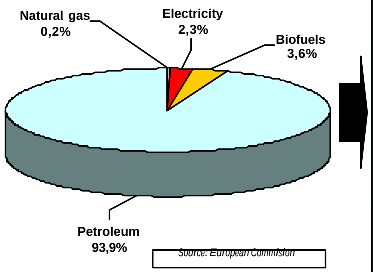
Fuels for Transportation (Mobility)

Biofuels	Bioethanol, Biodiesel
Electricity	Electric Vehicles
Hydrogen Produced from Renewable Electricity Hydropower, Photovoltaic, Wind Turbines	Hydrogen Fuel Cell


Energy Options for Transportation

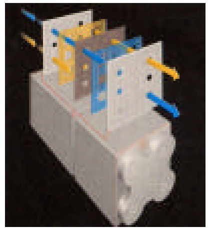
Energy used in EU transportation 2010
(road, rail, and air)

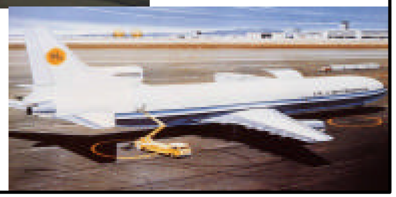


Alternatives are beeing sought

- To reduce emissions of greenhous gases into the atmosphere.
- To reduce our dependency on energy imports from a handful of countries, some of which are politically unstable.
- Because the world`s reserves of easily accessible crude oil are finite and new fields are becoming increasingly costly and risky to access.

Hydrogen and Fuel Cell for Mobility

Trade with Renewables ?

- Primary, the use of Renewables should not include long ways for transportation.
- Otherwise the **exchange of electricity** in an internationel (European) grid and the **import of bioenergy products**, especially from bio-fuels could support the security of sustainable energy systems.

Steps to Establish a „Sustainable Energy System“

Analysing the development of Energy Supply and Energy Consumption
Trend in for Energy-Efficiency and Renewables?

Estimates of the potential for more Energy-Efficiency and faster growth of Renewables

Barriers for realisation
State of the art of technologies, political framework, barriers, conflicts etc.
Proposals for solutions

Szenarios for Realisation
Reqirements for market development of Energy Supply and Renewables contribution

Recommendations for the realisation of the Energy Strategy

Methodology of Energy Strategy to achieve a Sustainable Energy System

(1) Improvement of Energy-Efficiency by Energy-Production and Energy-Consumption

Longterm, the Energy Services should be covered with the half of present energy supply.

(2) The Total Primary Energy Supply (TPES) – after measures for Energy Efficiency – should be covered by renewable energy sources, which will be not more than 30% of the actual share of renewables in energy supply.

Turn-over of Energy System *„Energiewende“*

Development of Annual Growth rate of Energy Services

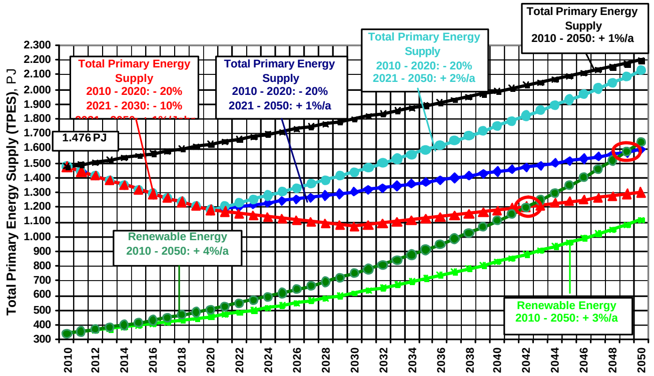
and

Development of Annual Growth rate of Renewable Energy

⬇

Time of Turn-over
„Energiewende“

Scenario for the Development of TPES in Austria



The Austria Energy Strategy 2050 for the Energy Consumption in Buildings

Goal 2050:

Total Substitution of Fossil Energy Sources for Heating and Cooling in Buildings

Assumptions for Annual Growth Rates

Average Annual Growth-rate for Energy Services and share of Renewable Energy in the period 2005 – 2010:

End-use Energy Consumption: - 1%/a
Total Primary Energy Supply: - 0,25%/a
Share of Renewables: + 3,30 %/a

Assumption for Scenario:

Energy-Sevices:
Reduction of 20% until 2020
Annual Growth-rate 2021 – 2050: 1%/ year
Share of Renewables:
2010 – 2050: 4%/ year

Energy Scenario 2050

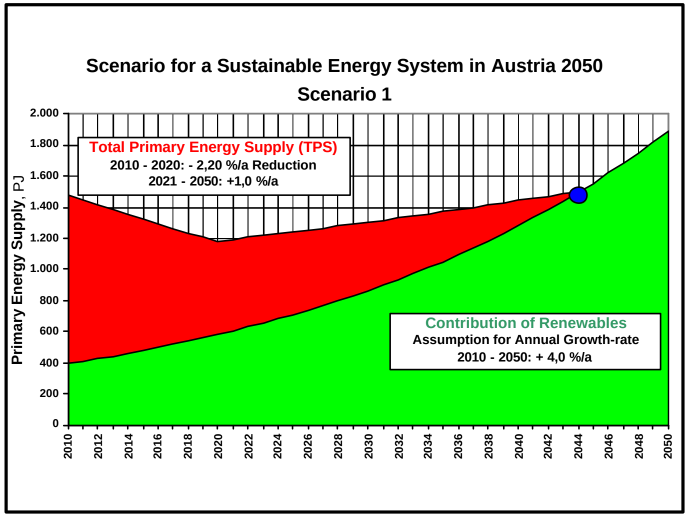
Austria-Total Primary Energy Supply (TPES)

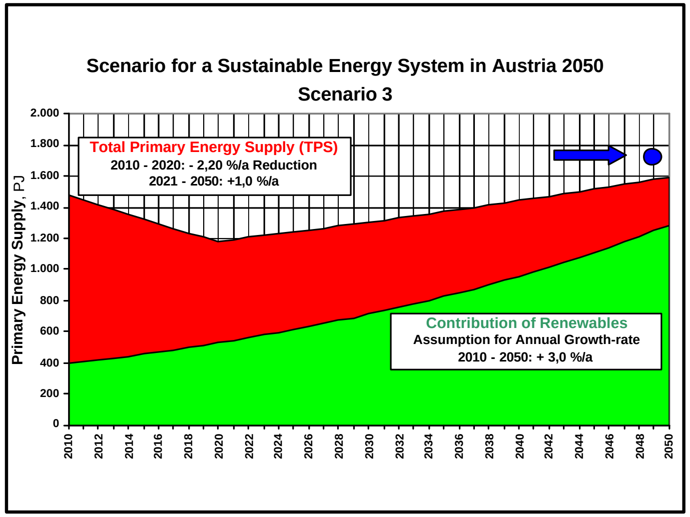
Basis Data 2010

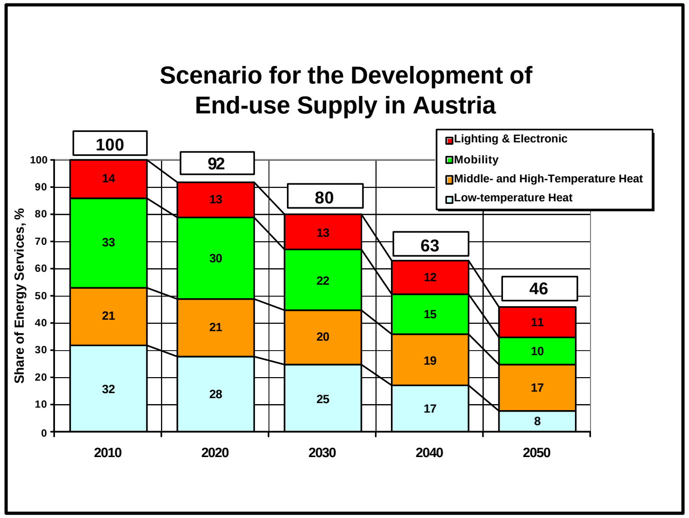
Energy Supply: 1.476 PJ
Renewable Energy Supply: 394 PJ
Share of Renewables: 27 %
Annual Production Capacity: 15 PJ/year

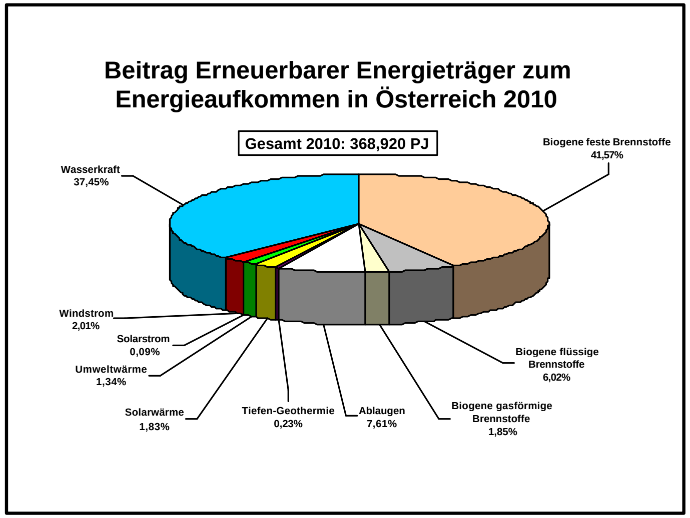
Assumptions and Result 2050

Reduction of 20% until 2020
Annual Growth-rate 2021 – 2050: 1%/ year
Average Annual Growth of Renewables: 4%/ year


Scenario for a Sustainable Energy System in Austria 2050
Scenario 1
Primary Energy Supply, PJ
Total Primary Energy Supply (TPS)
2010 - 2020: - 2,20 %/a Reduction
2021 - 2050: +1,0 %/a
Contribution of Renewables
Assumption for Annual Growth-rate
2010 - 2050: + 4,0 %/a

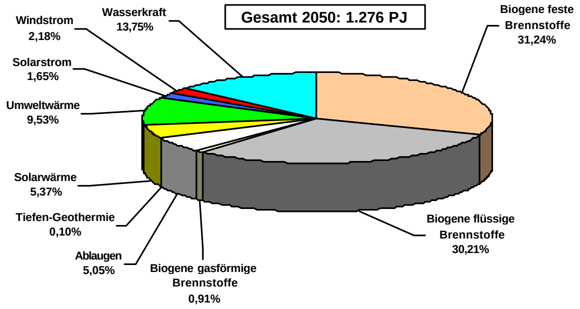

Scenario for a Sustainable Energy System in Austria 2050
Scenario 3
Primary Energy Supply, PJ
Total Primary Energy Supply (TPS)
2010 - 2020: - 2,20 %/a Reduction
2021 - 2050: +1,0 %/a
Contribution of Renewables
Assumption for Annual Growth-rate
2010 - 2050: + 3,0 %/a


Scenario for the Development of
End-use Supply in Austria
Share of Energy Services, %
Lighting & Electronic
Mobility
Middle- and High-Temperature Heat
Low-temperature Heat
100
92
80
63
46
2010
2020
2030
2040
2050


Beitrag Erneuerbarer Energieträger zum
Energieaufkommen in Österreich 2010
Gesamt 2010: 368,920 PJ
Biogene feste Brennstoffe 41,57%
Wasserkraft 37,45%
Windstrom 2,01%
Solarstrom 0,09%
Umweltwärme 1,34%
Solarwärme 1,83%
Tiefen-Geothermie 0,23%
Ablaugen 7,61%
Biogene gasförmige Brennstoffe 1,85%
Biogene flüssige Brennstoffe 6,02%

Beitrag Erneuerbarer Energieträger zum Energieaufkommen in Österreich 2050

Ambitioniertes Forcierungs-Szenario-2



Organisation for the Establishment "Sustainable Energy System"

Central / Federal Government

Goal and Criteria's: National Energy Strategy
With consideration of EU-Recommendations / Directives

Regional Governments

- National Strategy, adapted to regional characteristics.
- Regional strategy based on local and regional conditions, which include ecologic, topographic, economic and social situation.
- Coordination of regional planning in communities.
- Financial support for initiatives and activities in communities

Communities

- Increase the population's awareness for a "Sustainable Energy System" in the community.
- Identifying the value of renewable energy production for the local community.
- Motivation to become an "energy-autonomous" / "self-sufficient" community.
- Develop the concept for realisation: Action Plan
In cooperation with population and local interest groups
- Concept for land use and protection.
- Activities to avoid conflicts.

Chapter 5: Energy Strategy for Buildings

(1) Reduction of space heat demand of the building within measures for energy-efficiency in building construction and energy supply: 20% until 2020 and further 10% from 2020 to 2030. Related to 2020.

(2) Annual growth rate of solar thermal and heat pump systems of = 3 %/a, related to the annual installed capacity.

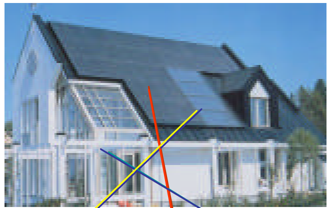
(3) Change of electrical space heating and hot water preparation to solar thermal systems and heat pumps.

(4) Use of high-efficient appliances, lighting and electrical equipment of the heating & cooling system.

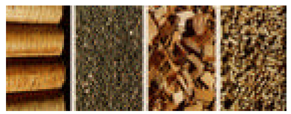
(5) Installation of building-integrated solar photovoltaic systems.

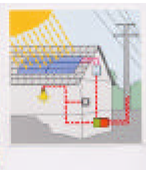
Outlook for Sustainable Residential Building

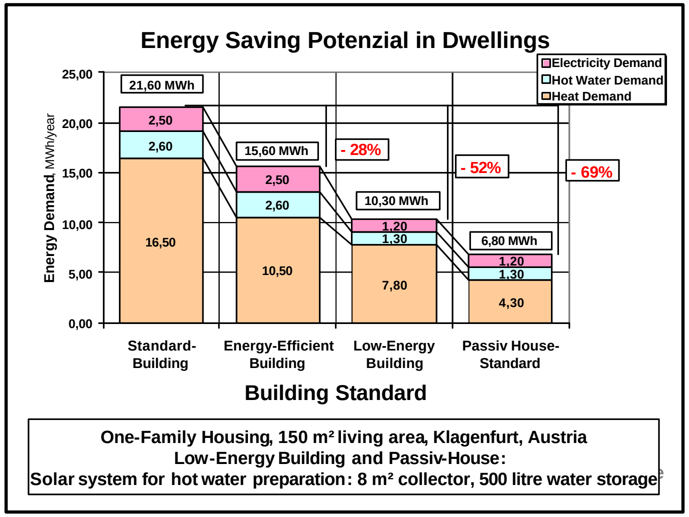
With Solar Heat, Ambient Heat, Biomass and Solar Electricity towards „Sustainable Building"

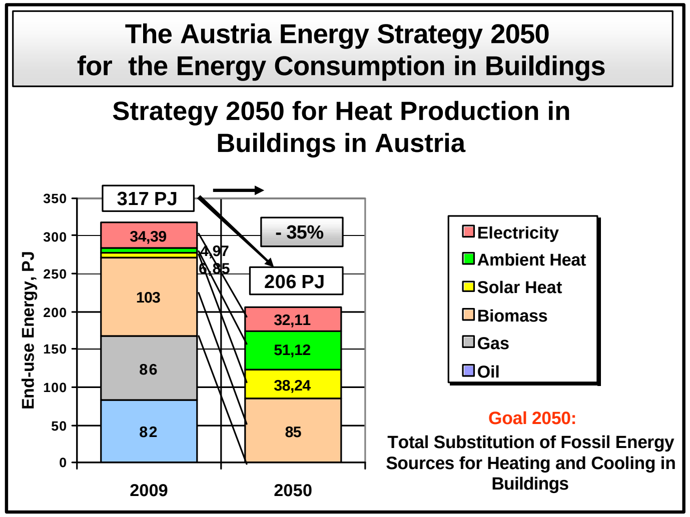


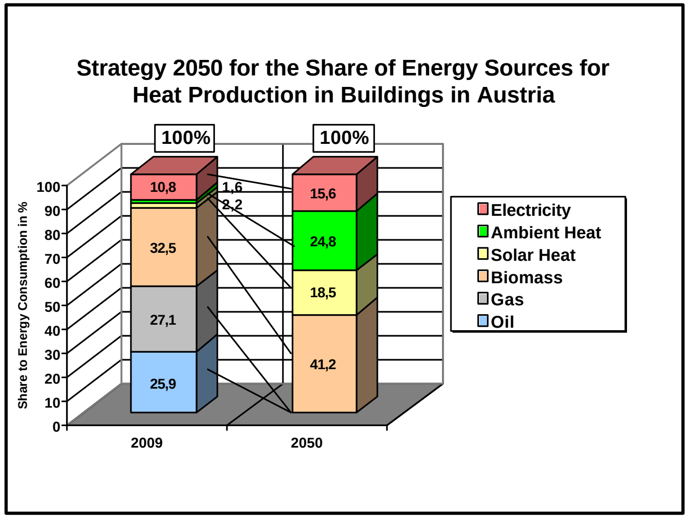
Low-energy building, integrated sunspace, thermal and electric solar system

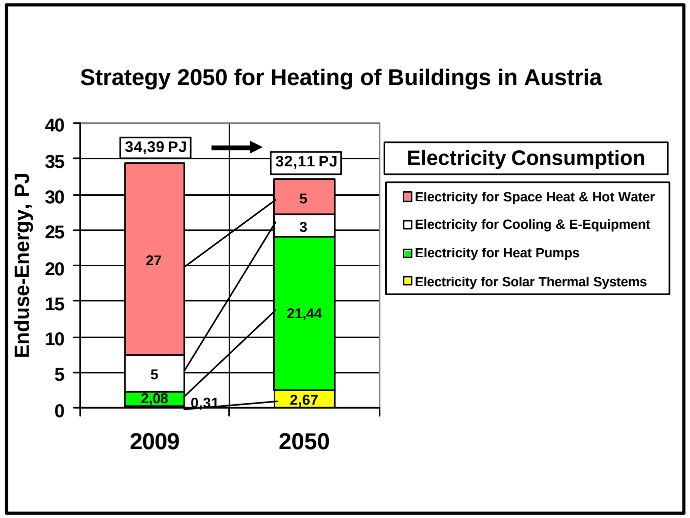




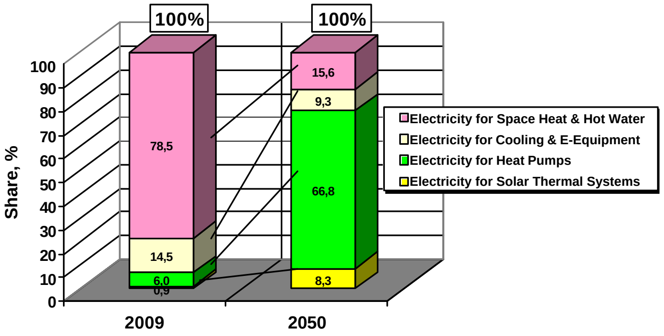

Energy Saving Potenzial in Dwellings
Electricity Demand
Hot Water Demand
Heat Demand
Energy Demand, MWh/year
21,60 MWh
15,60 MWh
10,30 MWh
6,80 MWh
- 28%
- 52%
- 69%
2,50
2,60
16,50
2,50
2,60
10,50
1,20
1,30
7,80
1,20
1,30
4,30
Standard-Building
Energy-Efficient Building
Low-Energy Building
Passiv House-Standard
Building Standard
One-Family Housing, 150 m² living area, Klagenfurt, Austria
Low-Energy Building and Passiv-House:
Solar system for hot water preparation: 8 m² collector, 500 litre water storage


The Austria Energy Strategy 2050
for the Energy Consumption in Buildings
Strategy 2050 for Heat Production in Buildings in Austria
End-use Energy, PJ
317 PJ
- 35%
206 PJ
34,39
4,97
6,85
103
86
82
32,11
51,12
38,24
85
2009
2050
Electricity
Ambient Heat
Solar Heat
Biomass
Gas
Oil
Goal 2050:
Total Substitution of Fossil Energy Sources for Heating and Cooling in Buildings


Strategy 2050 for the Share of Energy Sources for Heat Production in Buildings in Austria
Share to Energy Consumption in %
100%
100%
10,8
1,6
2,2
32,5
27,1
25,9
15,6
24,8
18,5
41,2
2009
2050
Electricity
Ambient Heat
Solar Heat
Biomass
Gas
Oil


Strategy 2050 for Heating of Buildings in Austria
Enduse-Energy, PJ
34,39 PJ
32,11 PJ
27
5
2,08
0,31
5
3
21,44
2,67
2009
2050
Electricity Consumption
Electricity for Space Heat & Hot Water
Electricity for Cooling & E-Equipment
Electricity for Heat Pumps
Electricity for Solar Thermal Systems

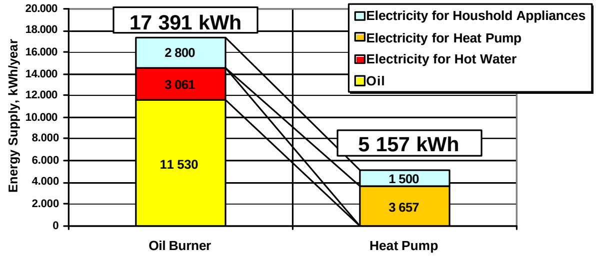
Strategy 2050 for Electricity Consumption in Buildings in Austria



Energy Supply in One-family Dwelling, 150 m²

Comparison between Oil-Burner and Electro-Boiler for Hot Water and Heat Pump & Solar Water Heating

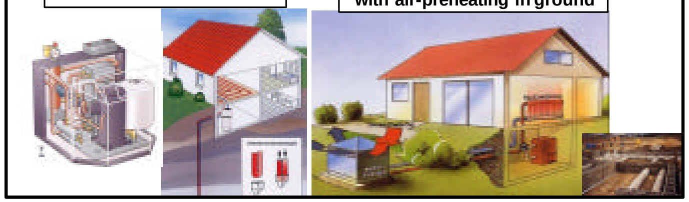
Heat demand: 9 800 kWh/year; Hot water: 3 000 kWh/year
Annual Efficiency Oil-burner: 85%; Annual Efficiency E-Boiler: 98%
Seasonal Performance Factor (Space Heat & Hot Water): 3,5



Heat Pump – Solar - Combisystems

Ground-coupled Heat Pump

Air Heat Pump
with air-preheating in ground



Solar-Heat Pump-Combisystem

Use of Solar Heat

Preheating of Heat Pump Source

Air-Heat Pump with Solar Absorber

Ground & Water Heat Recovery with Solar Heat

Goal: Increased Efficiency of Heat Pump System

Hot Water Preparation & Space Heating

Combination of Heat-Pump-System with Solar Thermal System

Goal:
Annual Efficiency of Heating System = 4 (SPF)

Solar Thermal Systems for Hot Water Preparation & combined with Space Heating

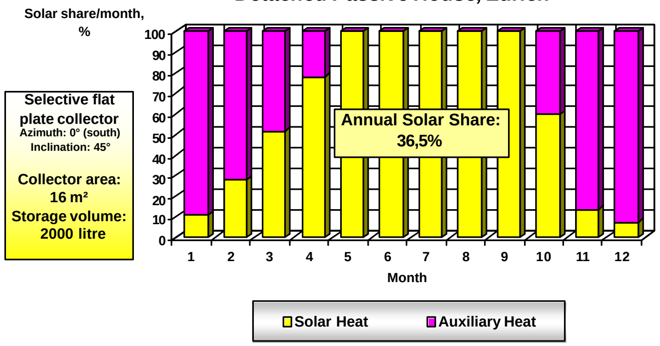
With **Solar Hot Water Systems**, the hot water demand of a household will be shared of about 40% to 60% on annual basis and of about 80% to 95 % during the summer period: North-, Middle- and South-Europe.

Solar-Combisystems contribute to the space heat and hot water supply between 40% to 60% on annual basis, in combination with water storages up to 2 000 litre.

For higher contributions seasonal storages with a volume of up to 80 m³ and a collector yield of more than 50 m² are necessary - a not economic solution.

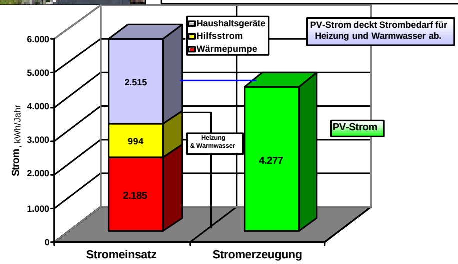
Solar Combisystem

Detached Passive House, Zurich



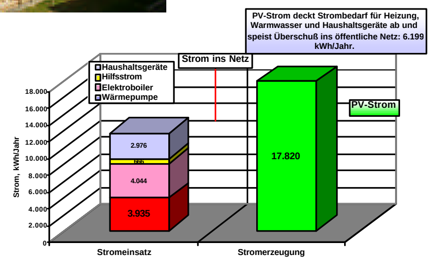
With PV to SOLAR-*ACTIVE*-Building

Heat Demand HWB: 39 kWh/(m², year)
Heat Pump/Solar-Combisystem
Soil-Heat Pump (SPF = 3,8)
16 m² Collector Area, 1500 Litre Water Strorage
3 kW_{peak} PV-System



With PV to *PLUS*-Energy Building

Heat Demand: 19 kWh/(m², yesr
Air/Air Heat Pump (SPF = 2,60)
Electrical Hot Water Preparation
14,85 kW_{peak} PV-System



Solar Thermal District Heating

The connection of solar thermal collectors with district heating systems is used in Northern Countries (e. g. Denmark, Sweden) and some district solar systems have been built in Germany; the most in combination with a seasonal water storage – for example in ground (Pit-storage).

• In Austria **solar-supported biomass-district heating systems** in rural regions are since 1980 in operation, with only a small market deployment rate.

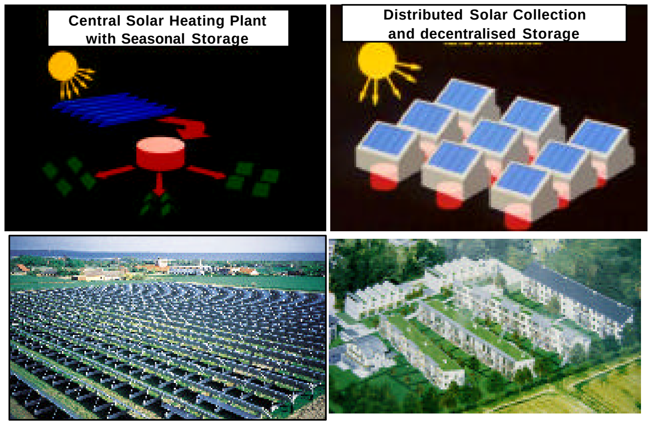
• More interest on the market could be found for “**Small district heating systems**” for Building Estates (Apartment Housing).

• With the market deployment of Energy-Efficient Buildings (New Buildings und Building Renovation), the efficiency of district heating and decentralised heating systems has to be analysed and compared.

• District heating have to offer heat over the full day, with high heat losses in the pipes, including circulation pipes in housing. The management of the heat supply in decentralised solar thermal system can be better and more efficient organised.

• In future, solar thermal supported district heating may be preferred in urban regions with Apartment Housing (Building Estates), but in rural regions decentralised heating systems may be the better decision.

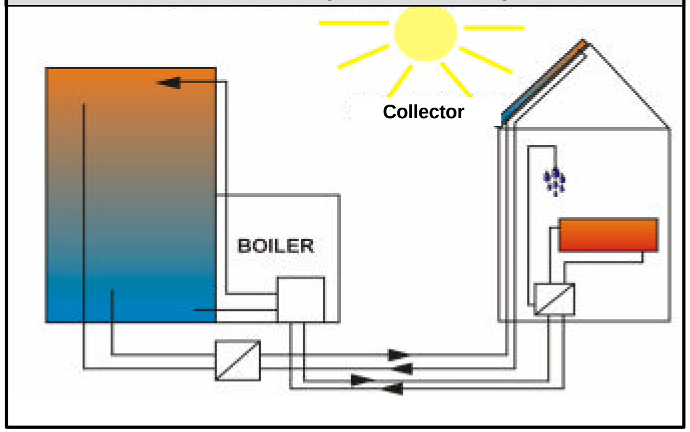
Solar District Heating



Solar Sytem for District Heating

Decentralised installation of collectors

Middle-Time- / Long-Time -Water Storage



Solar Supported Biomass District Heating

Solar Supported District Heating for Appartment Buildings, Salzburg/Austria

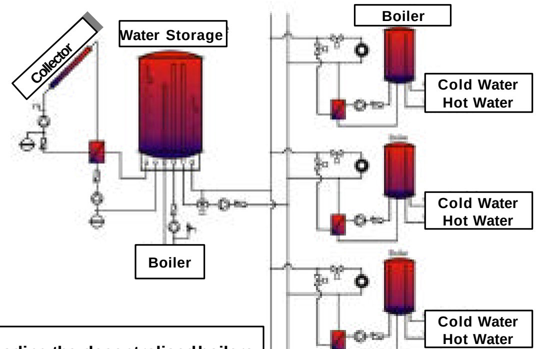
Annual Solar Share: 40% - 60%

Hot Water & Space Heat

AEE-Institute for Sustainable Technologies Acive and Passive Solar Thermal, Solar Photovoltaic and Central Pellets Boiler

Solar Thermal System for Apartment Building

Central Water Storage and decentralised Hot Water Storages in Units



Periodically loading the decentralised boilers to minimize heat distribution losses

Chapter 6: The Potential of Renewable Energy Sources in Austria

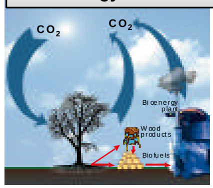
- Bio-Energy
- Solar Thermal Technologies
- Heat Pump Technologies
- Geothermal Energy
- Solar Photovoltaic Systems
- Hydro-Power
- Wind-Power

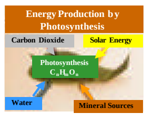
Bio-Energy Systems

Biomass – a key option within all energy sectors

Biomass energy, that is solar energy captured by plants through photosynthesis and fixed in carbohydrate material, is the traditional energy source of much of mankind. It can be used as plant material direct from the field or in the form of agricultural (including forest industries), household and industrial wastes.

Bioenergy-Production & and CO_2-Cycle





With Solar Energy and Carbon Dioxide in the atmosphere and Water on the Earth – Hydro Carbons are produced:
Forests and agricultural Products: Bioenergy.
The use of Biomass from a sustainable Forestry is seen as „CO_2-neutral“

- Among the non-fossil energy technologies in prospect for the future only biomass produces solid, liquid and gaseous fuels which can be used as, or easily transformed into, fuels for transport, electricity generation and heating applications.
- Simple biomass combustion technologies are already competitive with oil, in those rural areas where wood residues are available nearby and can be burned in small, decentralised plants, as well as in district heating plants in urban areas supported with the combustion of municipal wastes.
- Converting biomass to liquid (BTL) fuels is potentially very important for two reasons. It offers not only the prospect of retaining liquid chemical fuels for transport without increasing atmospheric CO_2 but also the possibility of a global trade in biomass-derived liquids, not really possible with solid biomass itself.

Bioenergy-Sources and Applications

Bioenergy-Sources	Conversion and Applications
Solid *Firewood, wood chips, bark, rapseed, sunflower, soy bean, Palm*	**Heat Production** *Decentralised and district heating,* **Gasification**
Liquid *Bioethanol, Biodiesel*	**Biological Conversion** *Biofuels for Mobility*
Gaseus *Biogas*	**Gasification** *Substitution of natural gas, Biomethan for Mobility*

BIOMASS TO ENERGY PATHWAYS

BIOMASS FEEDSTOCK → BIOMASS COMBUSTION → BIOENERGY CONSUMPTION

Conversion Processes

Energy Uses	Energy Crops	
Traditional Biomass (Heating & Cooling) Modern Energy Carriers (Transport Fuels) **Non-Energy Uses** Bio-Chemicals Bio-Material	Agriculture, Forestry, **Risidues and Byproducts,** Industries, Municipalities.	Heat Production, Electricity Production, Transport.

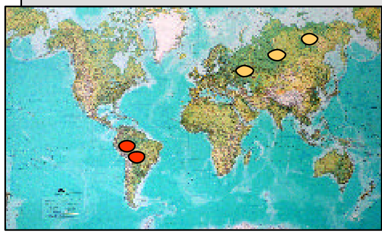
Bio-fuels from Agricultural and Forestry Wastes

- Agricultural and forestry wastes could provide a source of raw materials without impacting food prices or requiring deforestation.
- In 2010 the IEA estimated that if all agricultural and round-wood waste in world were converted into bio-fuels, that could displace approximately 40% of our crude oil consumption for transportation needs.
- However, since most of these „wastes“ are already used for the production of wood chips and pellets in the heating sector.
- It was estimated that only 10 to 25% are realistically available to convert into liqid bio-fuels.

→

- **Bio-fuels from agricultural and forestry wastes could therefore supply 4% to 10% of our transportation energy needs.**
- **This is good, but cannot be the only solution to the world`s transportation energy problem.**

Additional Farmland Required for Production of Bio-fuels



The amount of land needed to replace all gasoline and diesel in transportation with bio-fuels is nonetheless not achievable and also unacceptable.

The entire EU-27 has an area of 432 m ha.

But no land would be cleared if only a portion of gasoline and diesel were replaced with bio-fuels (e.g. unused farmland).

Option 1: First generation bio-fuel plantations in tropical climate: 255 m hectares of oil palm to produce bio-diesel and 280 m ha sugar cane to produce ethanol.

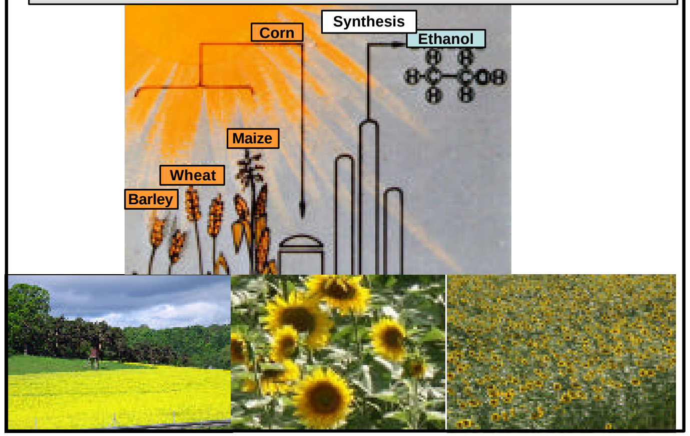
Option 2: Second generation bio-fuel plantation in temperate climate. 535 m ha hybrid polar or switchgrass to produce gasoline and diesel substitutes. Effectively same yield per hectare as first generation technology achieves in the tropics today.

Prospects for Bio-fuels

Bio-fuels could replace petroleum, but research and development must continue

- Whether „first“ or „second“ generation technologies are used, bio-fuels produced from plants that grow in soil are likely to be available in quantities that help supplement our energy mix rather than dominate it.
- Bio-fuels produced from agricultural and forestry wastes will also be available in quantities that meet some of our energy needs but will most likely not be able to completely replace petroleum, either
- Algea may offer the opportunity to produce bio-fuels in the quantities required to completely replace petroleum, but further research and development are required.

Agricultural Products for Bio-fuel Production



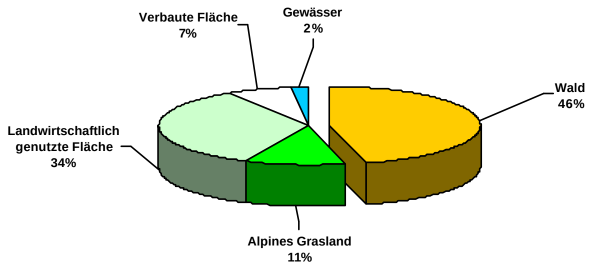
Future Prospects for Bioenergy

- Simple biomass combustion technologies are already competitive with oil, in those rural areas where wood residues are available nearby and can be burned in small, decentralised plants, and with oil and gas in urban areas where the combustion of municipal wastes saves the costs of transport to and disposal in scarce landfill sites.
- Biomass offers considerable flexibility of fuel supply due to the range and the diversity of fuels which can be produced at small or large scale, in a centralised or decentralised way. Cost of heat production from biomass, or bio-heat, depends firstly on the bio fuel cost.
- The cost depends on the country, the type and quality of the fuel, the demand, the organisation of the procurement chain, the quantity (individual user up to large industrial scale), etc.

- Converting biomass to liquid (BTL) fuels is potentially very important because it offers not only the prospect of retaining liquid chemical fuels for transport without increasing atmospheric CO_2 but also the possibility of a global trade in biomass-derived liquids, not really possible with solid biomass itself. Because of this potential of BTL to provide liquid fuels it is important to find biological processes for converting the ligno-cellulose parts of woody plants to liquids.
- The design and operation of conventional BTL plant for the different biomass feedstock which might become available in or to the EU would also be useful, in order that the conversion technology and costs of BTL fuels might be reduced or at least become less uncertain.
- **The worldwide potential for useful biomass resources is estimated to be about 400 - 1,400 EJ/year.**

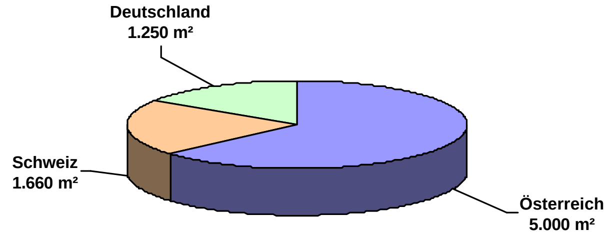
For Austria, Bioenergy is the key-option for a Sustainable Energy System

Waldland Österreich

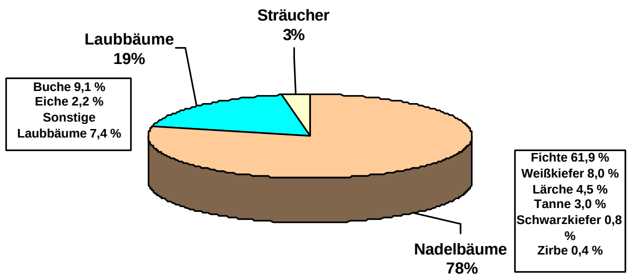


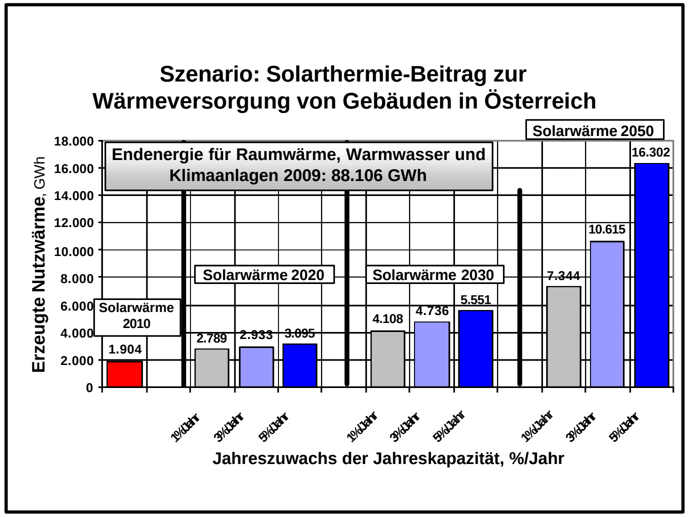
Bewaldungsanteil

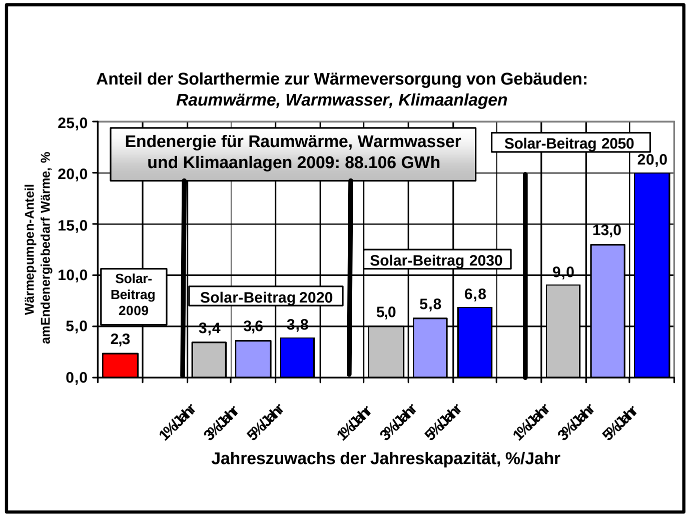
Waldfläche pro Einwohner

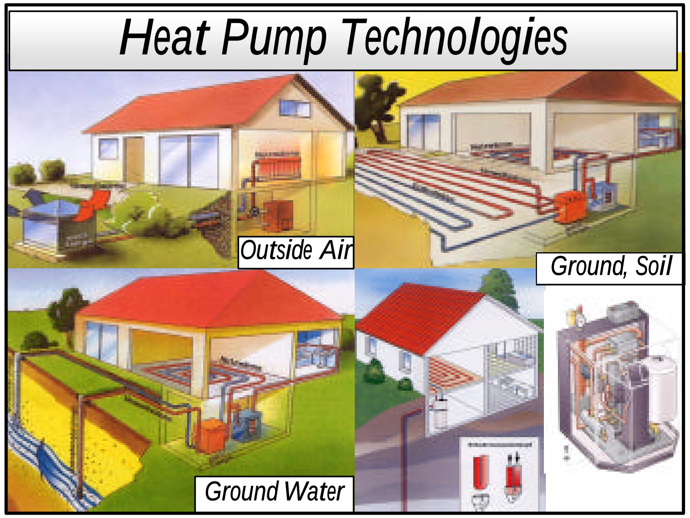


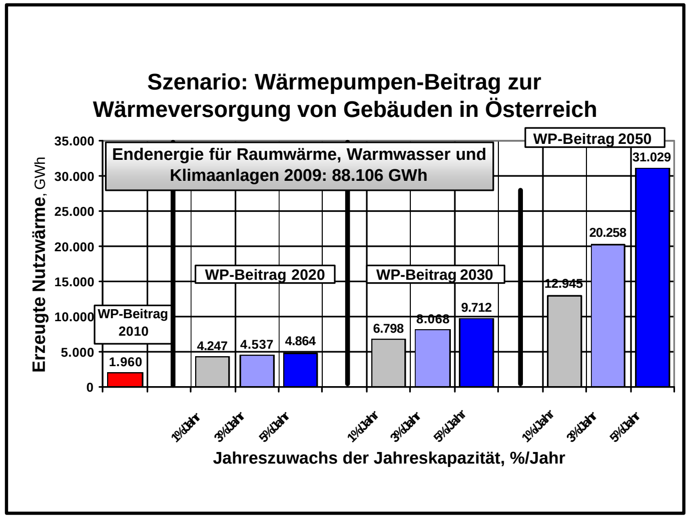
Holzarten in Österreich

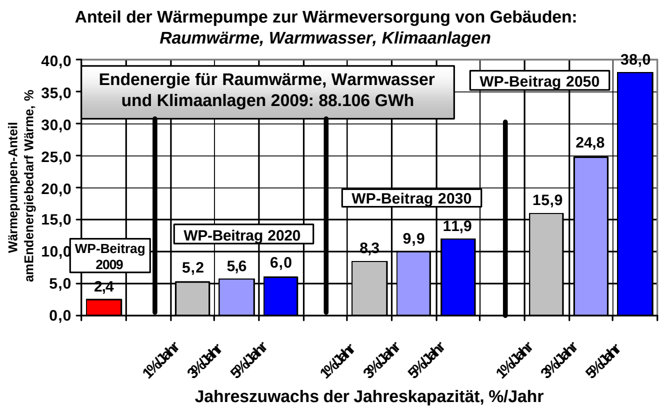



Szenario: Solarthermie-Beitrag zur
Wärmeversorgung von Gebäuden in Österreich
Erzeugte Nutzwärme, GWh
18.000
16.000
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0
Endenergie für Raumwärme, Warmwasser und Klimaanlagen 2009: 88.106 GWh
Solarwärme 2010
1.904
Solarwärme 2020
2.789
2.933
3.095
Solarwärme 2030
4.108
4.736
5.551
Solarwärme 2050
7.344
10.615
16.302
Jahreszuwachs der Jahreskapazität, %/Jahr


Anteil der Solarthermie zur Wärmeversorgung von Gebäuden:
Raumwärme, Warmwasser, Klimaanlagen
Wärmepumpen-Anteil amEndenergiebedarf Wärme, %
25,0
20,0
15,0
10,0
5,0
0,0
Endenergie für Raumwärme, Warmwasser und Klimaanlagen 2009: 88.106 GWh
Solar-Beitrag 2009
2,3
Solar-Beitrag 2020
3,4
3,6
3,8
Solar-Beitrag 2030
5,0
5,8
6,8
Solar-Beitrag 2050
9,0
13,0
20,0
Jahreszuwachs der Jahreskapazität, %/Jahr


Heat Pump Technologies
Outside Air
Ground, Soil
Ground Water


Szenario: Wärmepumpen-Beitrag zur
Wärmeversorgung von Gebäuden in Österreich
Erzeugte Nutzwärme, GWh
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0
Endenergie für Raumwärme, Warmwasser und Klimaanlagen 2009: 88.106 GWh
WP-Beitrag 2010
1.960
WP-Beitrag 2020
4.247
4.537
4.864
WP-Beitrag 2030
6.798
8.068
9.712
WP-Beitrag 2050
12.945
20.258
31.029
Jahreszuwachs der Jahreskapazität, %/Jahr



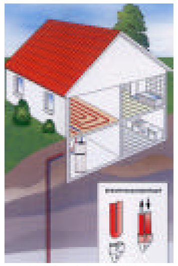
Geothermal Energy in Austria

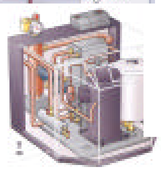
The use of Geothermal Energy in Austria is limited to Low-Temperature Heat in Wellness Centres

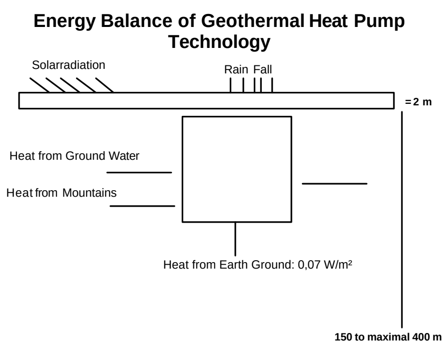
and

Geothermal Heat Pumps
(Soil and Ground Water)

Geothermal Heat Pump

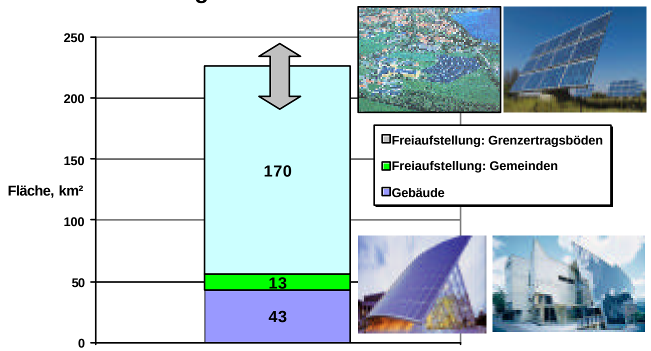






Areas for PV-Installations in Austria and possible Electricity Supply

Flächenangebot für PV-Module in Österreich



Flächenangebote für Netzgekoppelte PV-Anlagen in Österreich							PV-Anteil am Stromaufkommen 2011 %
STATISTIK AUSTRIA, Gebäude- und Wohnungszählung 2001 (Erstellt am 01.06.2007)							
Gebäude, Dachflächen							
Gebäude-Typ	Gebäude Gesamt	Gebäude PV-geeignet	Modulfläche m²/Gebäude	Verfügbare Modulfläche m²	PV-Leistung MW_{peak}	PV-Stromertrag GWh/Jahr	
Ein- und Zweifamilien-Wohnhäuser	1.557.420	778.710	25	19.467.750	2.290	2.519	4,56
Mehrparteien-Wohnhäuser	207.035	103.518	120	12.422.100	1.461	1.608	2,91
Nicht-Wohnhäuser	282.257	141.129	80	11.290.280	1.328	1.461	2,65
Gesamt	**2.046.712**	**1.023.356**		**43.180.130**	**5.080**	**5.588**	**10,12**
Annahmen							
Anteil der Gebäude mit für die Installation von PV-Modulen geeigneten Dachflächen, %				50			
Solarmodul-Fläche, m^2/kW_{peak}		8,5	**Mittlerer Stromertag**, kWh/kW_{peak}	1.100			
Stromaufkommen 2011, GWh		55.233					

Flächenangebote für Netzgekoppelte PV-Anlagen in Österreich				PV-Anteil am Stromaufkommen 2011 %
Freiaufstellung Im Rahmen der Raumplanung für Gemeinden freizugeben				
Flächenangebot	**Verfügbare Modulfläche** m²	**PV-Leistung** MW_{peak}	**PV-Stromertrag** GWh/Jahr	
Bodenfläche pro Gemeinde z. B. Bodenfläche entsprechend 1 Fußballfeld (8.500 m²) 2.300 Gemeinden	13.000.000	1.529	1.682	**3,05**
Grenzertragsböden und Sozialbrachen z. B. 10% von ca. 250 km²	170.000.000	20.000	22.000	**39,83**
Annahmen				
Solarmodul-Fläche, m^2/kW_{peak}	8,5	**Mittlerer Stromertag**, kWh/kW_{peak}		1.100
Stromaufkommen 2011, GWh	55.233			

Flächenangebote für solarthermische Kollektoren in Österreich						
STATISTIK AUSTRIA, Gebäude- und Wohnungszählung 2001 (Erstellt am 01.06.2007)						
Gebäude, Dachflächen						
Gebäude-Typ	Gebäude Gesamt	Gebäude Solarthermie	Kollektorfläche m²/Gebäude	Verfügbare Kollektorfläche m²	Solarwärme-Leistung MW_{peak}	Solarwärme-Ertrag GWh/Jahr
Ein- und Zweifamilien-Wohnhäuser	1.557.420	1.245.936	15	18.689.040	13.082	6.541
Mehrparteien-Wohnhäuser	207.035	165.628	80	13.250.240	9.275	4.638
Nicht-Wohnhäuser	282.257	225.806	80	18.064.448	12.645	6.323
Gesamt	**2.046.712**	**1.637.370**		**50.003.728**	**35.003**	**17.501**
Annahmen						
Anteil der Gebäude mit für die Installation von thermischen Solarkollektoren geeigneten Dachflächen, %					80	
Spezifischer Kollektor-Ertrag, kWh/m²		350				

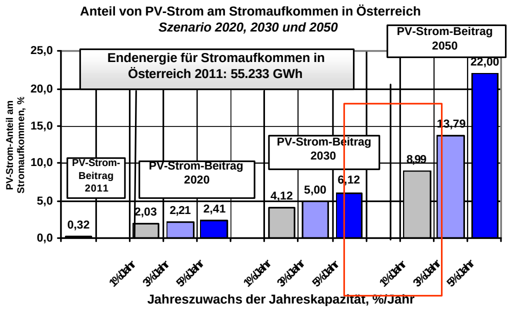
Flächenangebote für Solarthermische Anlagen in Österreich			
Freiaufstellung für Wärmenetze Im Rahmen der Raumplanung für Gemeinden freizugeben			
Flächenangebot	**Verfügbare Kollektorfläche** m²	**Solar-Leistung** $MW_{thermisch}$	**Solarertrag** GWh/Jahr
Bodenfläche pro Gemeinde z. B. Bodenfläche entsprechend 1 Fußballfeld (8.500 m²) 2.300 Gemeinden	13.000.000	9.100	4.550
Spezifischer Kollektor-Ertrag, kWh/m²	350		

Flächenangebot für PV-Anlagen
Freie Aufstellung
Für PV geeignete Bodenflächen im Rahmen der Raumordnung zuzuordnen
Südorientiert, 30° bis 45° Neigung, verschattungsfrei
(1) Pro Gemeinde: 8.500 m² (1 "Fußballfeld")
(2) Österreich insgesamt: Grenzertragsböden und Sozialbrache (10% von ca. 250 km²)
Technisches Potenzial:
PV-Leistung: 1.530 MWpeak (1), 20.000 MW_{peak} (2)
PV-Stromertrag: 1.682 GWh/Jahr (1), 22.000 GWh/Jahr (2)
PV-Anteil am Stromaufkommen 2011: 3% (1), 40% (2)
Priorität: Elektrizitätswirtschaft (Eigenerzeugung)

PV- Ausblick

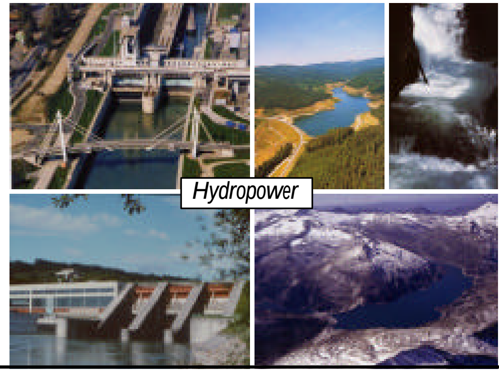
Welche Rolle kommt der Photovoltaik in der zukünftigen Stromversorgung zu und welchen Beitrag kann sie für ein „Nachhaltiges“ Energiesystem leisten?

10% bis 20% Anteil am Stromaufkommen 2050?



Hydropower in Austria (1)

Hydropower presently provides over 60% of Electricity Supply in Austria.



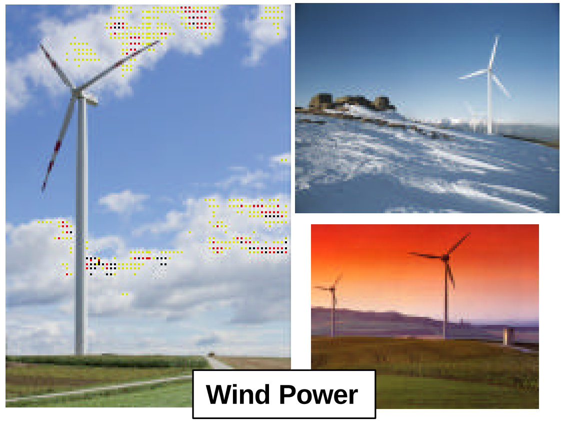
Hydropower in Austria (2)

• One of the greatest opportunities for quick gains to the renewable energy portfolio is to maximize the energy produced from existing projects through modernization. Gains of 5 to 10% are not an excessive target for most hydropower owners and where there are significant numbers of dams without generation, the numbers could be much higher.

• Interest in pumped storage will increase particularly in regions and countries where **variable renewable resources** are achieving relatively high penetration: Hydropower can work with other Renewable Energy technologies such as wind energy, solar photovoltaic, to develop symbiotic benefits for overlapping renewable energy technologies.

• **The Austrian Energy Strategy see no necessity to build new hydropower plants.**

Wind Power in Austria



Wind Power in Austria

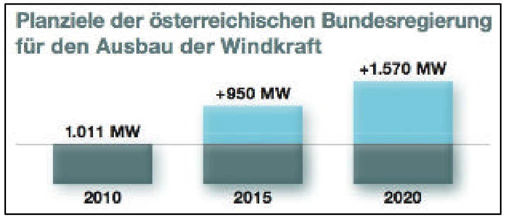
• For an economic use of Wind Power in Austria areas near Vienna, Burgenland and Lower Austria (Niederösterreich) are available and used.

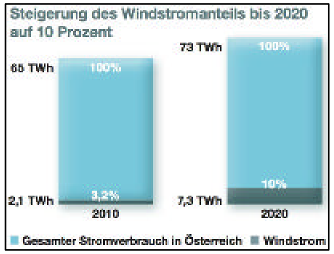
• Economic acceptable sites are those, where more than 2,000 full-load-equivalent hours per year would be reached.

• Further planning of Wind Parks has to consider ecological and economic criterias as well as habitat and landscape protection.

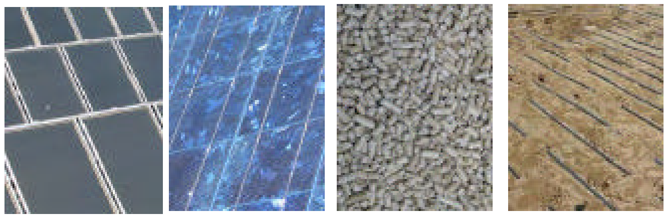
• The goal of the Austrian Energy Strategy is to douple the present electricity production until 2050.

• **At present, criterias of landscape protection have priority.**





ANNEX
Market Deployment of Renewable Energy Technologies in Austria



Innovative Energietechnologien in Österreich Marktentwicklung 2012
Biomasse, Photovoltaik, Solarthermie und Wärmepumpen
May 2013
Bundesministerium für Verkehr, Innovation und Technologie, BMVIT
Projektkoordination: Technische Universität Wien
Energy Economics Group (EEG), Dipl.-Ing. Dr. Peter Biermayr

Market development of Renewable Energy Technologies in Austria.

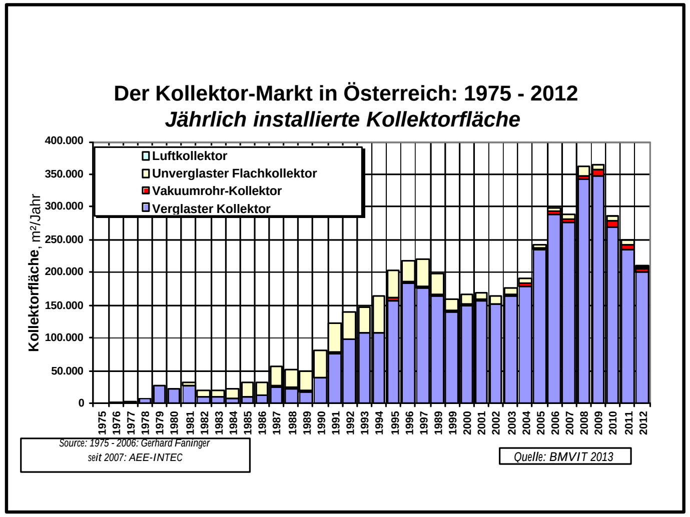
• The market development of the evaluated technologies:

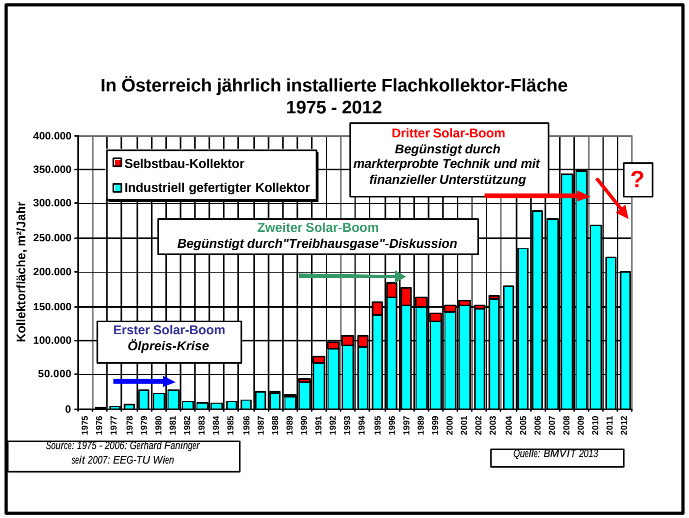
solid biomass, photovoltaics, solar thermal energy and heat pumps recovered in 2012.

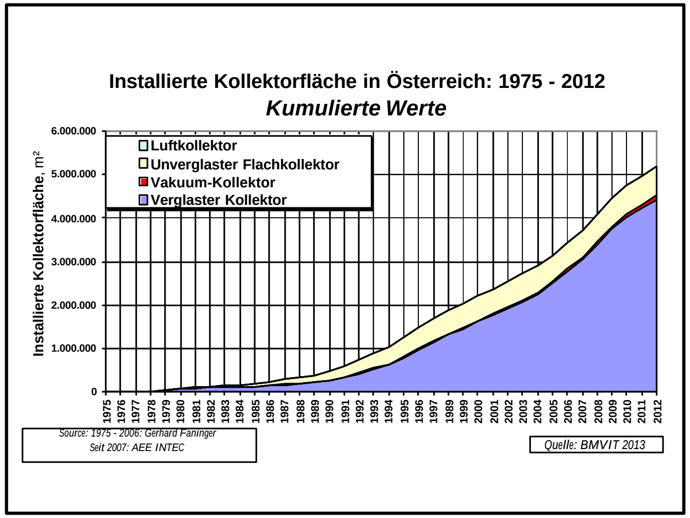
• However after a closer examination the development of the sales figures of the various technologies, performance classes and fuels was not uniform.

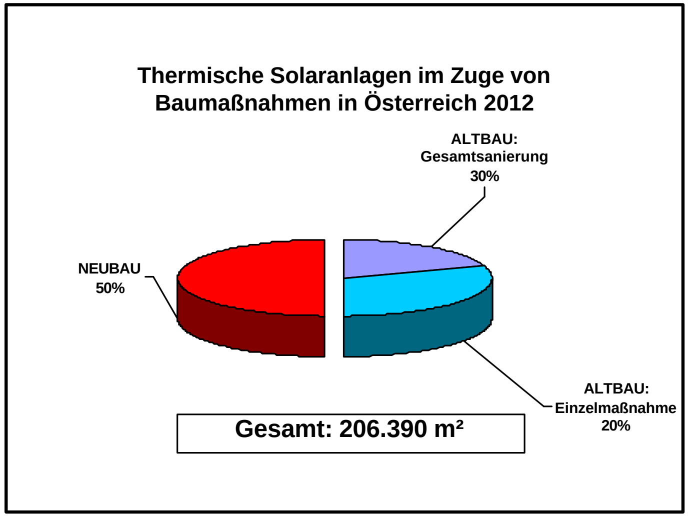
• Due to many different factors like the permanently high oil price in 2012, the reluctant development of the economy and the constant troubles in the Euro zone the market development was rather complex. Like in the previous year motivating factors for investments were mixed with obstacles.

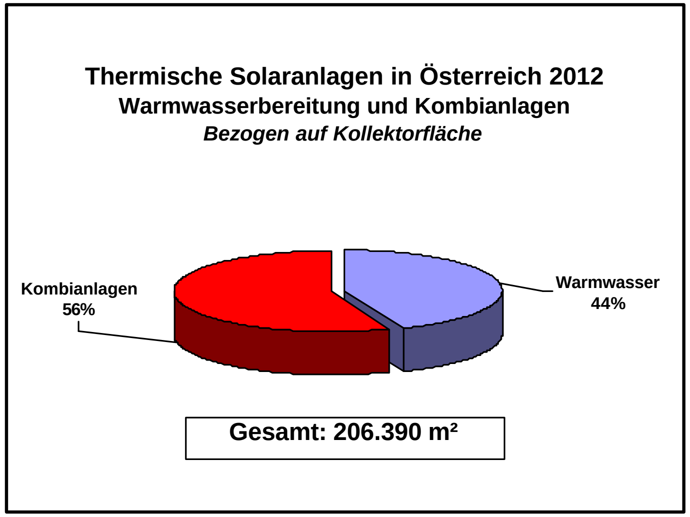

Solar Heating & Cooling

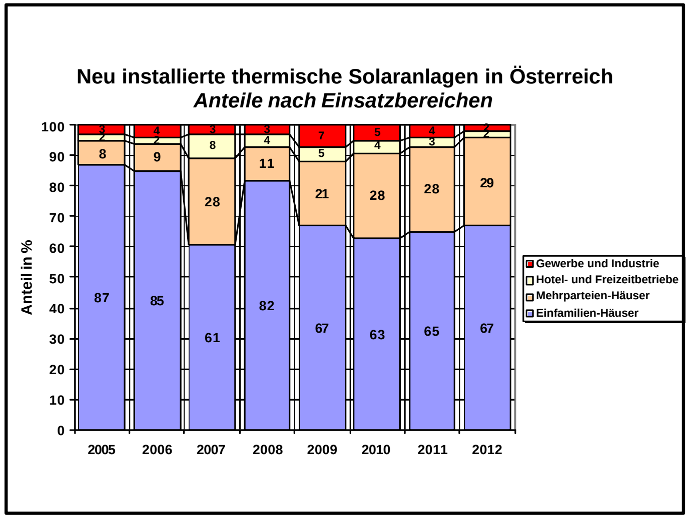

Der Kollektor-Markt in Österreich: 1975 - 2012
Jährlich installierte Kollektorfläche
Kollektorfläche, m²/Jahr
Luftkollektor
Unverglaster Flachkollektor
Vakuumrohr-Kollektor
Verglaster Kollektor
Source: 1975 - 2006: Gerhard Faninger
seit 2007: AEE-INTEC
Quelle: BMVIT 2013

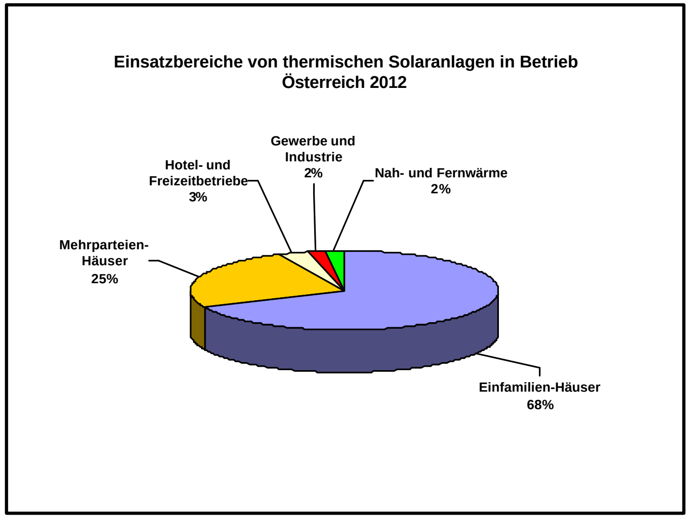

In Österreich jährlich installierte Flachkollektor-Fläche
1975 - 2012
Kollektorfläche, m²/Jahr
Selbstbau-Kollektor
Industriell gefertigter Kollektor
Dritter Solar-Boom
Begünstigt durch markterprobte Technik und mit finanzieller Unterstützung
?
Zweiter Solar-Boom
Begünstigt durch "Treibhausgase"-Diskussion
Erster Solar-Boom
Ölpreis-Krise
Source: 1975 - 2006: Gerhard Faninger
seit 2007: EEG-TU Wien
Quelle: BMVIT 2013

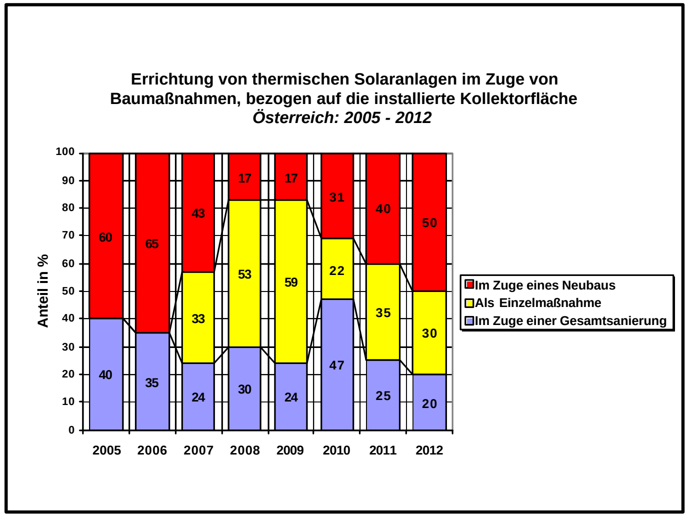

Installierte Kollektorfläche in Österreich: 1975 - 2012
Kumulierte Werte
Installierte Kollektorfläche, m²
Luftkollektor
Unverglaster Flachkollektor
Vakuum-Kollektor
Verglaster Kollektor
Source: 1975 - 2006: Gerhard Faninger
Seit 2007: AEE INTEC
Quelle: BMVIT 2013

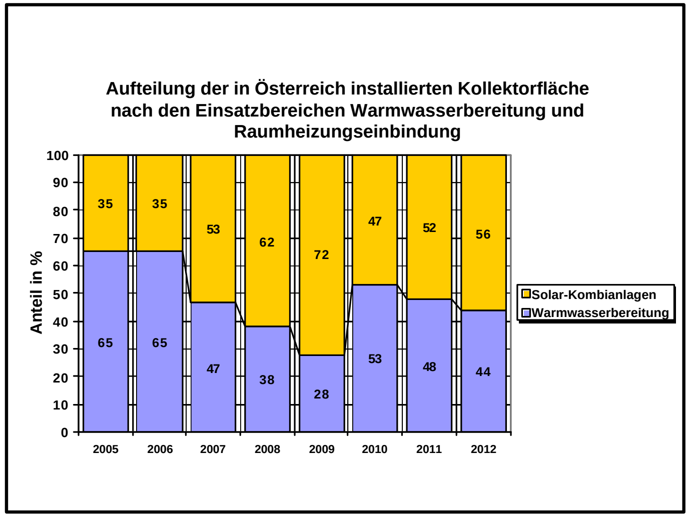

Thermische Solaranlagen im Zuge von
Baumaßnahmen in Österreich 2012
ALTBAU:
Gesamtsanierung
30%
NEUBAU
50%
ALTBAU:
Einzelmaßnahme
20%
Gesamt: 206.390 m²

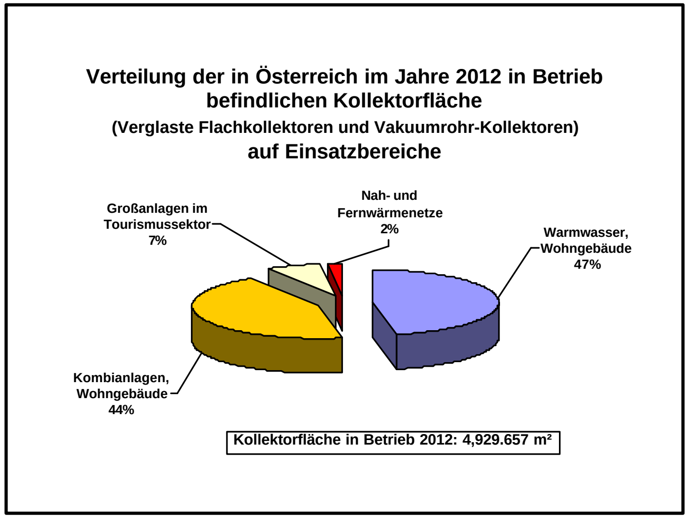

Thermische Solaranlagen in Österreich 2012
Warmwasserbereitung und Kombianlagen
Bezogen auf Kollektorfläche
Kombianlagen
56%
Warmwasser
44%
Gesamt: 206.390 m²


Neu installierte thermische Solaranlagen in Österreich
Anteile nach Einsatzbereichen
Anteil in %
100
90
80
70
60
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
3 2 8 87
4 2 9 85
3 8 28 61
3 4 11 82
7 5 21 67
5 4 28 63
4 3 28 65
2 2 29 67
Gewerbe und Industrie
Hotel- und Freizeitbetriebe
Mehrparteien-Häuser
Einfamilien-Häuser

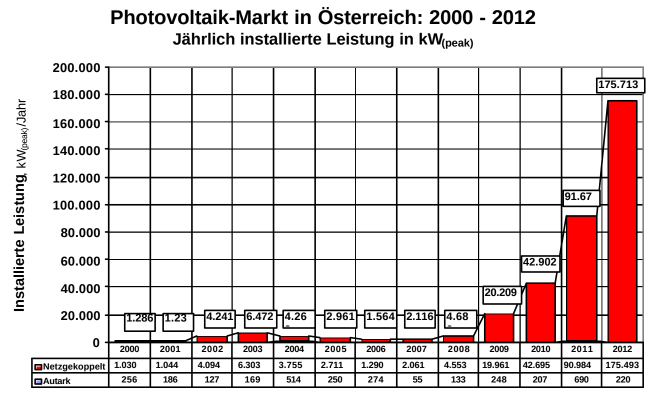

Einsatzbereiche von thermischen Solaranlagen in Betrieb
Österreich 2012
Gewerbe und
Industrie
2%
Hotel- und
Freizeitbetriebe
3%
Nah- und Fernwärme
2%
Mehrparteien-
Häuser
25%
Einfamilien-Häuser
68%


Errichtung von thermischen Solaranlagen im Zuge von Baumaßnahmen, bezogen auf die installierte Kollektorfläche
Österreich: 2005 - 2012
Anteil in %
100
90
80
70
60
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
60
65
43
17
17
31
40
50
33
53
59
22
35
30
40
35
24
30
24
47
25
20
Im Zuge eines Neubaus
Als Einzelmaßnahme
Im Zuge einer Gesamtsanierung

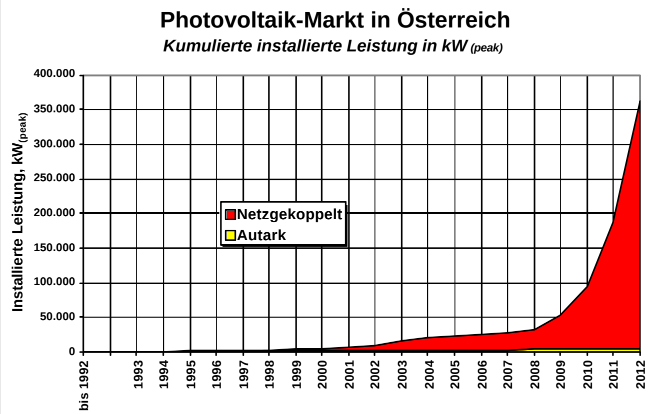

Aufteilung der in Österreich installierten Kollektorfläche nach den Einsatzbereichen Warmwasserbereitung und Raumheizungseinbindung
Anteil in %
100
90
80
70
60
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
35
35
53
62
72
47
52
56
65
65
47
38
28
53
48
44
Solar-Kombianlagen
Warmwasserbereitung

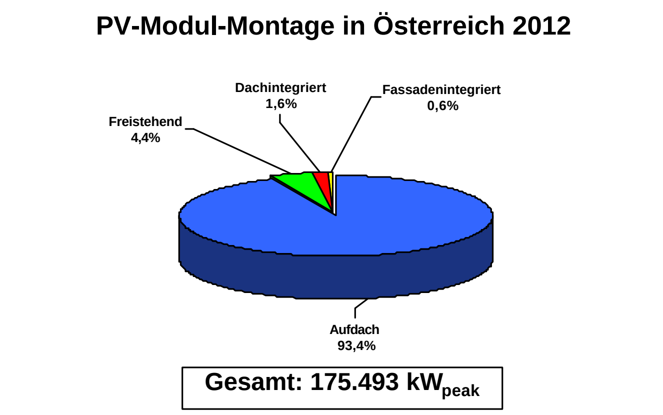

Verteilung der in Österreich im Jahre 2012 in Betrieb befindlichen Kollektorfläche
(Verglaste Flachkollektoren und Vakuumrohr-Kollektoren)
auf Einsatzbereiche
Großanlagen im Tourismussektor 7%
Nah- und Fernwärmenetze 2%
Warmwasser, Wohngebäude 47%
Kombianlagen, Wohngebäude 44%
Kollektorfläche in Betrieb 2012: 4,929.657 m²

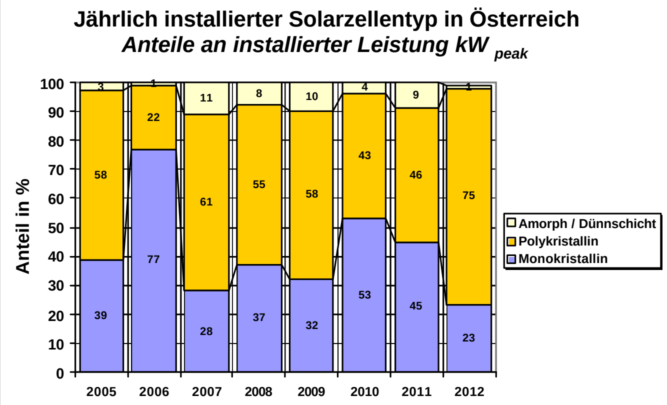

Solar Electric Technologies

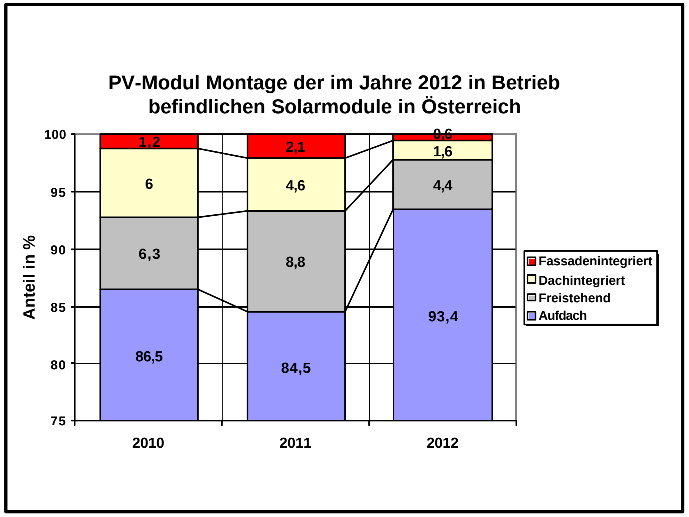


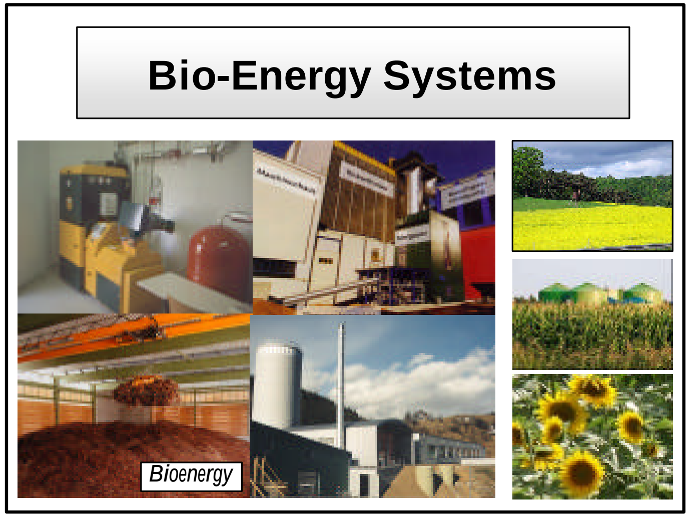
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Netzgekoppelt	1.030	1.044	4.094	6.303	3.755	2.711	1.290	2.061	4.553	19.961	42.695	90.984	175.493
Autark	256	186	127	169	514	250	274	55	133	248	207	690	220

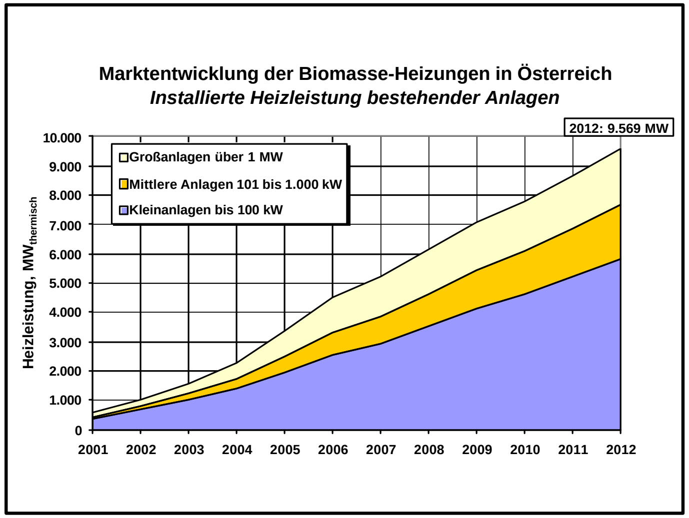


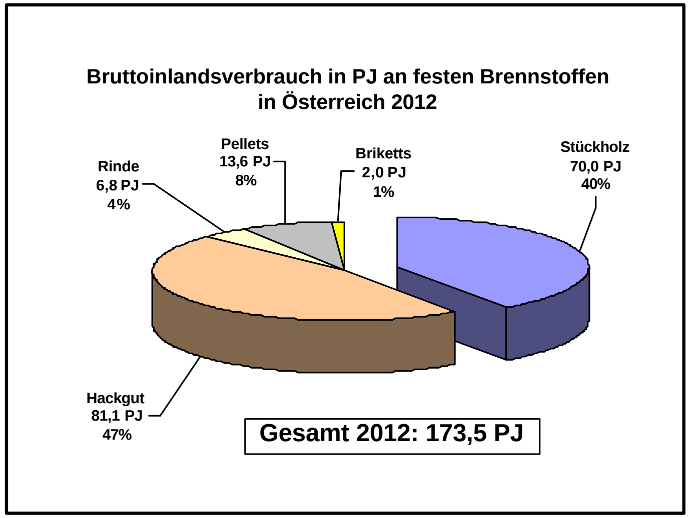


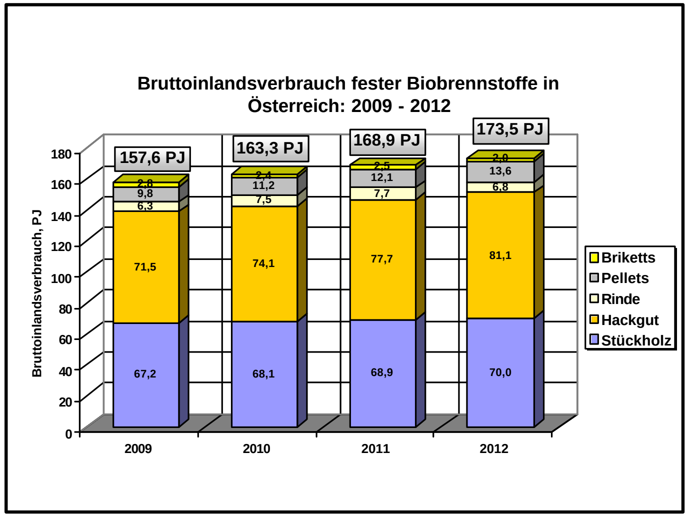


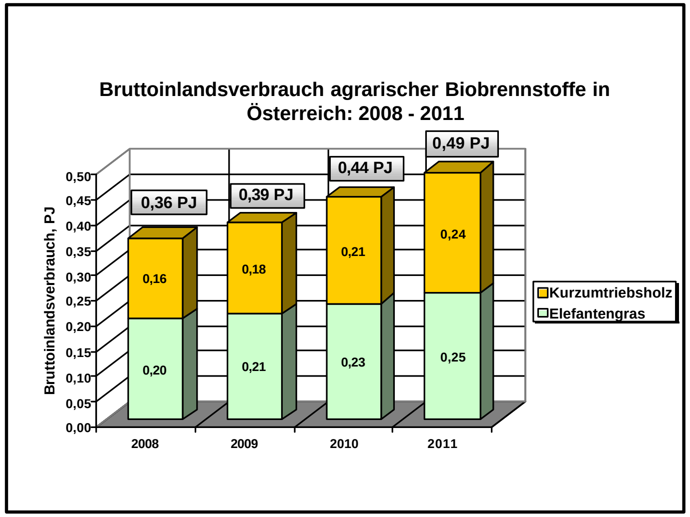

PV-Modul Montage der im Jahre 2012 in Betrieb befindlichen Solarmodule in Österreich
Anteil in %
100
95
90
85
80
75
1,2
6
6,3
86,5
2,1
4,6
8,8
84,5
0,6
1,6
4,4
93,4
2010
2011
2012
Fassadenintegriert
Dachintegriert
Freistehend
Aufdach

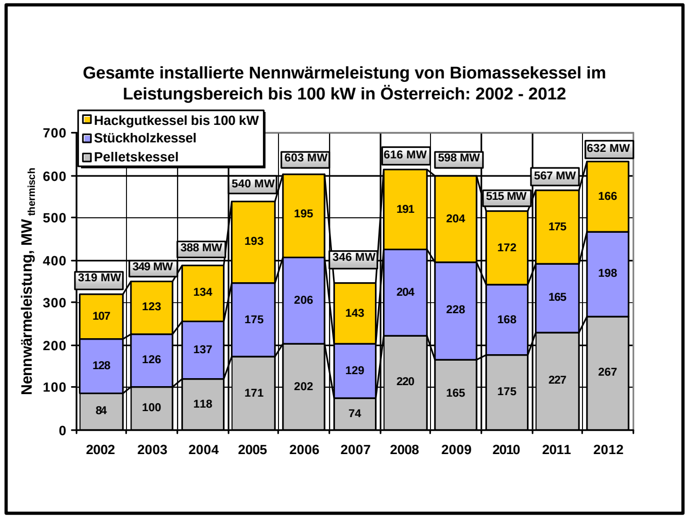

Bio-Energy Systems
Bioenergy

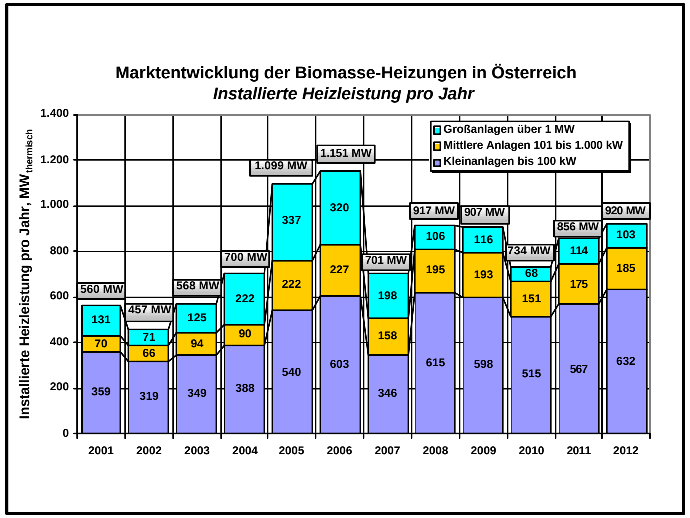

Marktentwicklung der Biomasse-Heizungen in Österreich
Installierte Heizleistung bestehender Anlagen
2012: 9.569 MW
Heizleistung, MWthermisch
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0
Großanlagen über 1 MW
Mittlere Anlagen 101 bis 1.000 kW
Kleinanlagen bis 100 kW
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012

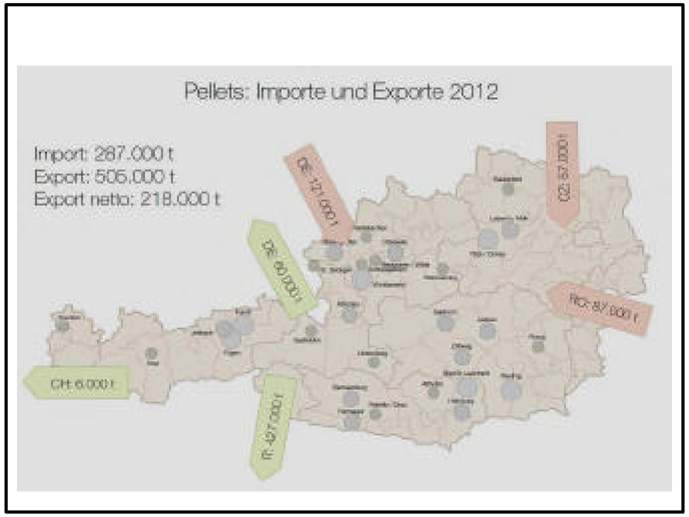

Bruttoinlandsverbrauch in PJ an festen Brennstoffen in Österreich 2012
Rinde 6,8 PJ 4%
Pellets 13,6 PJ 8%
Briketts 2,0 PJ 1%
Stückholz 70,0 PJ 40%
Hackgut 81,1 PJ 47%
Gesamt 2012: 173,5 PJ

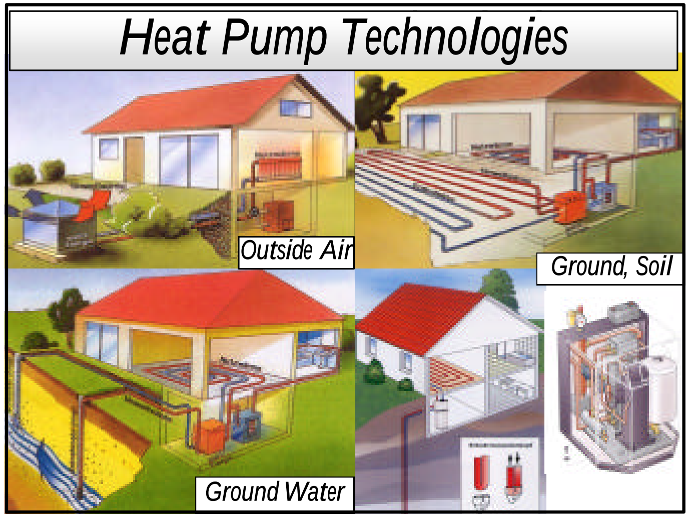

Bruttoinlandsverbrauch fester Biobrennstoffe in Österreich: 2009 - 2012
157,6 PJ
163,3 PJ
168,9 PJ
173,5 PJ
Bruttoinlandsverbrauch, PJ
Briketts
Pellets
Rinde
Hackgut
Stückholz
2009
2010
2011
2012

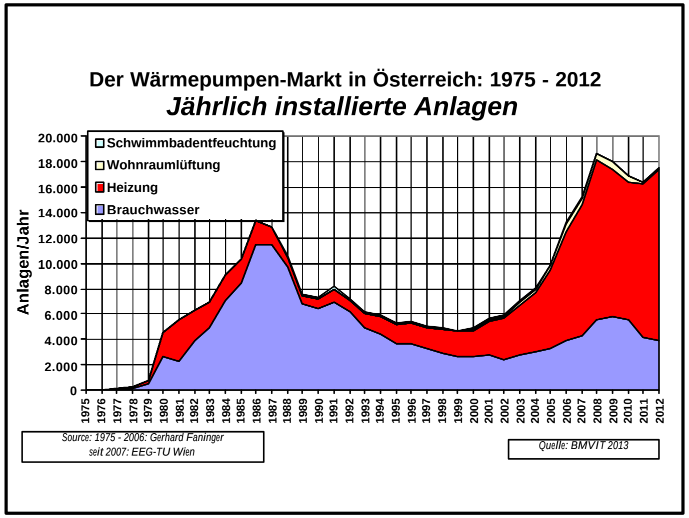

Bruttoinlandsverbrauch agrarischer Biobrennstoffe in Österreich: 2008 - 2011
0,36 PJ
0,39 PJ
0,44 PJ
0,49 PJ
Bruttoinlandsverbrauch, PJ
Kurzumtriebsholz
Elefantengras
2008
2009
2010
2011

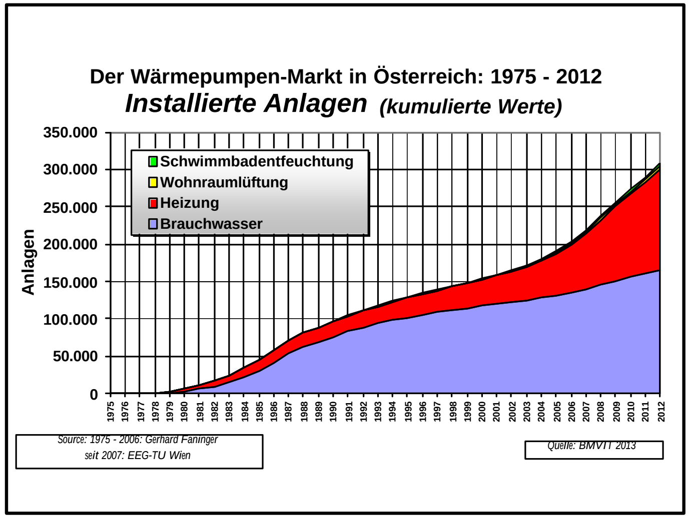

Gesamte installierte Nennwärmeleistung von Biomassekessel im Leistungsbereich bis 100 kW in Österreich: 2002 - 2012
Hackgutkessel bis 100 kW
Stückholzkessel
Pelletskessel
Nennwärmeleistung, MW thermisch
319 MW
349 MW
388 MW
540 MW
603 MW
346 MW
616 MW
598 MW
515 MW
567 MW
632 MW

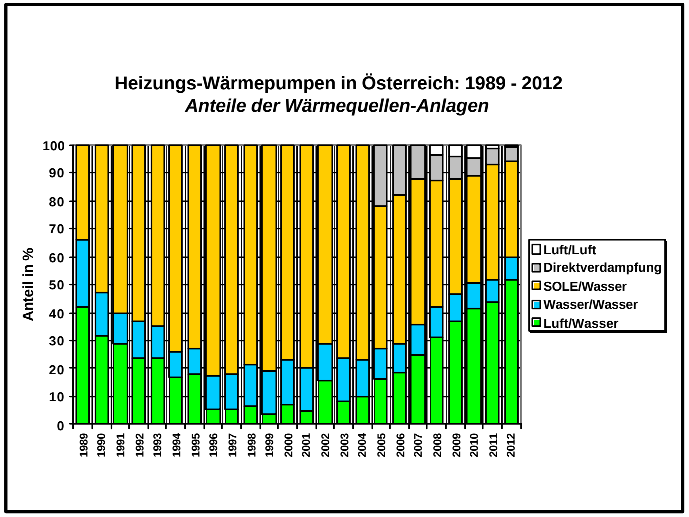

Marktentwicklung der Biomasse-Heizungen in Österreich
Installierte Heizleistung pro Jahr
Großanlagen über 1 MW
Mittlere Anlagen 101 bis 1.000 kW
Kleinanlagen bis 100 kW
Installierte Heizleistung pro Jahr, MW thermisch
560 MW
457 MW
568 MW
700 MW
1.099 MW
1.151 MW
701 MW
917 MW
907 MW
734 MW
856 MW
920 MW

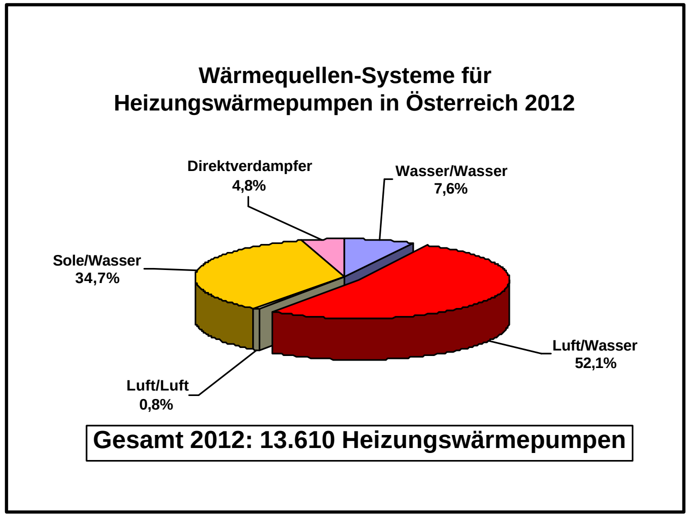

Pellets: Importe und Exporte 2012
Import: 287.000 t
Export: 505.000 t
Export netto: 218.000 t
DE: 121.000 t
CZ: 57.000 t
DE: 60.000 t
RO: 87.000 t
CH: 6.000 t
IT: 427.000 t

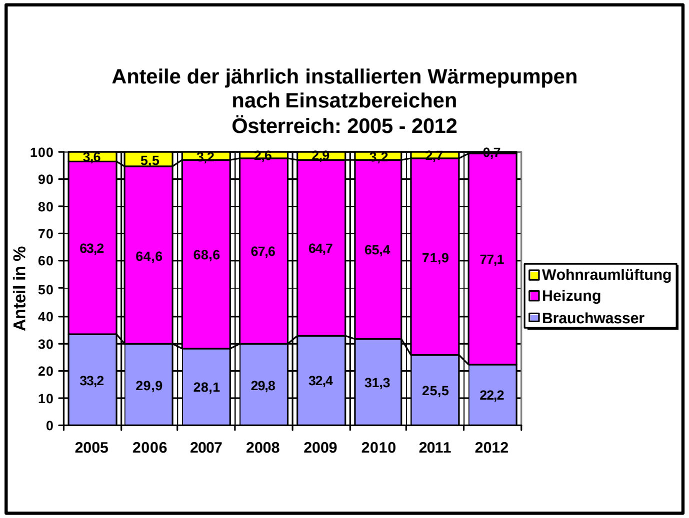

Heat Pump Technologies
Outside Air
Ground, Soil
Ground Water


Der Wärmepumpen-Markt in Österreich: 1975 - 2012
Jährlich installierte Anlagen
Schwimmbadentfeuchtung
Wohnraumlüftung
Heizung
Brauchwasser
Anlagen/Jahr
20.000
18.000
16.000
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0
Source: 1975 - 2006: Gerhard Faninger
seit 2007: EEG-TU Wien
Quelle: BMVIT 2013


Der Wärmepumpen-Markt in Österreich: 1975 - 2012
Installierte Anlagen (kumulierte Werte)
Schwimmbadentfeuchtung
Wohnraumlüftung
Heizung
Brauchwasser
Anlagen
350.000
300.000
250.000
200.000
150.000
100.000
50.000
0
Source: 1975 - 2006: Gerhard Faninger
seit 2007: EEG-TU Wien
Quelle: BMVIT 2013

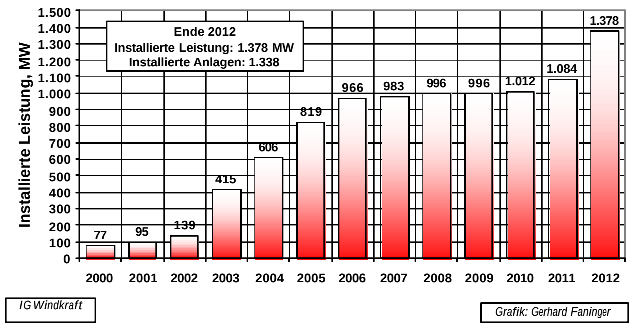

Heizungs-Wärmepumpen in Österreich: 1989 - 2012
Anteile der Wärmequellen-Anlagen
Anteil in %
100
90
80
70
60
50
40
30
20
10
0
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Luft/Luft
Direktverdampfung
SOLE/Wasser
Wasser/Wasser
Luft/Wasser


Wärmequellen-Systeme für
Heizungswärmepumpen in Österreich 2012
Direktverdampfer
4,8%
Wasser/Wasser
7,6%
Sole/Wasser
34,7%
Luft/Wasser
52,1%
Luft/Luft
0,8%
Gesamt 2012: 13.610 Heizungswärmepumpen


Anteile der jährlich installierten Wärmepumpen
nach Einsatzbereichen
Österreich: 2005 - 2012
Anteil in %
100
90
80
70
60
50
40
30
20
10
0
3,6
5,5
3,2
2,6
2,9
3,2
2,7
0,7
63,2
64,6
68,6
67,6
64,7
65,4
71,9
77,1
33,2
29,9
28,1
29,8
32,4
31,3
25,5
22,2
2005
2006
2007
2008
2009
2010
2011
2012
Wohnraumlüftung
Heizung
Brauchwasser


Windstrom

Marktentwicklung der Windkraft in Österreich



Wirtschaftliche und Energetische Bewertung Erneuerbarer Energieträger in Österreich

Markt Erneuerbare Energie 2010

	Markt 2009/2010	Umsatz, Mio Euro	*Anteil, %*	Vollarbeitsplätze	Anteil, %
Biomasse	-15%	1.306	*33,8*	13.300	*33,2*
Kessel		867	*22,5*	4.097	*10,2*
Aufbringung		*439*	*11,4*	*9.203*	*22,9*
Solarthermie	-21%	420	*10,9*	4.700	*11,7*
Photovoltaik	114%	150	*3,9*	4.414	*11,0*
Wärmepumpe	-3%	207	*5,4*	1.100	*2,7*
Windstrom	1,6	470	*12,2*	3.300	*8,2*
	GESAMT	**3.859**	***100,0***	**40.114**	***100,0***

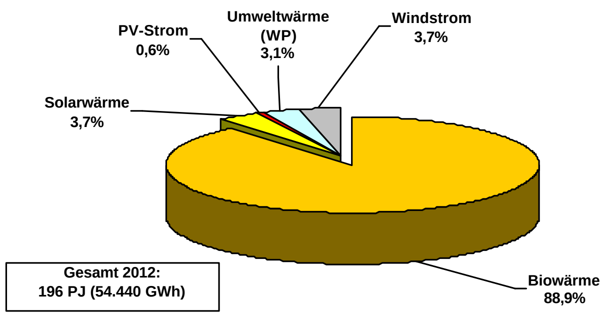
Wärme- und Stromertrag 2010

	PJ/Jahr	GWh/Jahr	*Anteil, %*	CO_2-Einsparung Tonnen/Jahr	Anteil, %
Biowärme	163,30	45.397	*89,4*	9.400.000	*81,6*
Solarwärme	6,75	1.876	*3,7*	411.596	*3,6*
PV-Strom	0,32	89	*0,2*	36.733	*0,3*
Umweltwärme (WP)	5,01	1.381	*2,7*	375.500	*3,3*
Windstrom	7,26	2.019	*4,0*	1.300.000	*11,3*
GESAMT	**182,64**	**50.762**	***100,0***	**11.523.829**	***100,0***

Erneuerbare Energieträger in Österreich 2012

ohne Wasserkraft

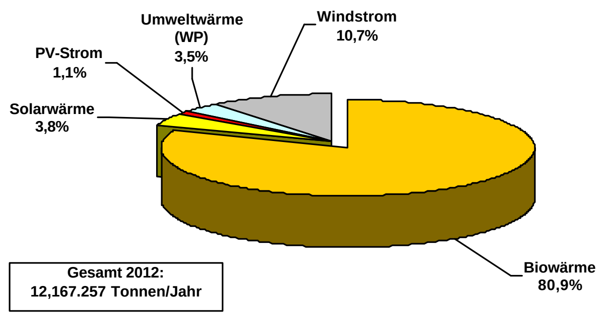
Wärme- und Stromertrag



Erneuerbare Energieträger in Österreich 2012

ohne Wasserkraft

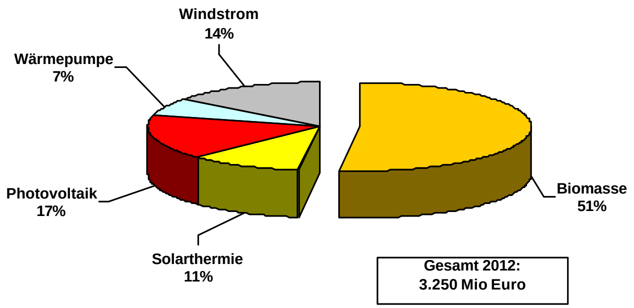
CO_2-Einsparung, Tonnen/Jahr



Erneuerbare Energieträger in Österreich 2012

ohne Wasserkraft

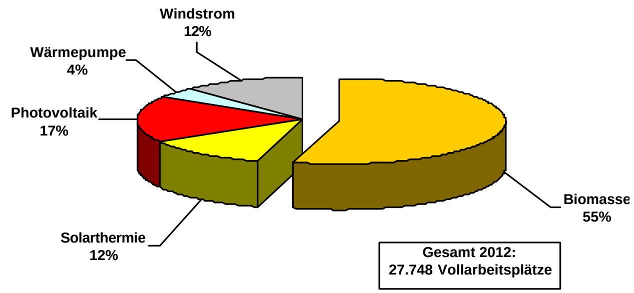
Umsatz



Erneuerbare Energieträger in Österreich 2012

ohne Wasserkraft

Vollarbeitsplätze



Sources:

/1/ Energie Strategie Österreich
Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft und Bundesministerium für Wirtschaft, Familie und Jugend. März 2010
www.energiestrategie.at

/2/ Erneuerbare Energie 2020: Potenziale und Verwendung in Österreich
Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (Lebensministerium). März 2009

/3/ Die Bedeutung von kombinierten Solar-Wärmepumpe-Heizungssystemen in der Österreichischen Energiestrategie
Gerhard Faninger. Zeitschrift für Erneuerbare Energie - Zeitschrift für eine nachhaltige Energiezukunft., AEE Gleisdorf, September 2012. www.aee-intec.at

/4/ Nachhaltige Gebäude: Bewertungskriterien und Bewertungsmodell
Gerhard Faninger. Zeitschrift für Erneuerbare Energie, AEE Gleisdorf, Dezember 2009. www.aee-intec.at

/5/ „Innovative Energietechnologien in Österreich: Marktentwicklung 2012“ (Peter Biermayer et. al), herausgegeben vom Bundesministerium für Verkehr, Innovation und Technologie, BMVIT. Berichte aus Energie- und Umweltforschung 26/2012. Kostenloses Download unter: www.nachhaltigwirtschaften.at/iea/marktentwicklung2010.

/6/ Online-Bewertungsprogramm: Energiestrategie für Wohngebäude
Gerhard Faninger. http://www.uni-klu.ac.at/iff/ikn/inhalt/18.htm

Autor:

Gerhard Faninger, Dipl.-Ing. Dr. mont., Univ.-Prof. i. R.
Institut für Interventionsforschung und Kulturelle Nachhaltigkeit
Fakultät für Interdisziplinäre Forschung und Fortbildung
Alpen-Adria Universität Klagenfurt
and
Institut für Energiesysteme und Elektrische Anlagen,
Institute of Energy Systems and Electric Drives, Energy Economics Group,
EEG. Technische Universität Wien

http://www.uni-klu.ac.at/iff/ikn/inhalt/18.htm#energie_und_umwelt