Europe’s energy in a changing climate

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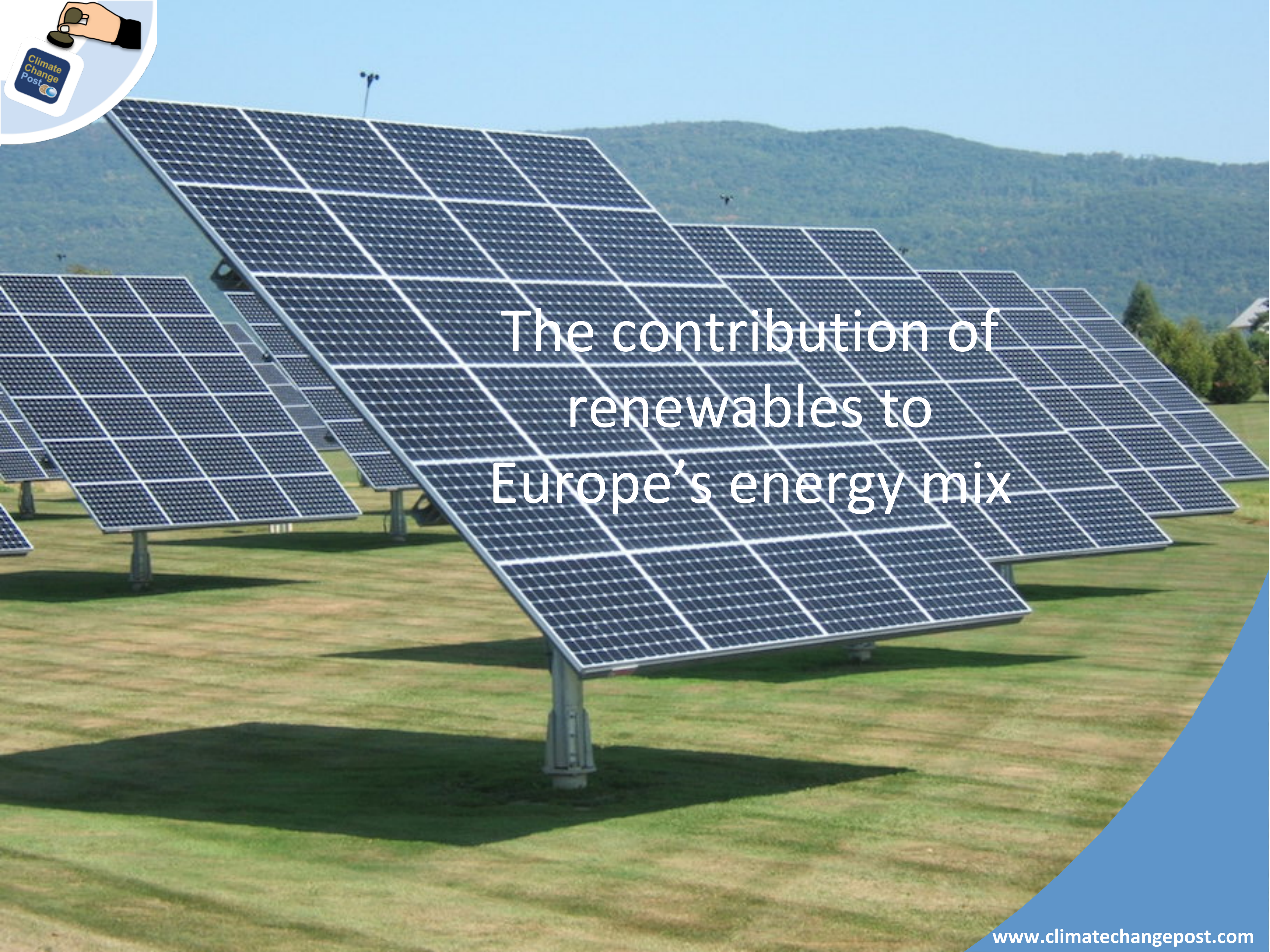
Latest update: 1 March 2019

The contribution of renewables to Europe’s energy mix

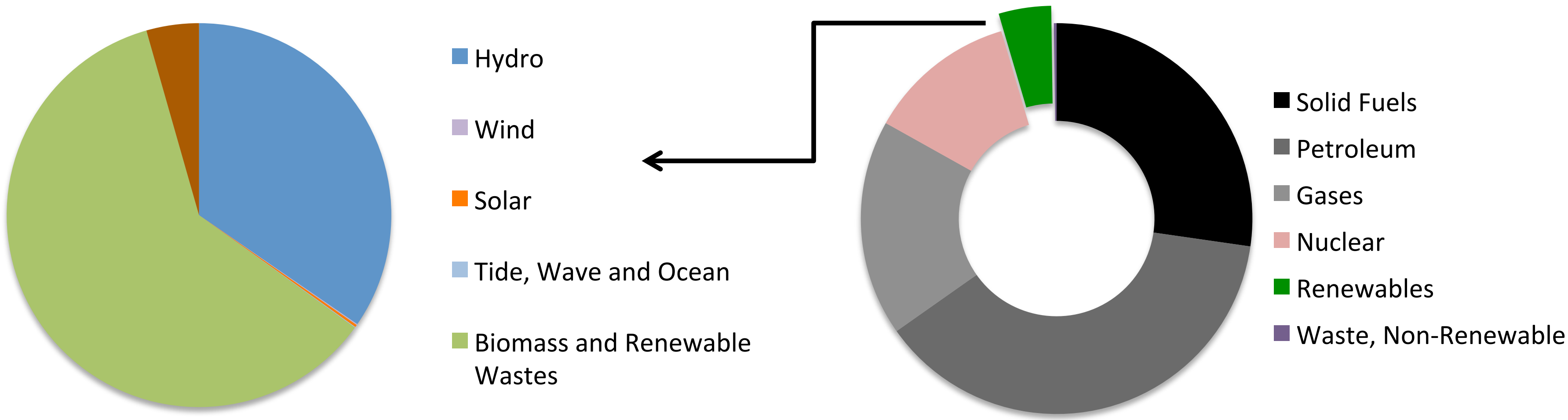


Energy: the energy mix of the 28 countries of the European Union

The change from 1990 to 2016

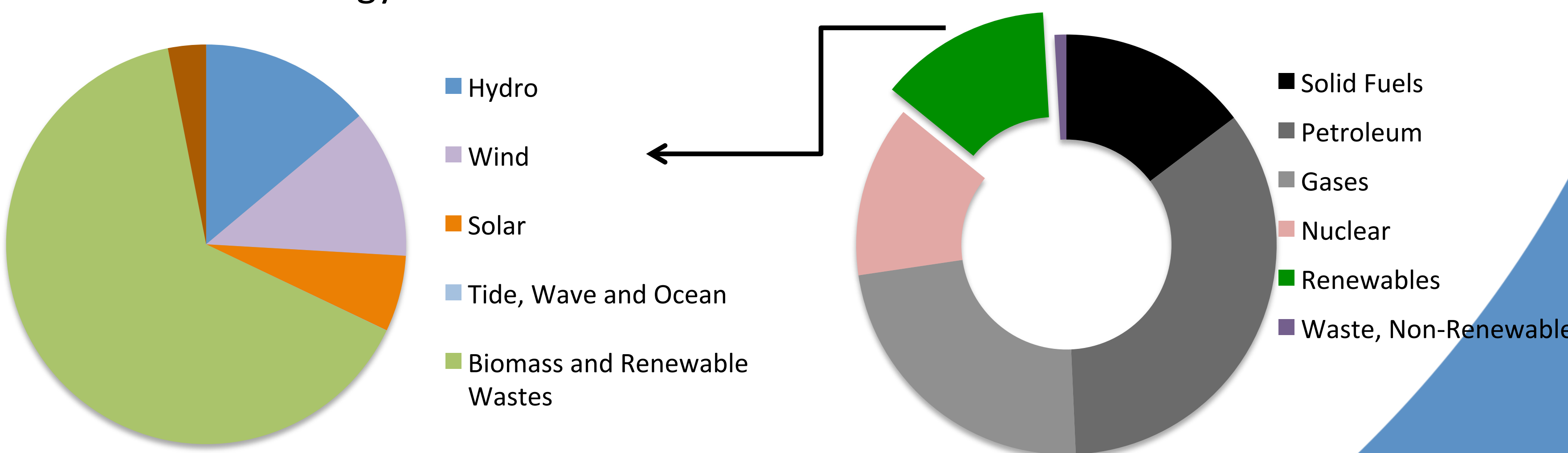
Renewables energy mix EU28 1990

Energiemix EU28 1990



Renewables energy mix EU28 2016

Energiemix EU28 2016



Source data: www.ec.europa.eu

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Energy: renewables

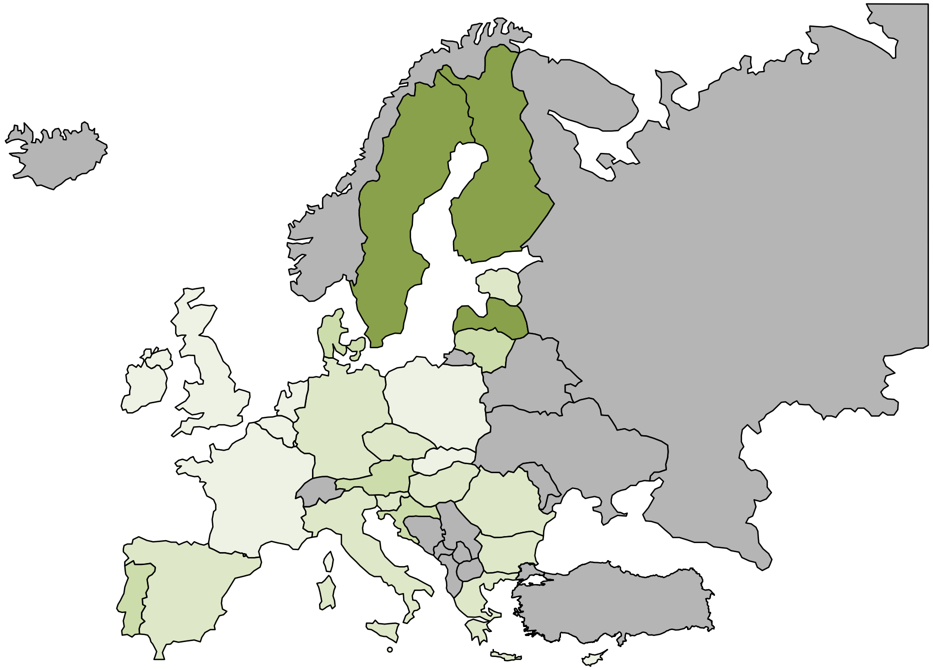
Situation 2016 and projection 2050

Renewable Energy Directive EU:
At least 20% of the EU's total energy needs to be fulfilled with renewables by 2020. In a new agreement (2018) this percentage is 32% in 2030.

Contribution to gross inland energy consumption (%):

- 0 – 10%
- 10 – 20%
- 20 – 30%
- 30 – 40%
- 40 – 50%

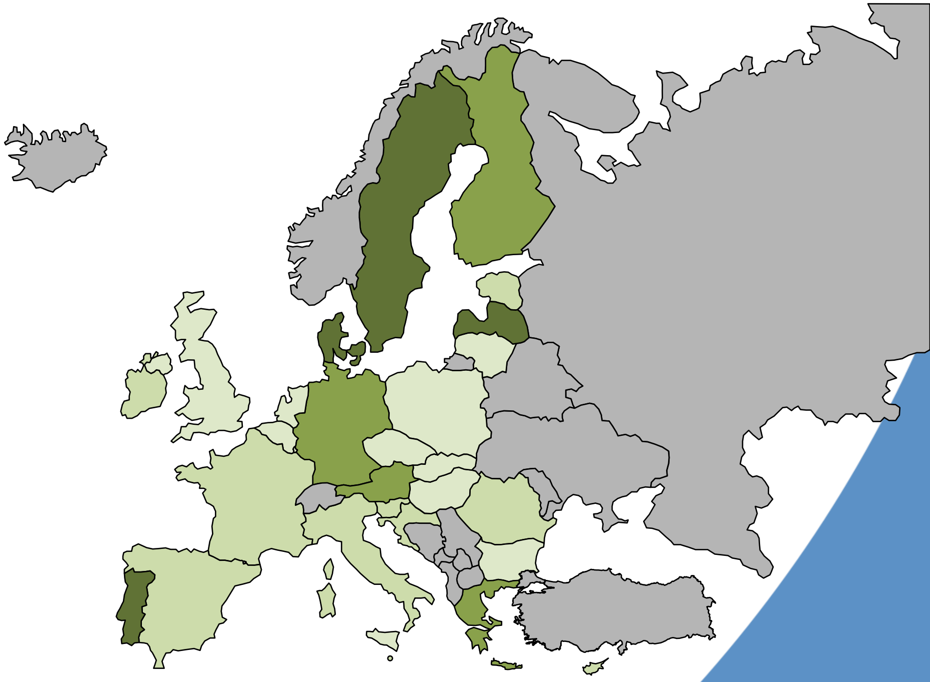
Situation 2016



In 2016 renewables contributed 13.2% to the EU 28's gross inland energy consumption.

Source data: www.ec.europa.eu

Projection 2050



The estimated contribution of renewables to the EU 28's gross inland energy consumption in 2050 is projected to be 38.9%.

Source data: EC (2013)

Energy: renewables

Situation 2016

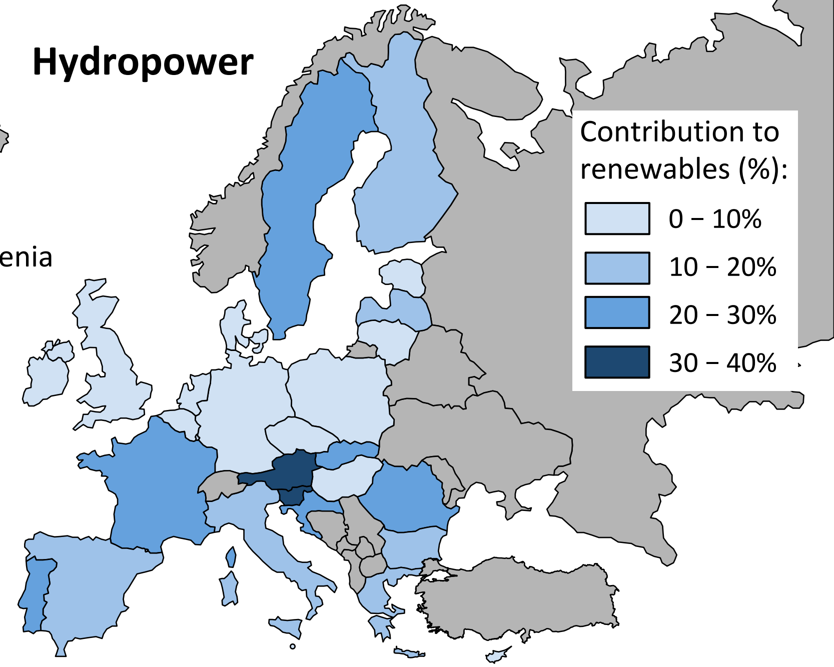
Contribution to renewables is relatively large in

Austria and Slovenia for hydropower

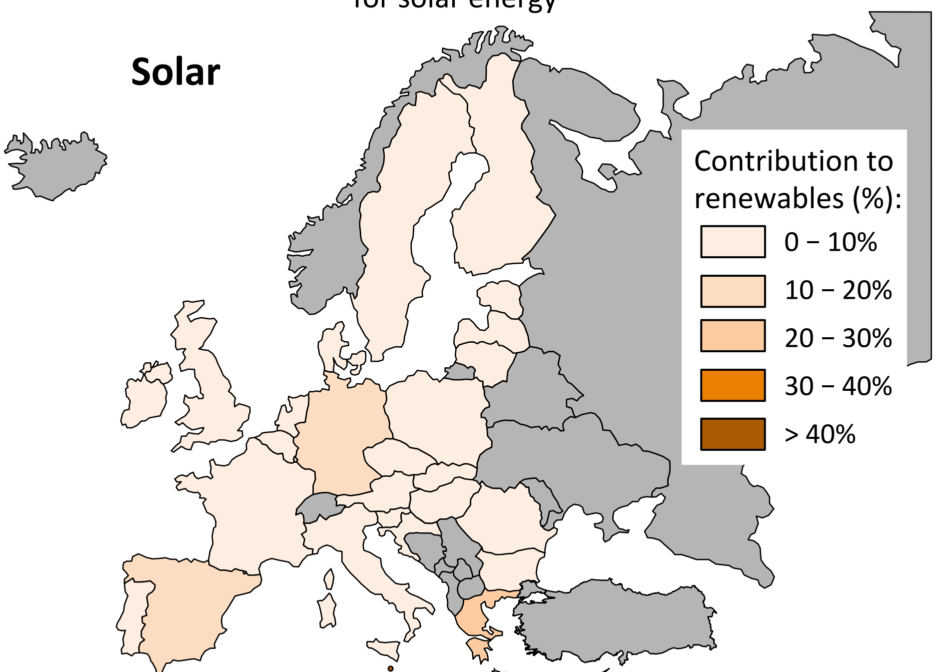
Greece, Cyprus and Malta for solar energy

Ireland and Denmark for wind energy

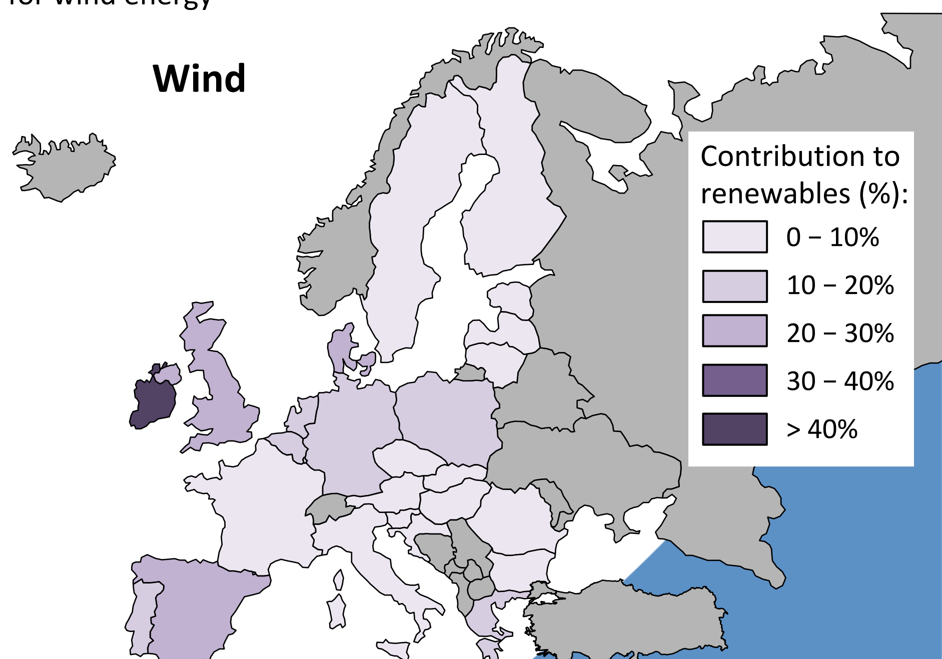
Hydropower



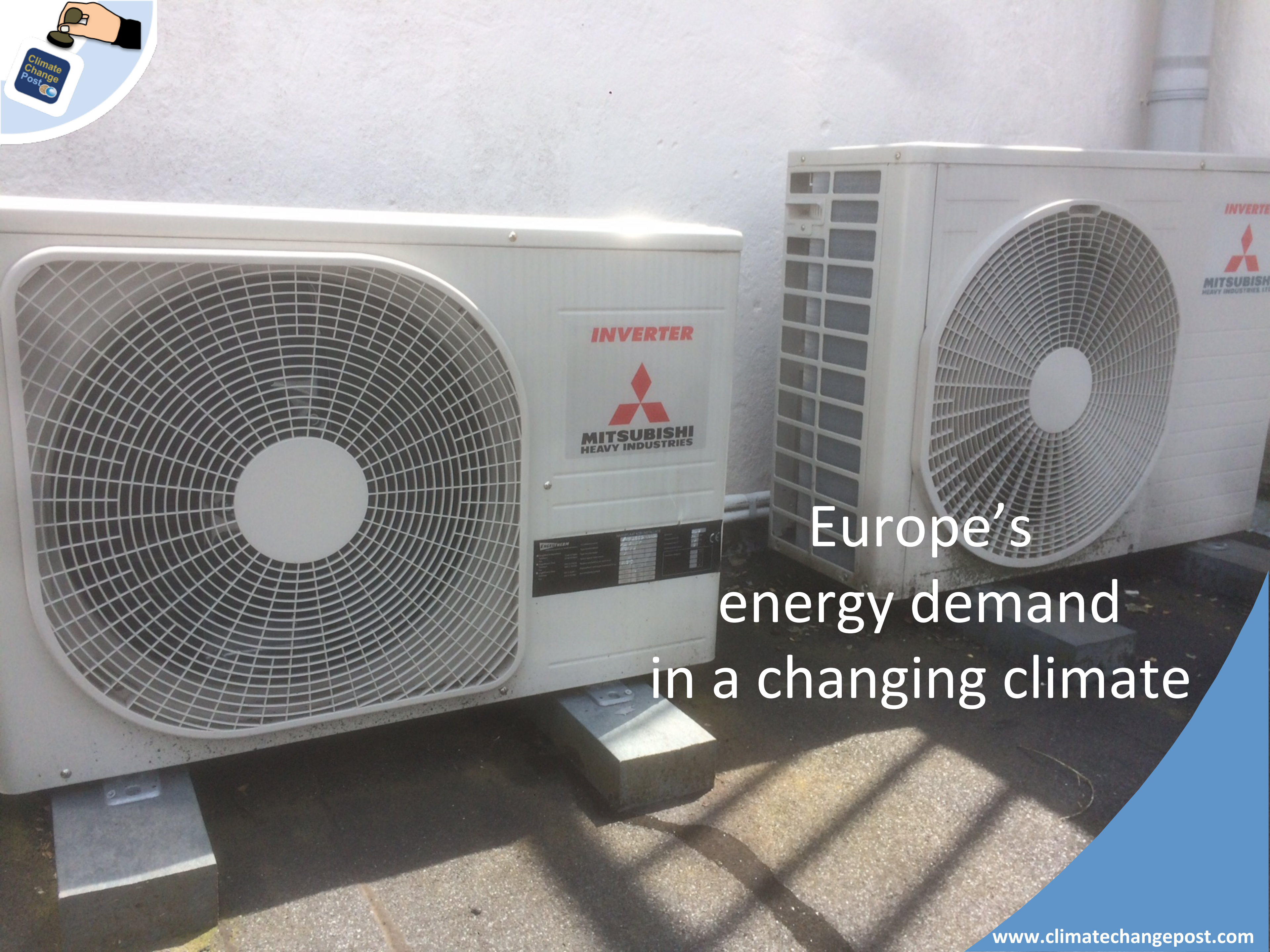
Solar



Wind



Source data: www.ec.europa.eu



Europe's energy demand in a changing climate

Energy: demand

Heating versus cooling

Global warming has two contradictory effects on energy consumption: it leads to a drop in heating requirements on the one hand, and an increase in demand linked to air conditioning on the other.

It may become more challenging to meet energy demands during peak times due to more frequent heat waves and drought conditions.

Strong distributional patterns are expected across Europe — with rising cooling (electricity) demand in summer in southern Europe, compared with reduced heating (energy) demand in winter in northern Europe.

Energy: demand

Europe overall

Europe will use more energy for cooling than can be saved with heating

Demand Scandinavia:
Increased temperature leads to **a reduction in demand for electricity** in Norway and Sweden from 2001-2040 of approximately 3%. Finland will have a total reduction in demand of 4% from 2001-2040. Denmark is expected to face a reduction in annual demand of 2.5%: the reduction will be approximately 1% less due to smaller temperature changes.

However,
Demand for electricity in Scandinavia will increase by 1.4% (estimate). This is a result of more supply leading to reduced prices, and consequently an increase in demand that will more than offset the initial temperature effect.

Demand Europe:
If the population of Europe would remain constant towards 2100, the combined effect of less heating in the North and more cooling in the South would be a gradual decrease of energy demand over Europe. A **net energy saving would be the result**.

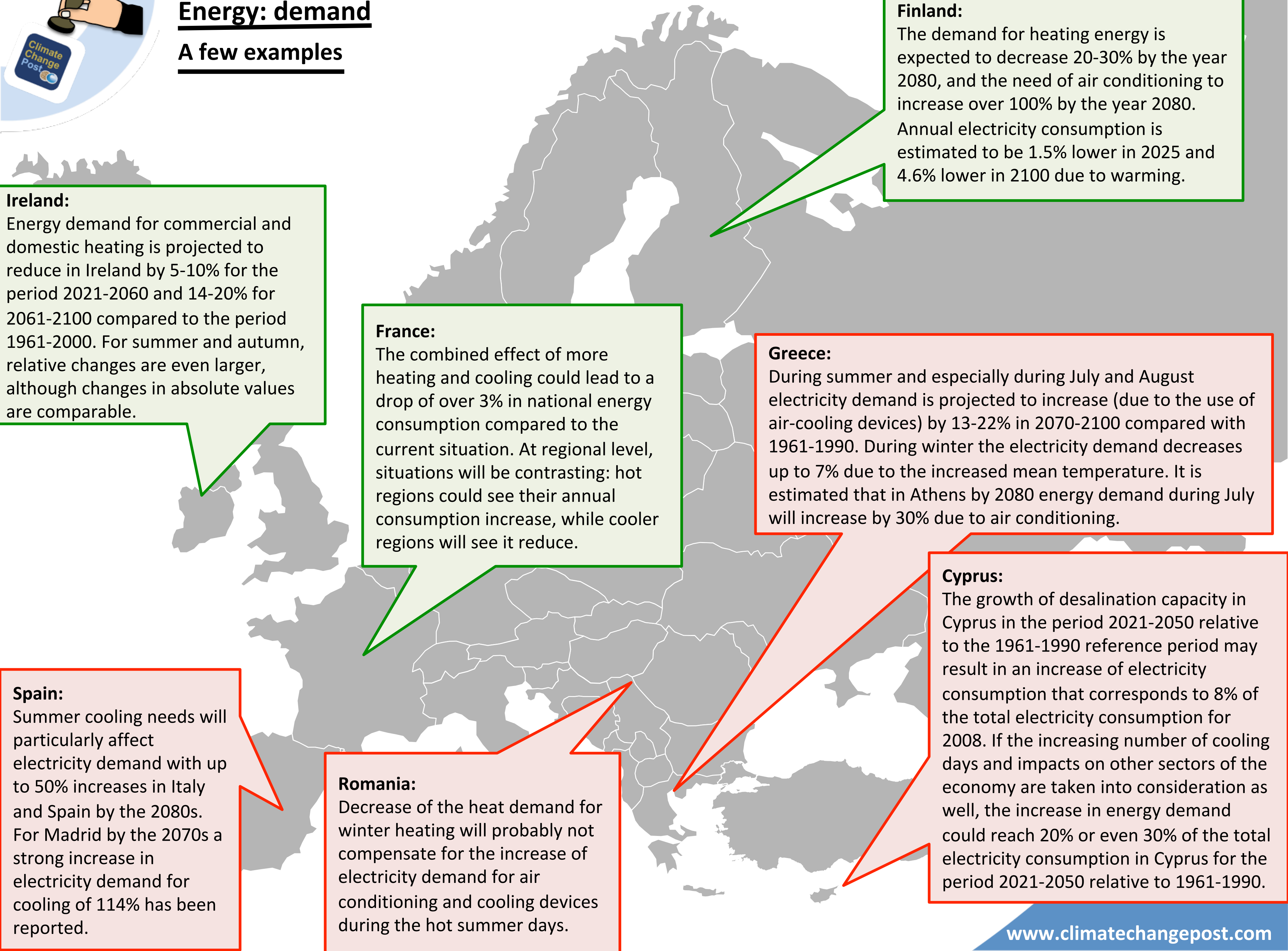
However,
When projections of future population growth and decline are included in the calculations, energy demand is projected to increase over northern Europe, the Baltic countries, Great Britain, Ireland, Benelux, the Alps, Spain, and Cyprus, resulting in an overall increase of energy demand over Europe.

Demand Mediterranean:
The main increase of cooling energy requirements in the northern Mediterranean will be in the south of the Iberian Peninsula, in the north of Italy, on the Balkans and in Greece, and in the south of Turkey. **Energy consumption may increase**. An up to 10% decrease in energy heating requirements and an up to 28% increase in cooling requirements is estimated for 2030 for the south-east Mediterranean region.

However,
There are regions that escape any significant increase in cooling requirements: the south of Italy (including Sicily and Sardinia), the south of France, Cyprus, the northern part of Turkey (because of Black Sea), and the north-western tip of Spain.

Energy: demand

A few examples



Finland:
The demand for heating energy is expected to decrease 20-30% by the year 2080, and the need of air conditioning to increase over 100% by the year 2080. Annual electricity consumption is estimated to be 1.5% lower in 2025 and 4.6% lower in 2100 due to warming.

Ireland:
Energy demand for commercial and domestic heating is projected to reduce in Ireland by 5-10% for the period 2021-2060 and 14-20% for 2061-2100 compared to the period 1961-2000. For summer and autumn, relative changes are even larger, although changes in absolute values are comparable.

France:
The combined effect of more heating and cooling could lead to a drop of over 3% in national energy consumption compared to the current situation. At regional level, situations will be contrasting: hot regions could see their annual consumption increase, while cooler regions will see it reduce.

Greece:
During summer and especially during July and August electricity demand is projected to increase (due to the use of air-cooling devices) by 13-22% in 2070-2100 compared with 1961-1990. During winter the electricity demand decreases up to 7% due to the increased mean temperature. It is estimated that in Athens by 2080 energy demand during July will increase by 30% due to air conditioning.

Cyprus:
The growth of desalination capacity in Cyprus in the period 2021-2050 relative to the 1961-1990 reference period may result in an increase of electricity consumption that corresponds to 8% of the total electricity consumption for 2008. If the increasing number of cooling days and impacts on other sectors of the economy are taken into consideration as well, the increase in energy demand could reach 20% or even 30% of the total electricity consumption in Cyprus for the period 2021-2050 relative to 1961-1990.

Spain:
Summer cooling needs will particularly affect electricity demand with up to 50% increases in Italy and Spain by the 2080s. For Madrid by the 2070s a strong increase in electricity demand for cooling of 114% has been reported.

Romania:
Decrease of the heat demand for winter heating will probably not compensate for the increase of electricity demand for air conditioning and cooling devices during the hot summer days.

Energy: demand

Adaptation: options to balance supply and demand

It's about greening the urban environment
Incorporate the use of natural ventilation, shading, and green spaces for cooling into building design. Increase street tree planning and maintenance, green roofs and high-albedo surfaces to reduce urban heat and unsustainable energy demand for air conditioning.

It's about intelligent buildings
Developing intelligent buildings and houses that provide for a constant year-round temperature by design and do not require additional heating.

It's about resilient supply networks

- Construct power supply networks in such a way that the consumer may get their energy from several directions.
- Make preparations for the reliable meeting of energy demand also in emergency situations caused by extreme weather events.

It's about consumer behaviour

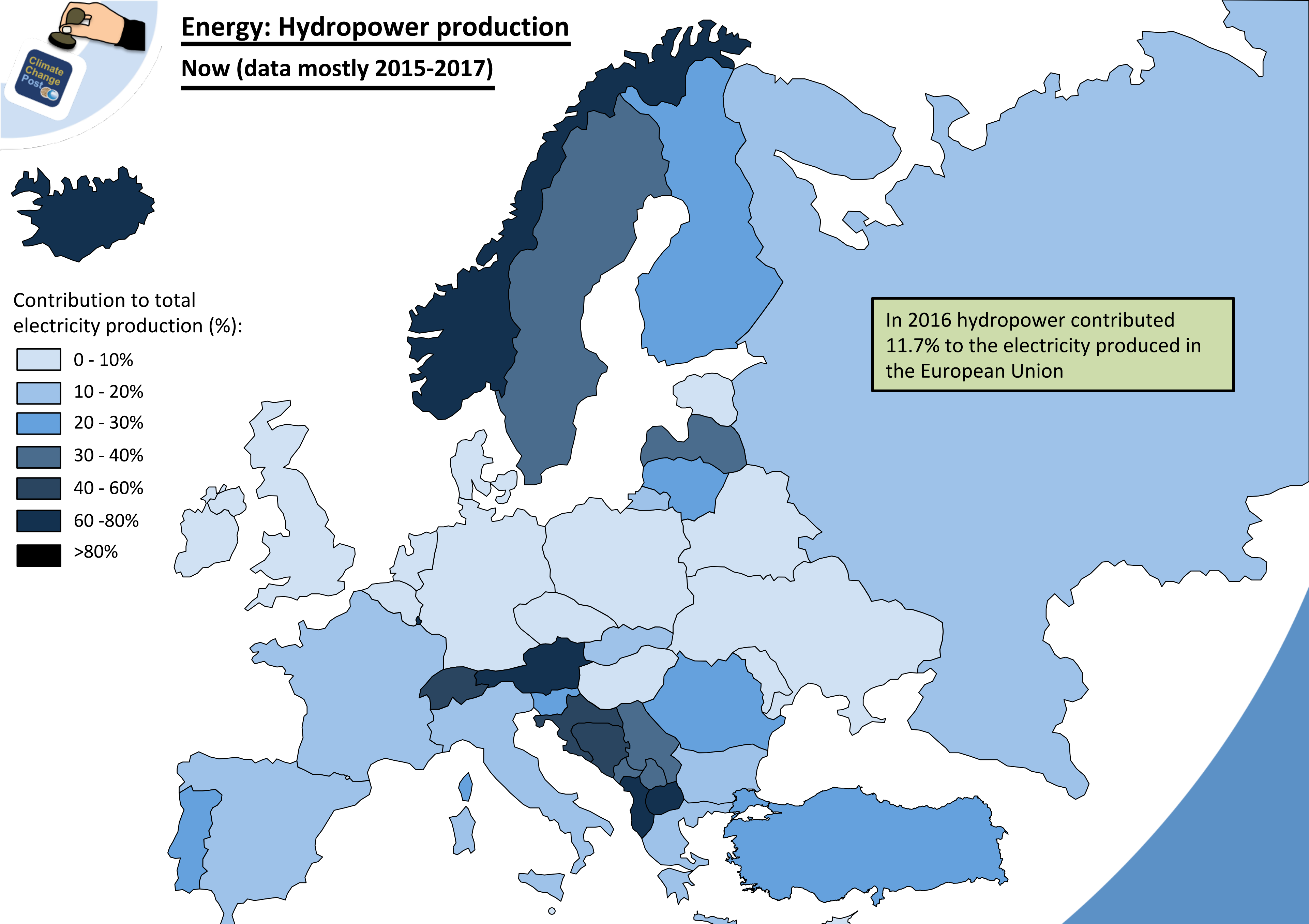
- Enhance energy-saving and environment-aware education starting with that in kindergarten.
- Balance consumption by making more efficient use of the electricity produced during night hours through Demand Side Management measures.
- Implement energy saving lighting and equipment in households, industry and in all sectors of the national economy. Also a public awareness campaign and relevant tariff incentives (higher tariffs for high energy use).

Europe's supply by hydropower in a changing climate

Photo credit: François Bianco, www.flickr.com

Energy: Hydropower production

Now (data mostly 2015-2017)

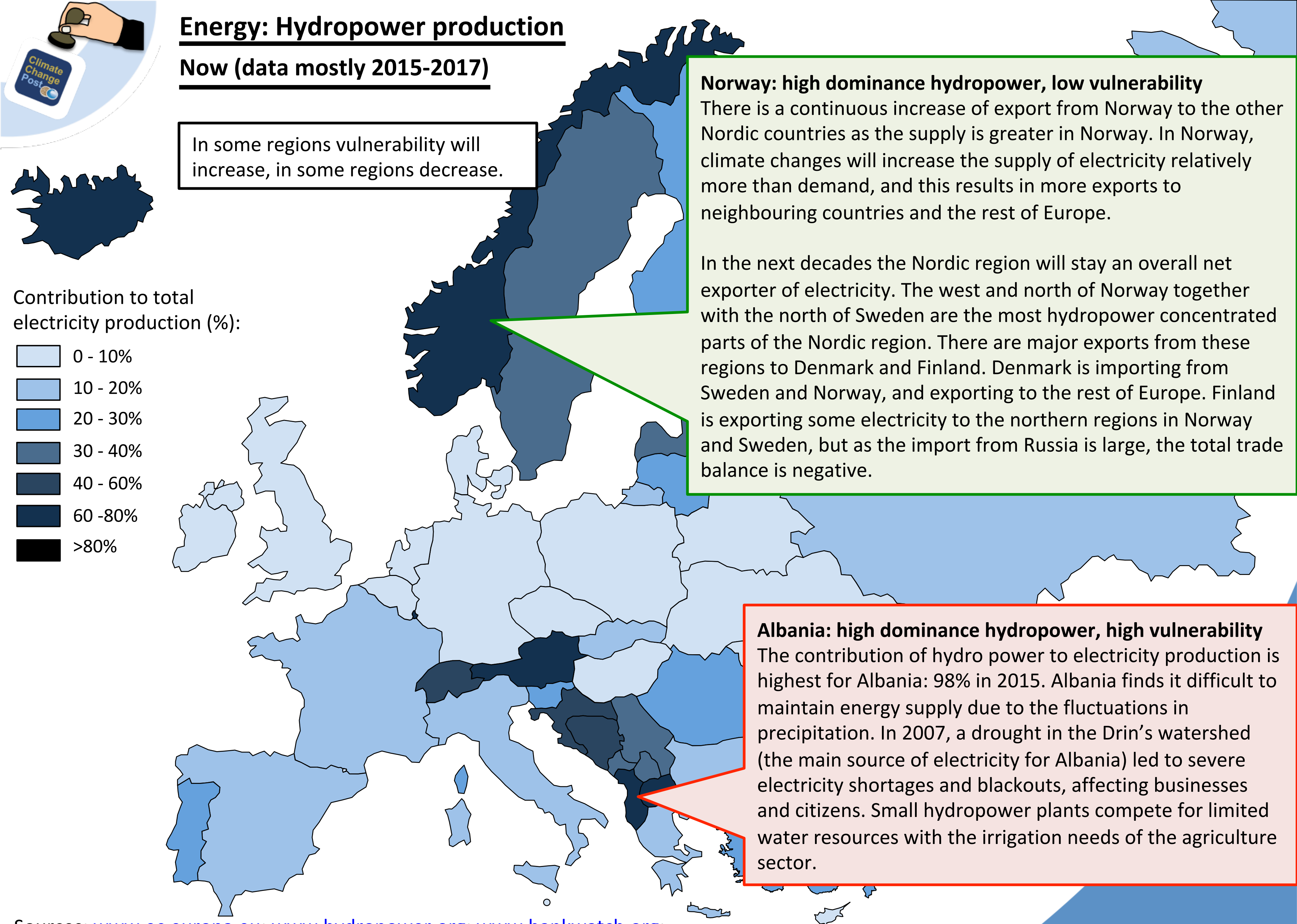


Sources: www.ec.europa.eu; www.hydropower.org; www.bankwatch.org; www.theglobaleconomy.com; www.iea.org; www.bfe.admin.ch

Energy: Hydropower production

Now (data mostly 2015-2017)

In some regions vulnerability will increase, in some regions decrease.



Norway: high dominance hydropower, low vulnerability
There is a continuous increase of export from Norway to the other Nordic countries as the supply is greater in Norway. In Norway, climate changes will increase the supply of electricity relatively more than demand, and this results in more exports to neighbouring countries and the rest of Europe.

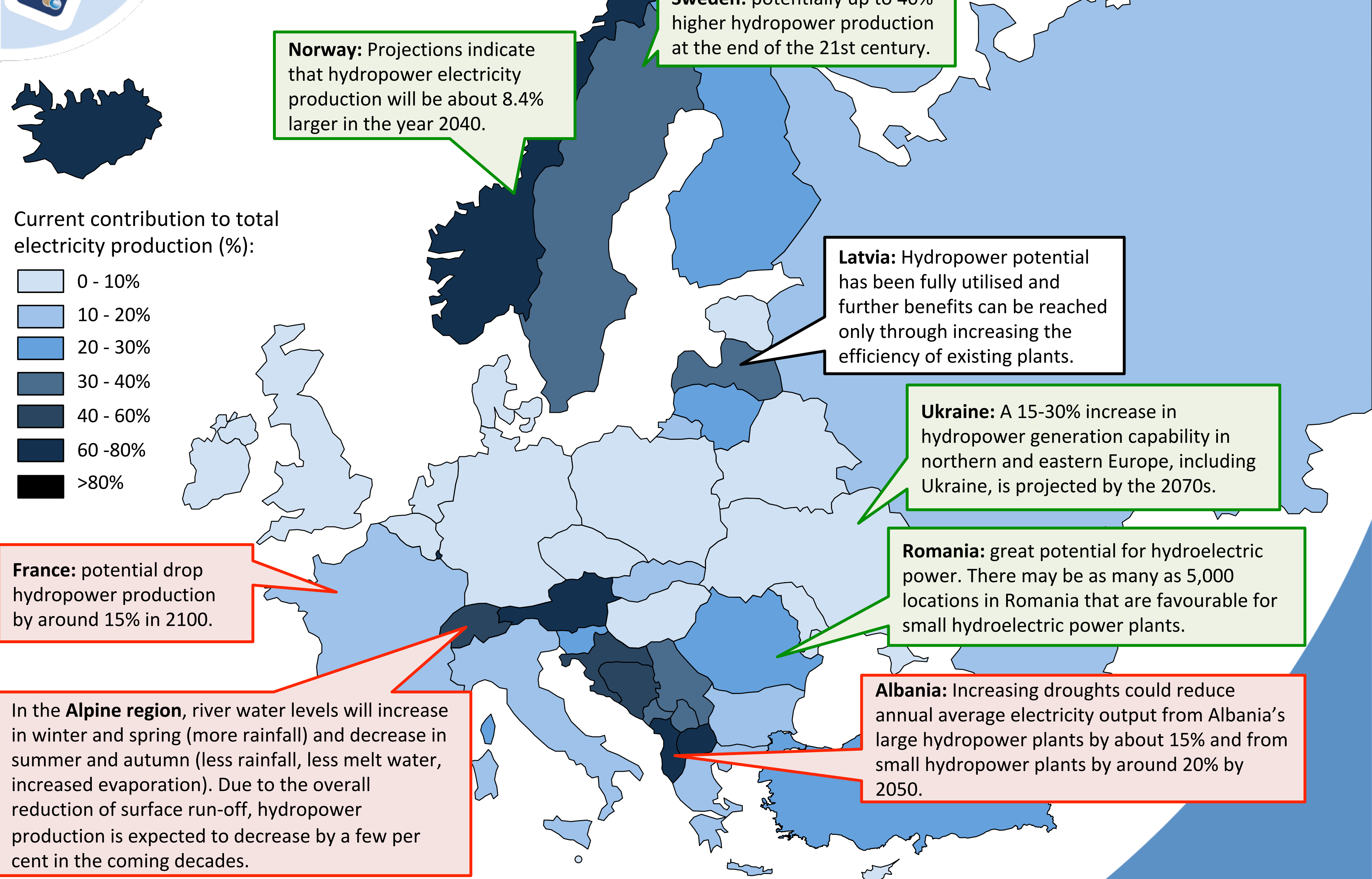
In the next decades the Nordic region will stay an overall net exporter of electricity. The west and north of Norway together with the north of Sweden are the most hydropower concentrated parts of the Nordic region. There are major exports from these regions to Denmark and Finland. Denmark is importing from Sweden and Norway, and exporting to the rest of Europe. Finland is exporting some electricity to the northern regions in Norway and Sweden, but as the import from Russia is large, the total trade balance is negative.

Albania: high dominance hydropower, high vulnerability
The contribution of hydro power to electricity production is highest for Albania: 98% in 2015. Albania finds it difficult to maintain energy supply due to the fluctuations in precipitation. In 2007, a drought in the Drin's watershed (the main source of electricity for Albania) led to severe electricity shortages and blackouts, affecting businesses and citizens. Small hydropower plants compete for limited water resources with the irrigation needs of the agriculture sector.

Sources: www.ec.europa.eu; www.hydropower.org; www.bankwatch.org; www.theglobaleconomy.com; www.iea.org; www.bfe.admin.ch

Energy: Hydropower production

Future projections



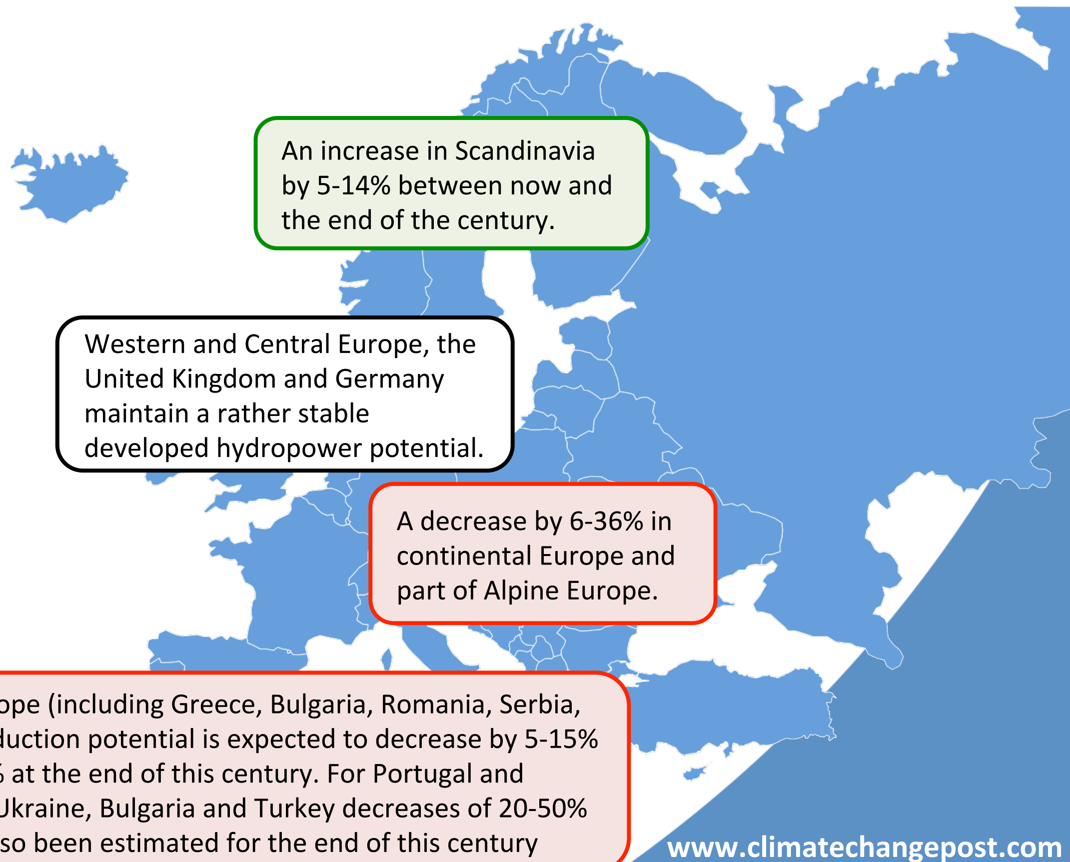
Sources: www.ec.europa.eu; www.hydropower.org; www.bankwatch.org; www.theglobaleconomy.com; www.iea.org; www.bfe.admin.ch

Energy: Hydropower potential

Future projections

Global
Currently, on a global scale, only 5% of the upper limit of gross hydropower potential is being used for hydropower. Thus, there seems to be a lot of potential globally to further increase hydropower and thermoelectric power.
Climate change will increase gross hydropower potential on a global scale by 2.4% - 6.3% between now and the end of this century.

Europe
Hydropower potential in Europe is projected to decline by 4-6% on average by the 2070s.



An increase in Scandinavia by 5-14% between now and the end of the century.

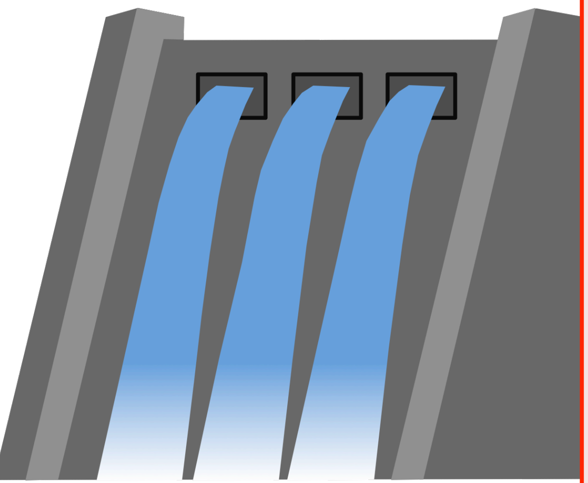
Western and Central Europe, the United Kingdom and Germany maintain a rather stable developed hydropower potential.

A decrease by 6-36% in continental Europe and part of Alpine Europe.

For Southern Europe (including Greece, Bulgaria, Romania, Serbia, Macedonia), production potential is expected to decrease by 5-15% in 2050 and >15% at the end of this century. For Portugal and Spain, as well as Ukraine, Bulgaria and Turkey decreases of 20-50% and more have also been estimated for the end of this century

Energy: vulnerabilities

Hydropower



Manage peak-load periods

The decreasing hydropower production can be particularly critical for the electric system. This production not only contributes to satisfy the base load of the system but it also contributes to manage peak-load periods by using water previously pumped into an elevated storage reservoir during off-peak periods when excess generating capacity is available to do so.

Manage floods

High water events due to heavy precipitation events are expected to become more frequent than today. While today most water is lost during strong melt periods in summer, in the future overflows will occur in particular during heavy precipitation events in fall. This represents new challenges for hydropower companies to adapt their infrastructures accordingly. Besides, glacier retreat and permafrost degradation will substantially increase the sediment transport in rivers, which will have implications for the management of reservoirs, and ultimately affect hydropower production as well.

Extreme floods will affect dam safety and operating procedures for hydro power stations.

Manage droughts

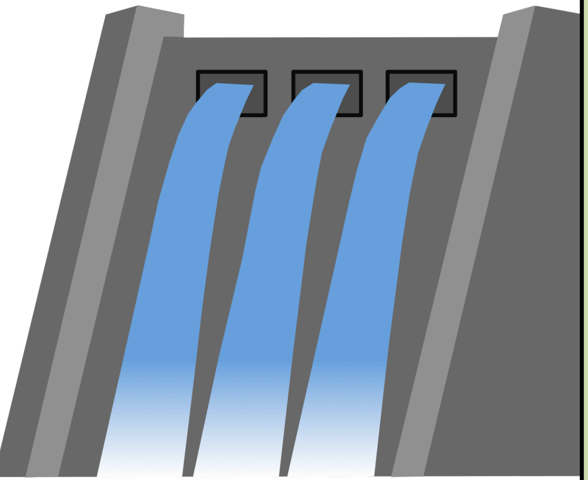
In the south, the peak in energy demand falls in the dry season, which is expected to become even drier in the future. A low water supply reduces energy production from hydroelectric plants, as well as from conventional power plants, which require water for cooling and for driving the turbines. As a result, energy demands may not be met in the warm period of the year.

Glacier retreat

Glacier retreat is already affecting hydropower production across the Alps, particularly in Switzerland, where reservoirs are frequently glacier fed. Future projections show that total runoff generation for hydropower production will decrease during the 21st century by about one third due to the massive retreat of the glaciers. The reduction of ice melt will not be compensated by the potential increase of precipitation. Hydropower production will shift from summer to spring: the increased snow and ice melt in spring will lead to enhanced runoff in spring while runoff in the second half of the year will be significantly lower. Hydropower production, therefore, is expected to decrease by over half by the end of the century during the summer months. This seasonal shift may be advantageous for hydropower production: runoff may become more consistent throughout the year.

Energy: adaptation strategies

Hydropower



More (extreme) heavy precipitation events

The seasonal shift of the hydrological cycle and the reduced ice melt generation will very likely force hydropower companies to adapt new water management strategies. The new strategies have to take into account that ice melt in summer will be drastically reduced, but the frequency of heavy precipitation events during fall will increase. Accordingly, the current practice of hydropower companies, of producing maximum energy during winter and relying on ice melt to fill the reservoirs, might be jeopardized by the end of the century.

Dam safety is crucial if the seasonal distribution of inflow to the reservoirs changes. It is important to be prepared for potential heavy rains in late summer autumn or even winter instead of keeping the reservoirs filled for wintertime after spring floods.

More (severe) droughts

Due to reduced water flows, especially in periods of drought, in the sphere of energy supply we can expect a smaller contribution from conventional hydroelectric power plants to the daily regulation of production. This is one further reason for re-examining plans to construct pumped storage plants in order to balance daily fluctuations in the consumption of electric power. In addition, the construction must be reconsidered of seasonal accumulation basins for flow enrichment during drought periods for the more balanced production of electricity and for reducing the adverse effects of low flows on river populations. For enhancing the stability of the energy system it is also important to diversify sources, for example by exploiting wind energy.

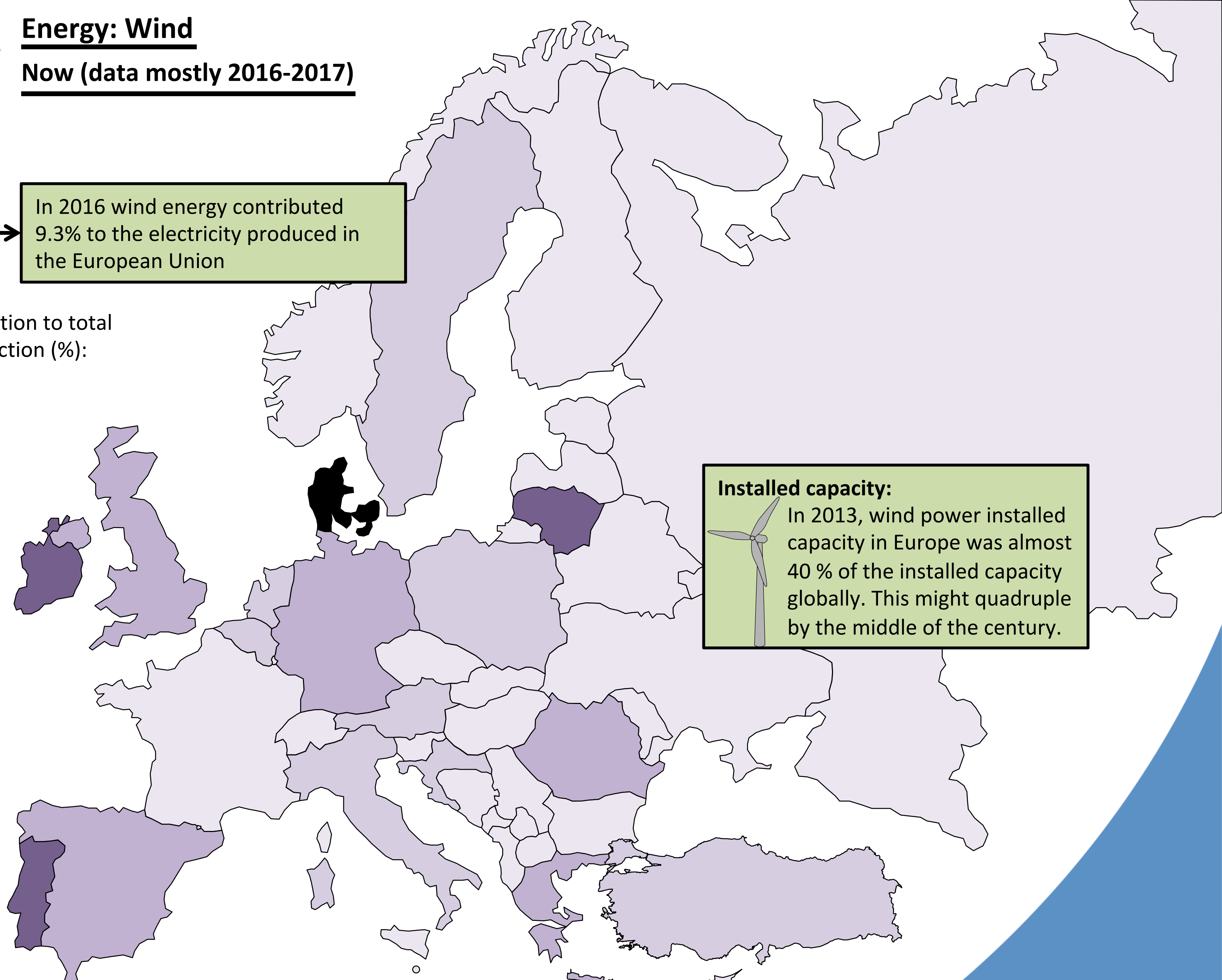
Europe's supply by wind energy in a changing climate

Photo credit: Jeff Kubina, www.flickr.com

Energy: Wind

Now (data mostly 2016-2017)

In 2016 wind energy contributed 9.3% to the electricity produced in the European Union



Current contribution to total electricity production (%):

- 0 - 5%
- 5 - 10%
- 10 - 20%
- 20 - 30%
- 30 - 40%
- 40 - 50%

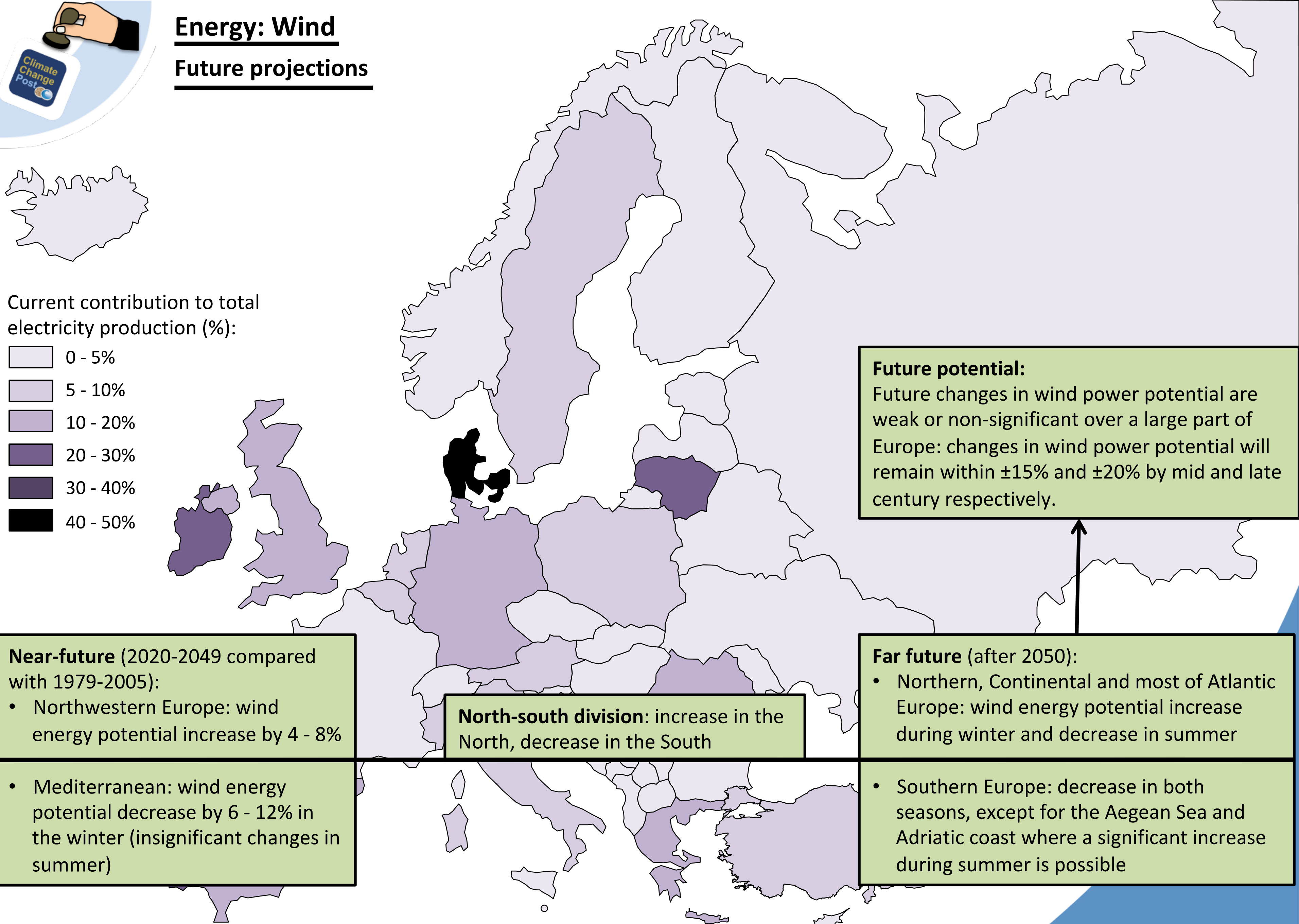
Installed capacity:

In 2013, wind power installed capacity in Europe was almost 40 % of the installed capacity globally. This might quadruple by the middle of the century.

Sources: www.ec.europa.eu; www.worldenergy.org; www.belarusdigest.com; www.reuters.com; www.icelandmag.is; www.balkangreenenergynews.com; www.regjeringen.no; www.bfe.admin.ch; www.enerji.gov.tr; www.kyivpost.com

Energy: Wind

Future projections



Future potential:
Future changes in wind power potential are weak or non-significant over a large part of Europe: changes in wind power potential will remain within ±15% and ±20% by mid and late century respectively.

Near-future (2020-2049 compared with 1979-2005):

- Northwestern Europe: wind energy potential increase by 4 - 8%
- Mediterranean: wind energy potential decrease by 6 - 12% in the winter (insignificant changes in summer)

North-south division: increase in the North, decrease in the South

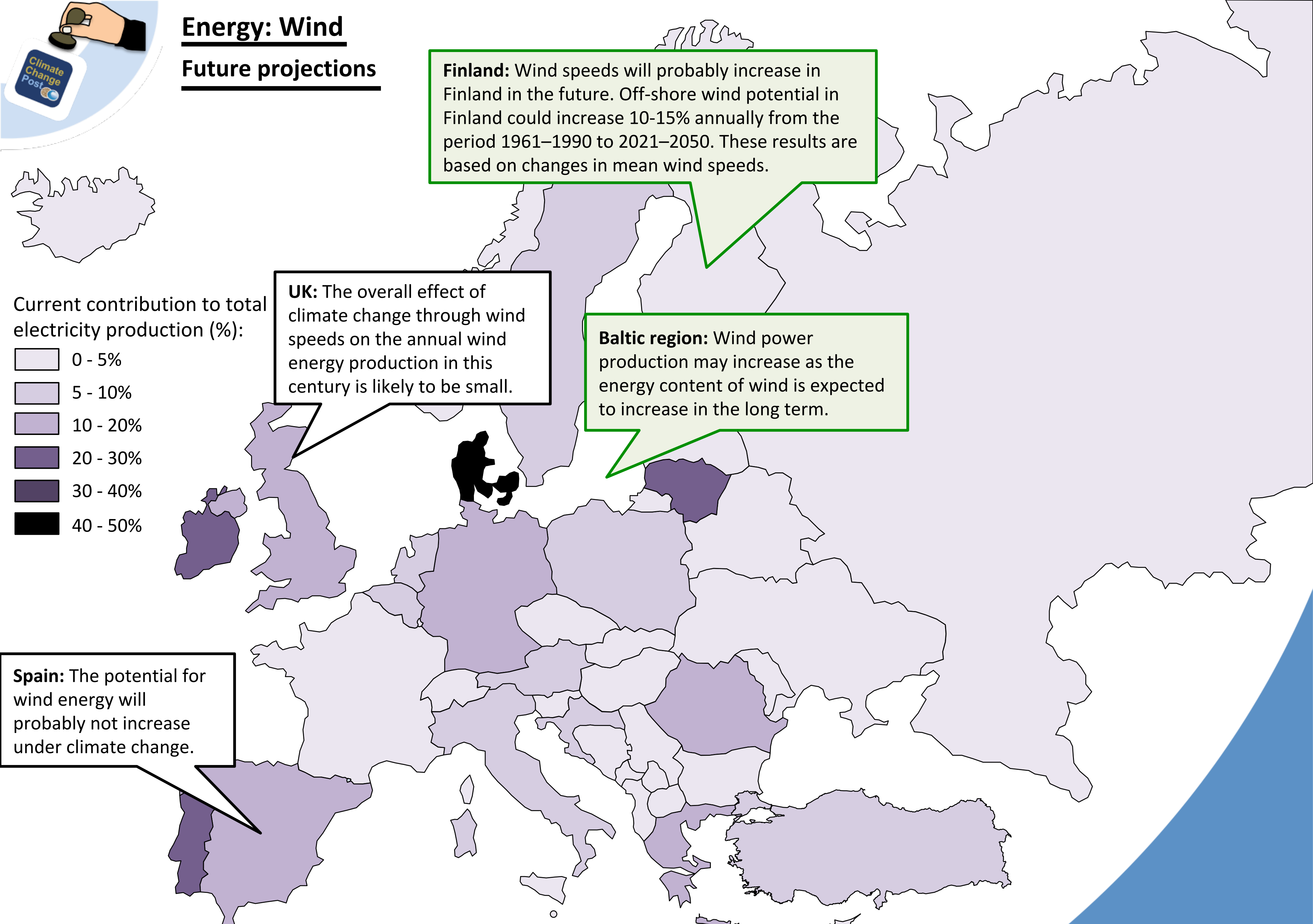
Far future (after 2050):

- Northern, Continental and most of Atlantic Europe: wind energy potential increase during winter and decrease in summer
- Southern Europe: decrease in both seasons, except for the Aegean Sea and Adriatic coast where a significant increase during summer is possible

Sources: www.ec.europa.eu; www.worldenergy.org; www.belarusdigest.com; www.reuters.com; www.icelandmag.is; www.balkangreenenergynews.com; www.regjeringen.no; www.bfe.admin.ch; www.enerji.gov.tr; www.kyivpost.com

Energy: Wind

Future projections



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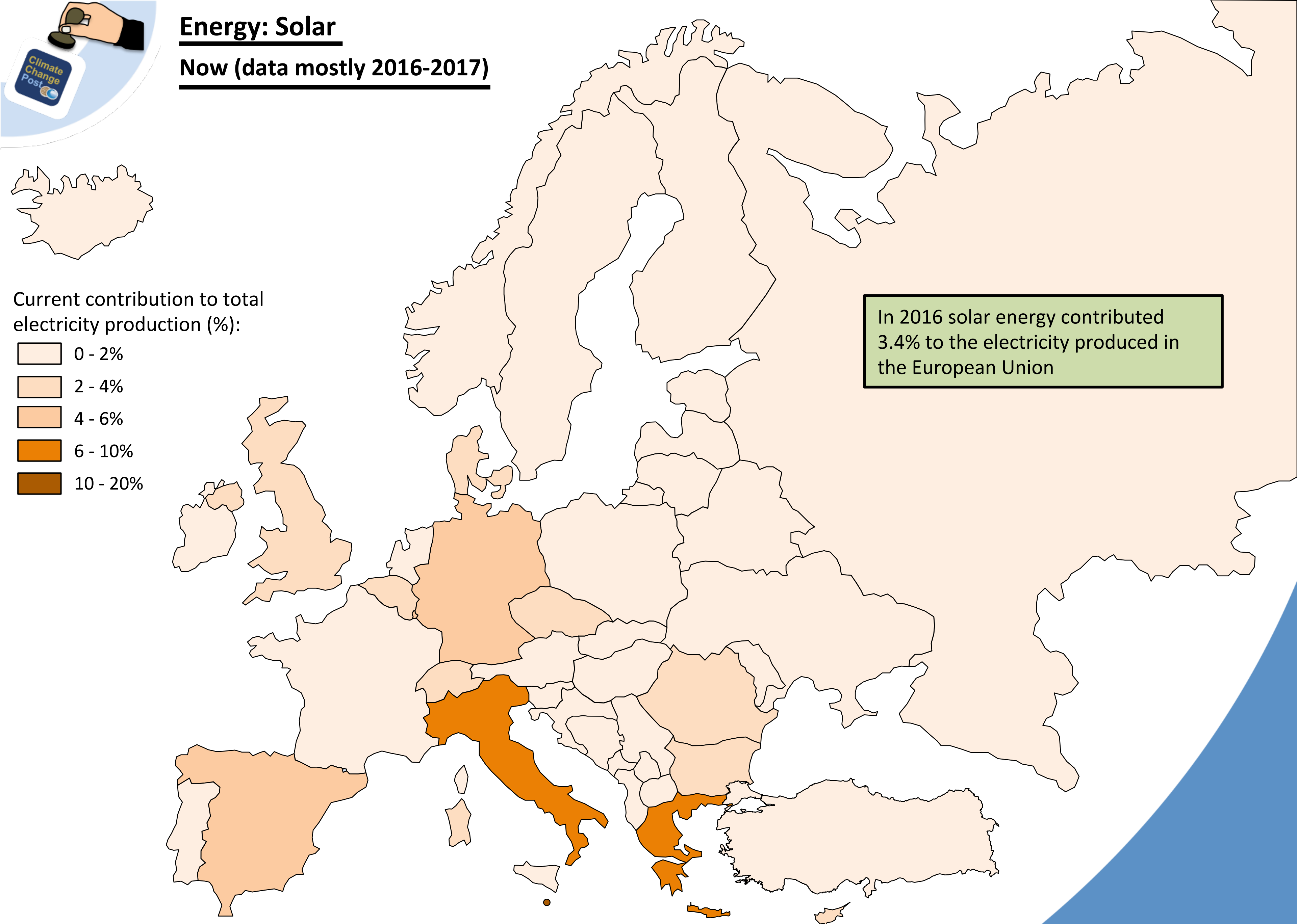
Europe's supply by solar energy in a changing climate

Photo credit: Michael Mees, www.flickr.com

Energy: Solar

Now (data mostly 2016-2017)



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Europe's supply by thermal power in a changing climate

Photo credit: Alf Altendorf, www.flickr.com

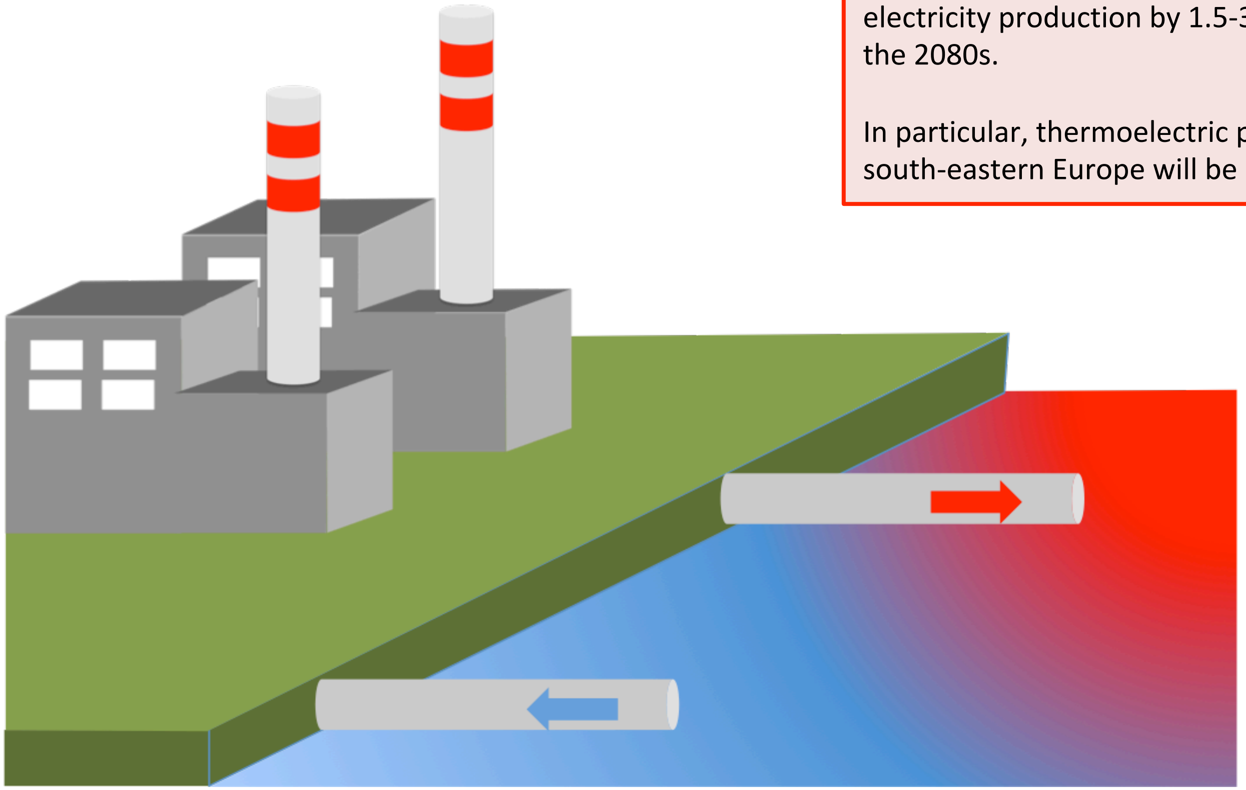
Energy: Thermal power

Vulnerabilities

For Europe, a decrease of the summer average usable capacity of power plants up to 19% has been projected by mid century compared to the end of last century, due to increasing water temperatures and decreasing river runoff.

There are numerous examples, from Switzerland, Germany and France in 2003, and from France, Spain and Germany in 2006, where high ambient water temperatures have resulted in reduced power output at several thermal power plants; some of them even had to be shut down. Under moderate climate change, warmer cooling water may reduce thermal electricity production by 1.5-3% in European countries by the 2080s.

In particular, thermoelectric power plants in southern and south-eastern Europe will be affected.



Energy: Thermal power

Adaptation options

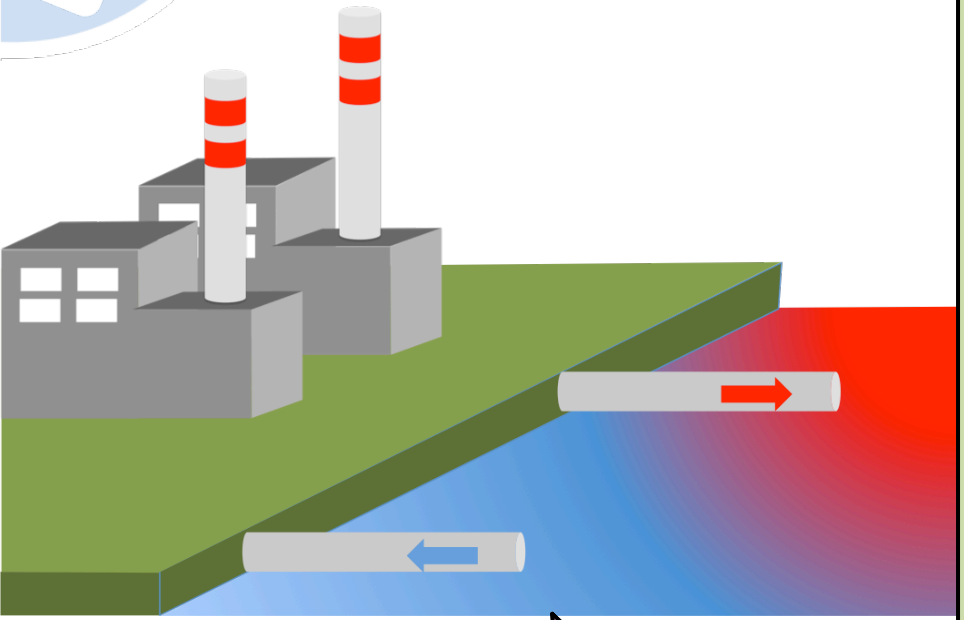
Adapt cooling options:

Use small tri-generation plants. They need less water for cooling than big thermoelectric plants.

Use tower cooling systems, in particular hybrid cooling, where cooling towers can operate both with and without cooling water. They need less water than once-through cooling systems. Besides, security of supply increases by enabling the use of air-cooling during low flows when abstractions may be prohibited.

Use so-called non-traditional waters: waters that are not withdrawn from a river, lake, the groundwater, or the ocean, but are otherwise obtained from the environment, for instance, recirculation of water from oil and gas fields or coal mines. Reuse process water.

Use dry cooling towers that emit surplus heat only by convection without causing water loss through evaporation. Use regenerative cooling where the compressed steam cools down because it is allowed to expand. Use heat pipe exchangers that allow the conveyed steam to release heat to the environment without direct contact (the cooled/condensed steam can recirculate).



Four types of cooling systems are being used:

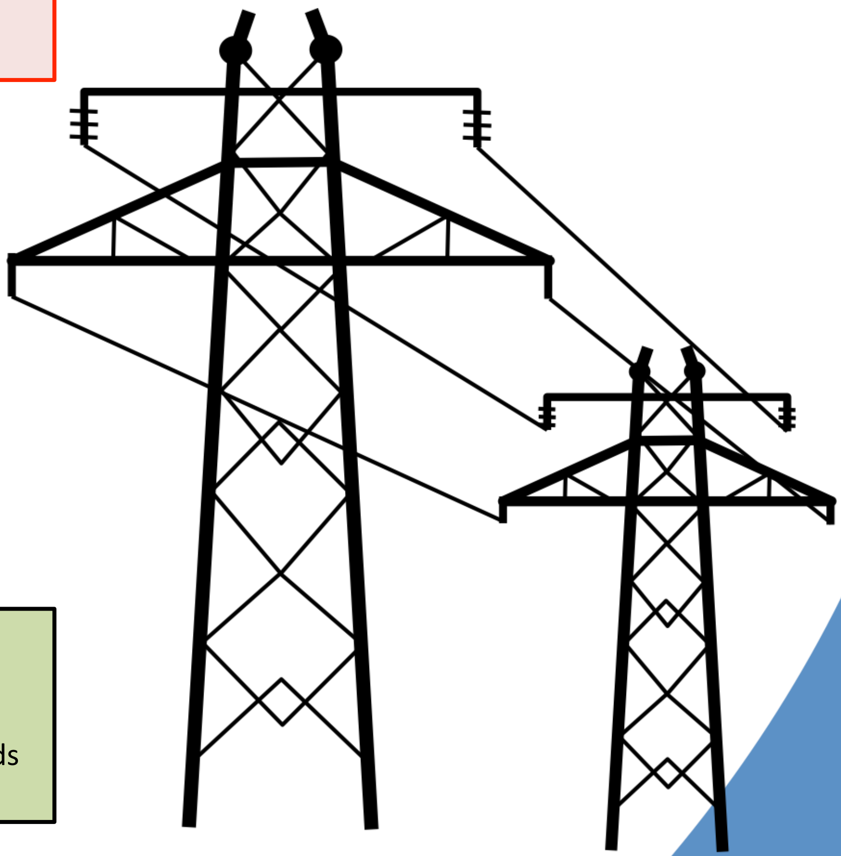
- once through (open loop), where heat is removed through transfer to a running water source
- closed (re-circulatory), where heat is removed to the air by re-circulating water cooled in ponds or under cooling towers
- air-cooled, where heat is removed by air circulation via fans and radiators (a setup that can operate without water)
- hybrid, where cooling towers can operate both with and without cooling water

Energy providers should prepare for extreme weather events by providing emergency water connections for power stations in case cooling with river water becomes impossible due to drought

Energy: Transport infrastructure

Vulnerabilities

Critical infrastructure located on the coast is vulnerable to rising sea levels, storm surges and higher waves. Critical infrastructure elsewhere on land and below-ground facilities such as cable tunnels and basements are at increasing risk of flooding. Extreme winds could damage overhead power lines.



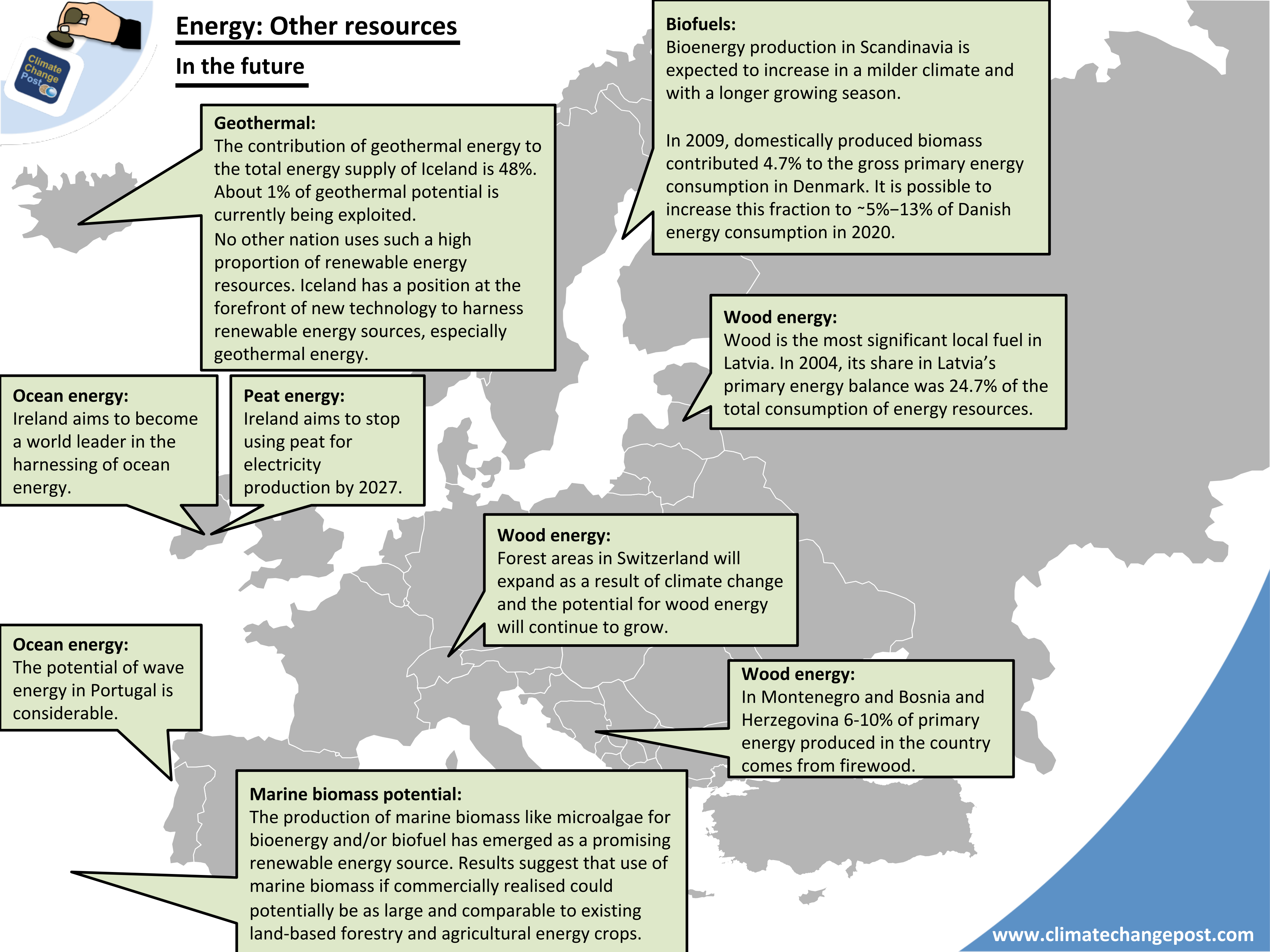
Adaptation options

Adjust standards for construction and protection of power plants and connected infrastructure. Install cables underground instead of overhead wires, as the former are less vulnerable to storm, wind throw, and freezing/ice loads on wire.


Europe's
other renewable energy sources
in a changing climate
Photo credit: Nick,
www.flickr.com
www.climatechangepost.com

Energy: Other resources

In the future



Geothermal:
The contribution of geothermal energy to the total energy supply of Iceland is 48%. About 1% of geothermal potential is currently being exploited.
No other nation uses such a high proportion of renewable energy resources. Iceland has a position at the forefront of new technology to harness renewable energy sources, especially geothermal energy.

Biofuels:
Bioenergy production in Scandinavia is expected to increase in a milder climate and with a longer growing season.

In 2009, domestically produced biomass contributed 4.7% to the gross primary energy consumption in Denmark. It is possible to increase this fraction to ~5%–13% of Danish energy consumption in 2020.

Wood energy:
Wood is the most significant local fuel in Latvia. In 2004, its share in Latvia’s primary energy balance was 24.7% of the total consumption of energy resources.

Ocean energy:
Ireland aims to become a world leader in the harnessing of ocean energy.

Peat energy:
Ireland aims to stop using peat for electricity production by 2027.

Wood energy:
Forest areas in Switzerland will expand as a result of climate change and the potential for wood energy will continue to grow.

Ocean energy:
The potential of wave energy in Portugal is considerable.

Wood energy:
In Montenegro and Bosnia and Herzegovina 6-10% of primary energy produced in the country comes from firewood.

Marine biomass potential:
The production of marine biomass like microalgae for bioenergy and/or biofuel has emerged as a promising renewable energy source. Results suggest that use of marine biomass if commercially realised could potentially be as large and comparable to existing land-based forestry and agricultural energy crops.

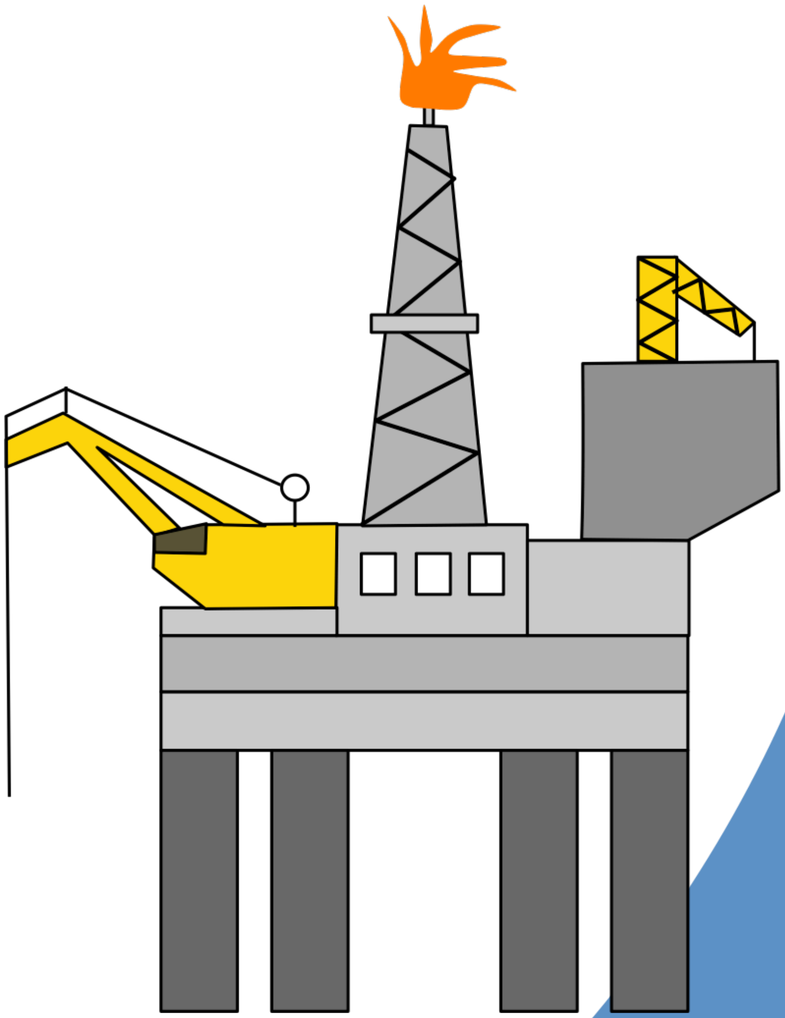
Europe's oil and gas sector in a changing climate

Photo credit: Ken Hodge, www.flickr.com

Energy: Oil and gas sector

Vulnerabilities

Climate change and extreme weather events represent a real physical threat to the oil and gas sector, particularly in low-lying coastal areas and areas exposed to extreme weather events. Climate-related events in the past have led to oil spills and releases of hazardous materials. The economic, social, and environmental impacts caused by the disruption of and damage to the oil and gas sector could be huge.



Adaptation options

According to experts platforms will be floating rather than attached to the sea floor by the 2050s. Such structures are less susceptible to wave damage. The physical impacts of climate change are not considered a major issue for the offshore industry.

Climate Change Post

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