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Climate change mitigation strategies and vulnerability for the Argentinean electricity supply

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Climate Change Mitigation Strategies and Vulnerability for the Argentinean Electricity System

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Energy & Environment Concerns

The growing concern over the availability of the fossil energy resources.

The high incidence that its combustion causes to the environment
(Climate change)

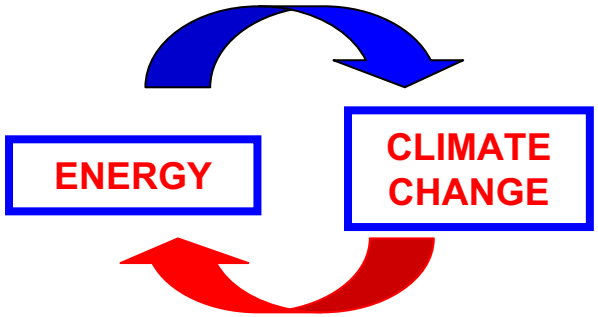
The increasing demand for electric power, and

the need of expansion of the Argentine electrical generation capacity

The question is:

How nuclear electricity will contribute to the expansion of the Argentine electrical system and to the mitigation of Climate change

Objective



Argentine electrical system with regard to:

(i) present and future supply options and their relationship with greenhouse gas mitigation strategies,

(ii) its vulnerability to Climate change, with special emphasis on hydroelectricity.

Overview

1. Introduction to Climate change → Mitigation & Strategies / Vulnerability Assessment

2. Argentine Electrical System → Power Generation Technologies

3. Sensitivity to Current Climate → Working Problems

4. Future Scenarios of Climate Change (dowscaling) → Hydropower Vulnerability Assessment

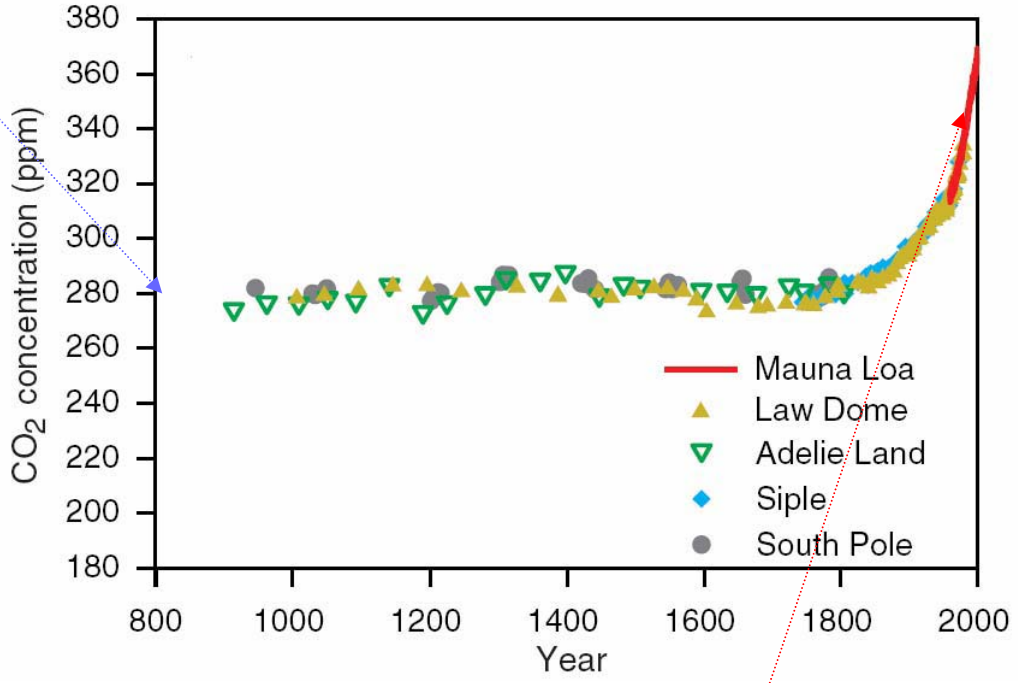
Conclusions

Concentration of Carbon Dioxide

~ 280 ppm

Since the beginning of the Industrial Revolution a period of intense use of fossil fuels started.

COAL OIL GAS

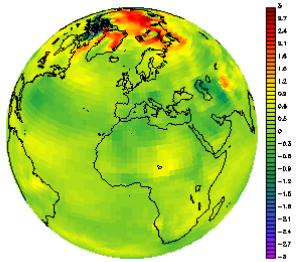


Concentration of carbon dioxide in the atmosphere in the last 1000 years. Source: IPCC report, 2001

370 ppm

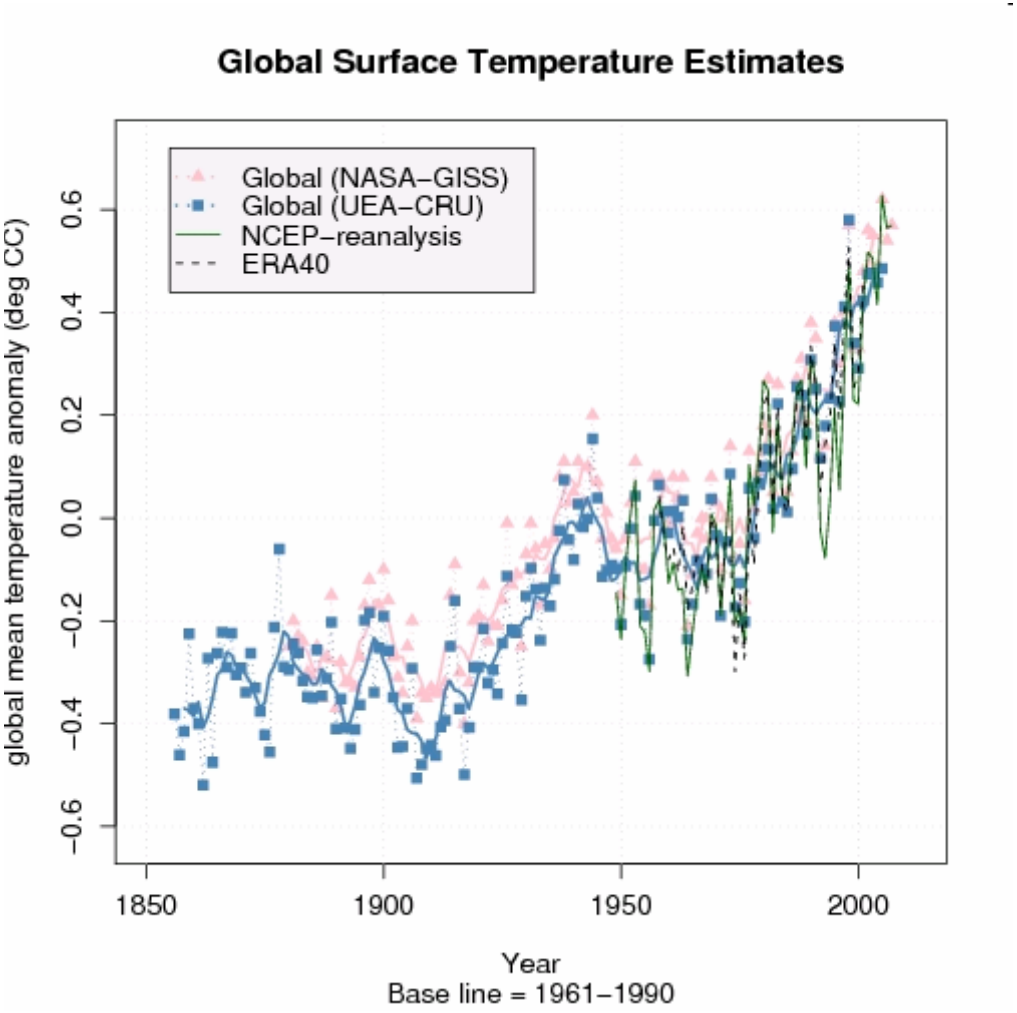
Global warming is "unequivocal". Human-caused emissions of greenhouse gases are the primary cause of global warming. IPCC, 2007.

Evidence for Global Warming



Global Warming is now evident from observations of global average temperature increase.

This involves also an important **Change in the Climate**, not only in temperature but in other climate variables such as rainfall, winds, humidity ...



International Response

UNFCCC
(Signed in 1992)

- The UN Framework Convention on Climate Change resulted in a Treaty intended to **stabilize GHG concentrations in the atmosphere** that would *prevent dangerous anthropogenic interference with the climate system*. The treaty is considered legally non-binding.

Kyoto Protocol
(Adopted COP3 - 1997)

- The UNFCCC negotiations produced the Kyoto Protocol which established **binding emissions reduction targets** for developed countries for 2008 – 2012

Emission reductions

Gases

CO_2
N_2O CH_4
HFC
PFC SF_6

developed countries

baseline year
1990 -5%
1995 for new gases

commitment period
2008-2012

2005
advances

Copenhagen 2009 COP 15

Mexico 2010 COP 16

These efforts to cope with Climate Change did not work as expected. Negotiations continue.

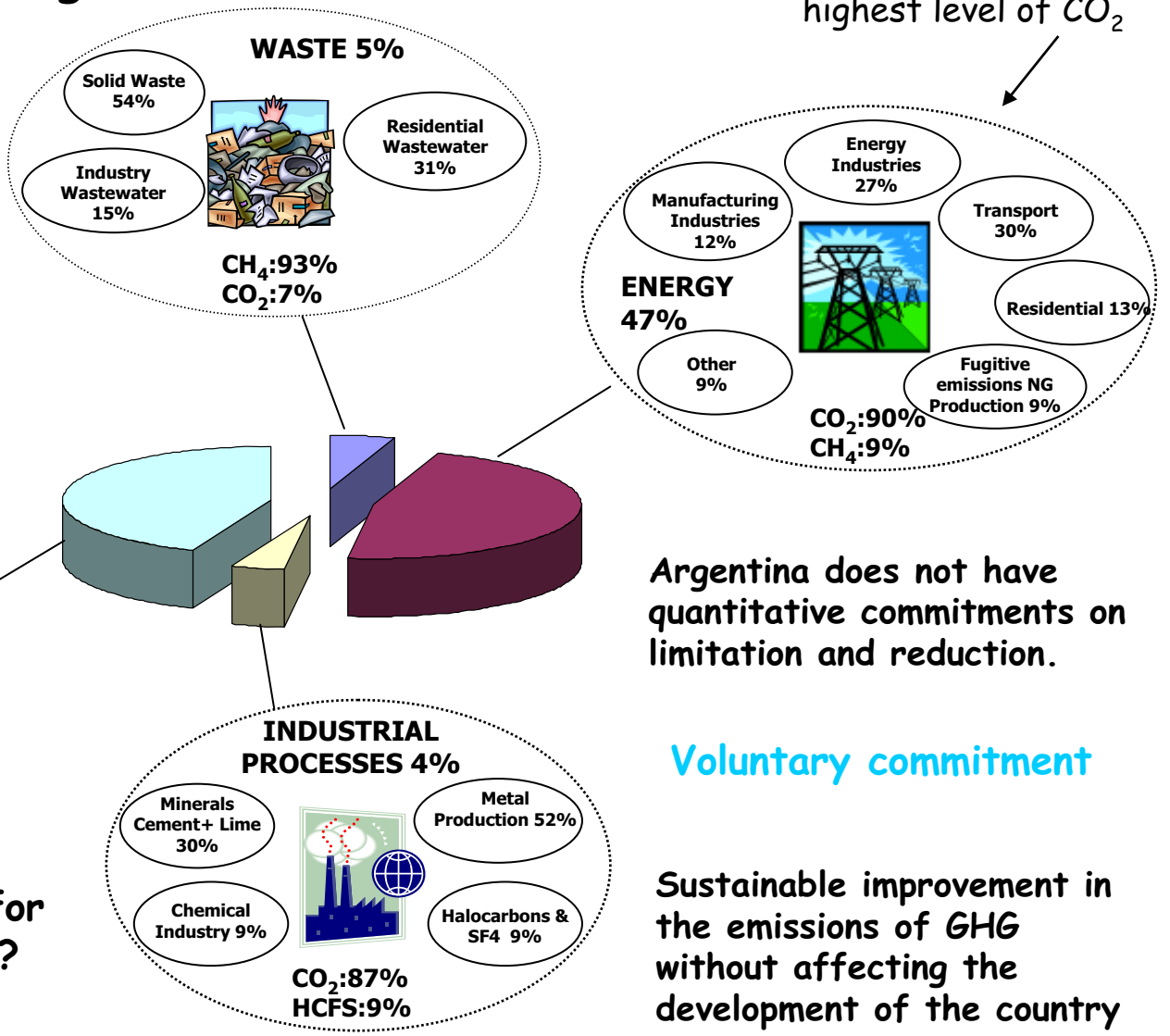
Copenhagen Accord acknowledges the need to limit global temperature rise to a minimum of 2°C.

Emissions in Argentina

Energy sector produces the highest level of CO_2

Participation by Sector

2000 GHG Emissions inventories – Argentina -



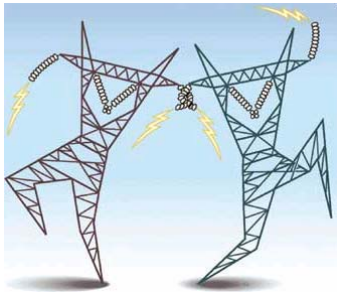
Argentina does not have quantitative commitments on limitation and reduction.

Voluntary commitment

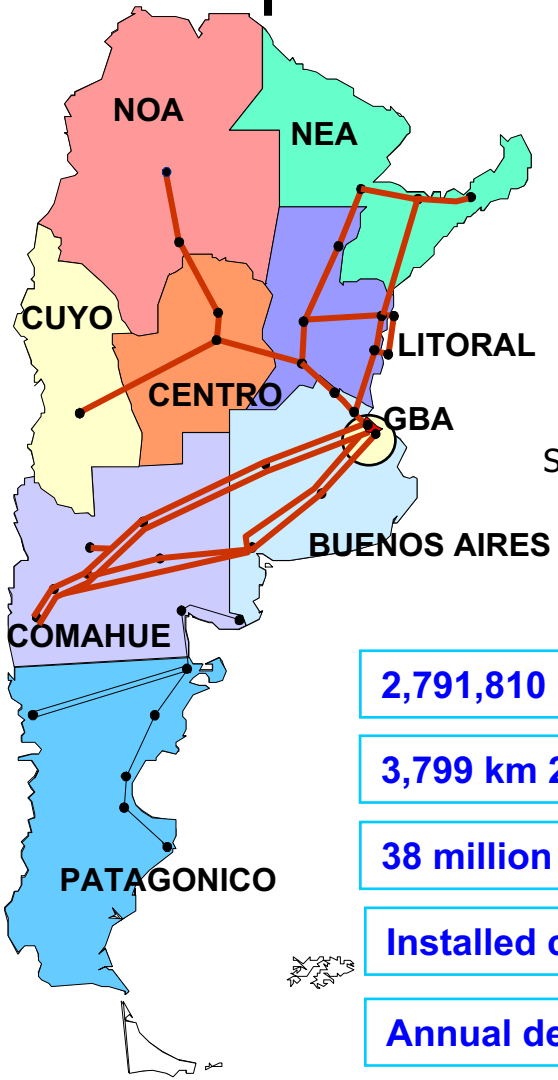
What are the possibilities for Argentina to limit emissions?

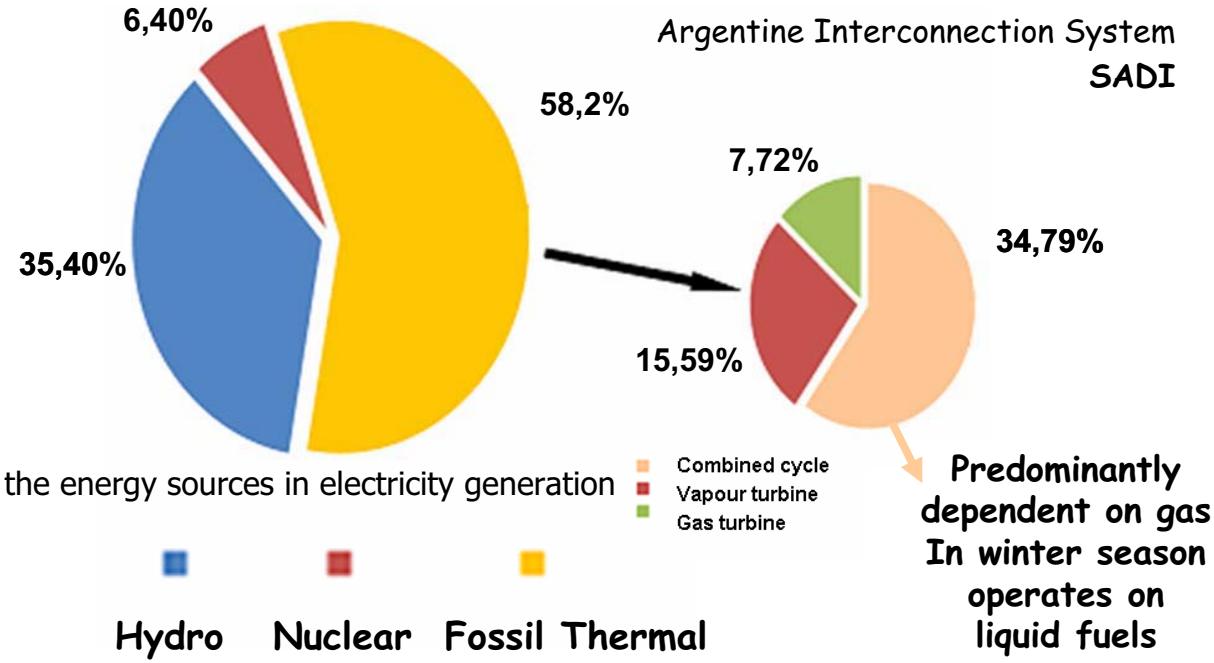
Sustainable improvement in the emissions of GHG without affecting the development of the country

Argentine Electrical System



Argentine Interconnection System
SADI





Share of the energy sources in electricity generation

Predominantly dependent on gas
In winter season operates on liquid fuels

- 2,791,810 km^2,
- 3,799 km 22º- 55ºS.
- 38 million people
- Installed capacity ~ 27,000 MW
- Annual demand growth over 5%

Generation takes place in a competitive and mostly-liberalized market.

75% of the generation capacity is owned by private enterprises

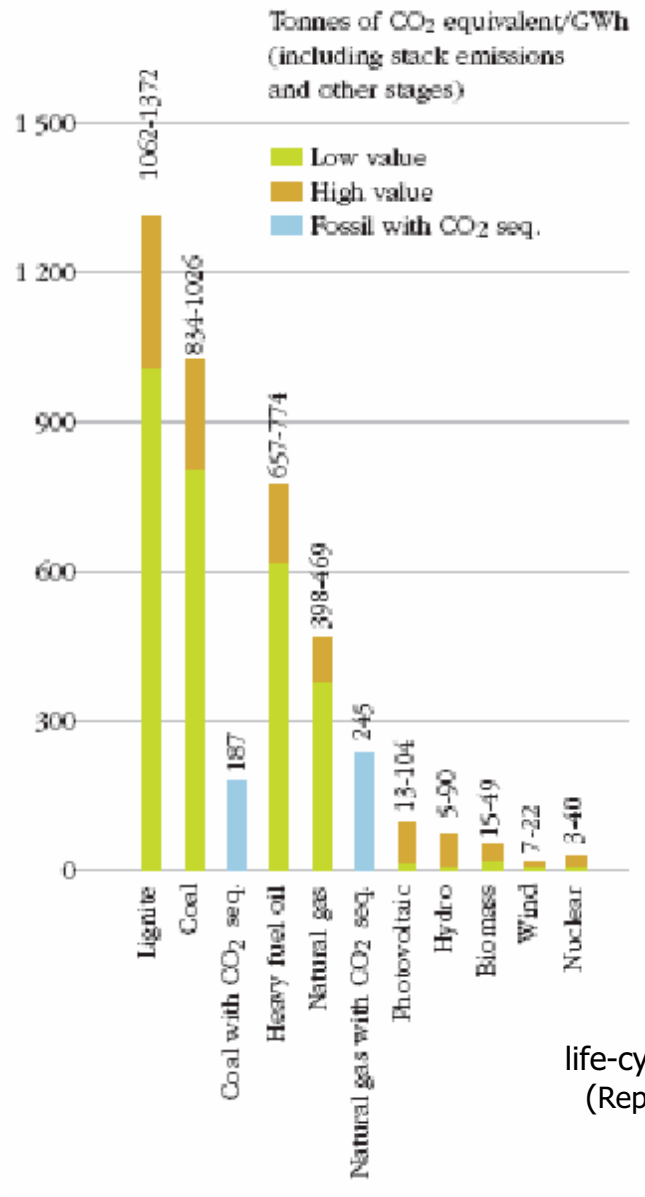
Comparison of life cycle CO_2 emissions from Electricity Production

ENERGY

CLIMATE CHANGE

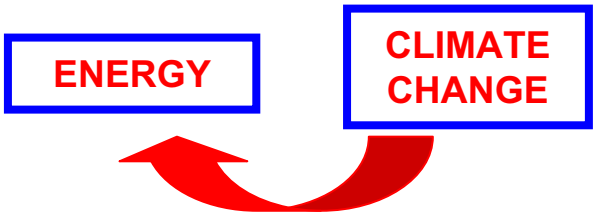
Hydro and Nuclear power are the energies with the lowest emissions of CO_2 per GWh.

Our future depends on today's decisions making, related with technologies.



Comparison of energy systems using life-cycle assessment, Special (Report World Energy Council, London, 2004)

Vulnerabilities of the Argentine Electrical System



Climate change could impact energy on supply and demand

ENERGY PLANNING REQUIRED:

the identification and analysis of the vulnerabilities to changes that:

- have been occurring in the climate
- will probably happen in the next 30 to 100 years. Planning horizon.

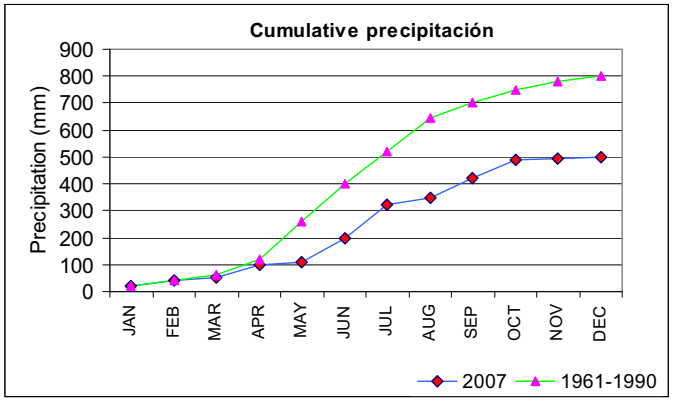
I. Sensitivity to Current Climate → to establish the climatic variables that affect the working of the Electrical System

II. High Resolution Scenarios of Climate change → to assess the vulnerability in the Comahue Region.
One of the major hydro electricity sources in the country

Sensitivity to Current Climate

Electricity demand

COLDWAVES



2007 Annual accumulated and climatological precipitation

2007 one of the coldest winters in 100 years

Historical peaks of energy demand

17.072 MW and 316 GWh

Gas Lack

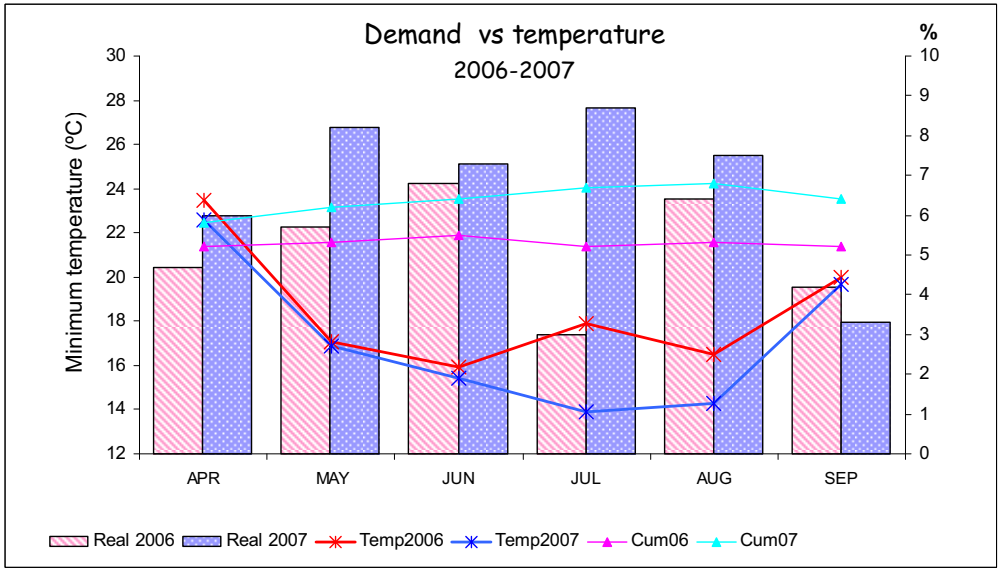
Very low precipitation rates

Less hydropower generation

Service restrictions

Extra 1000 MW import

Frequent and intense polar air irruptions happened



Comparison between electricity power demand versus monthly minimum temperature in 2006 and 2007

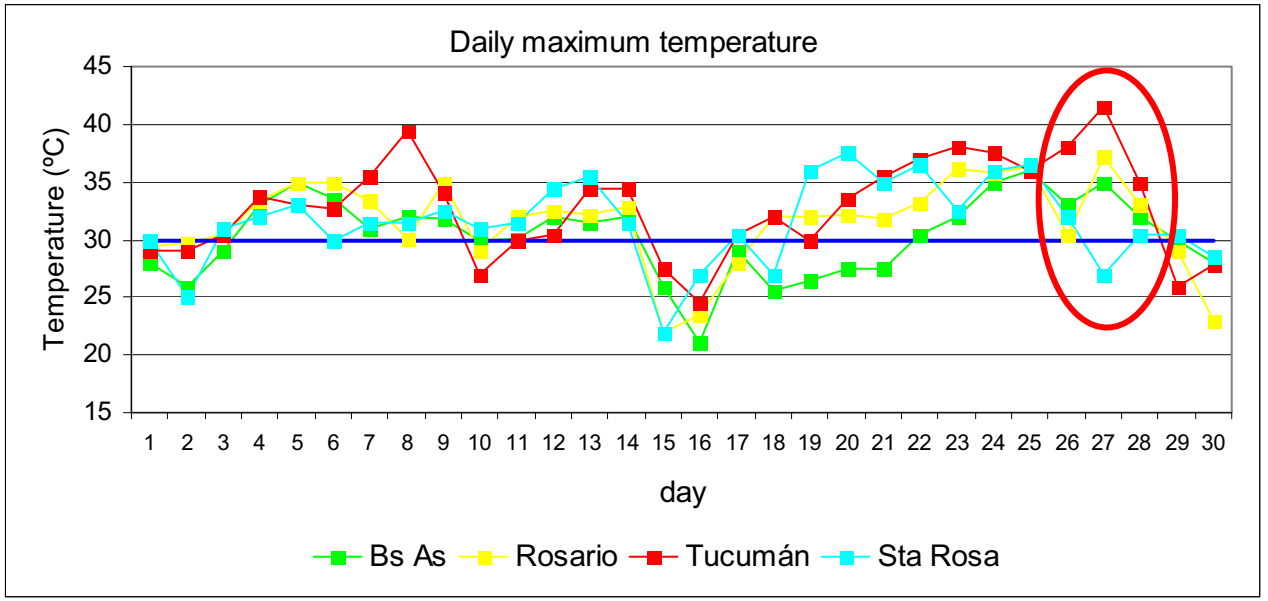
Sensitivity to Current Climate

Electricity demand **HEATWAVES**

Historical peaks of energy demand

394 GWh 27th November 2008

Electrical power disruptions



Daily maximum temperature in November 2008.

November 2008 maximum temperatures much higher than climatological values

In third place on the historical series of maximum temperatures from 1906

Sensitivity to Current Climate

Electricity supply

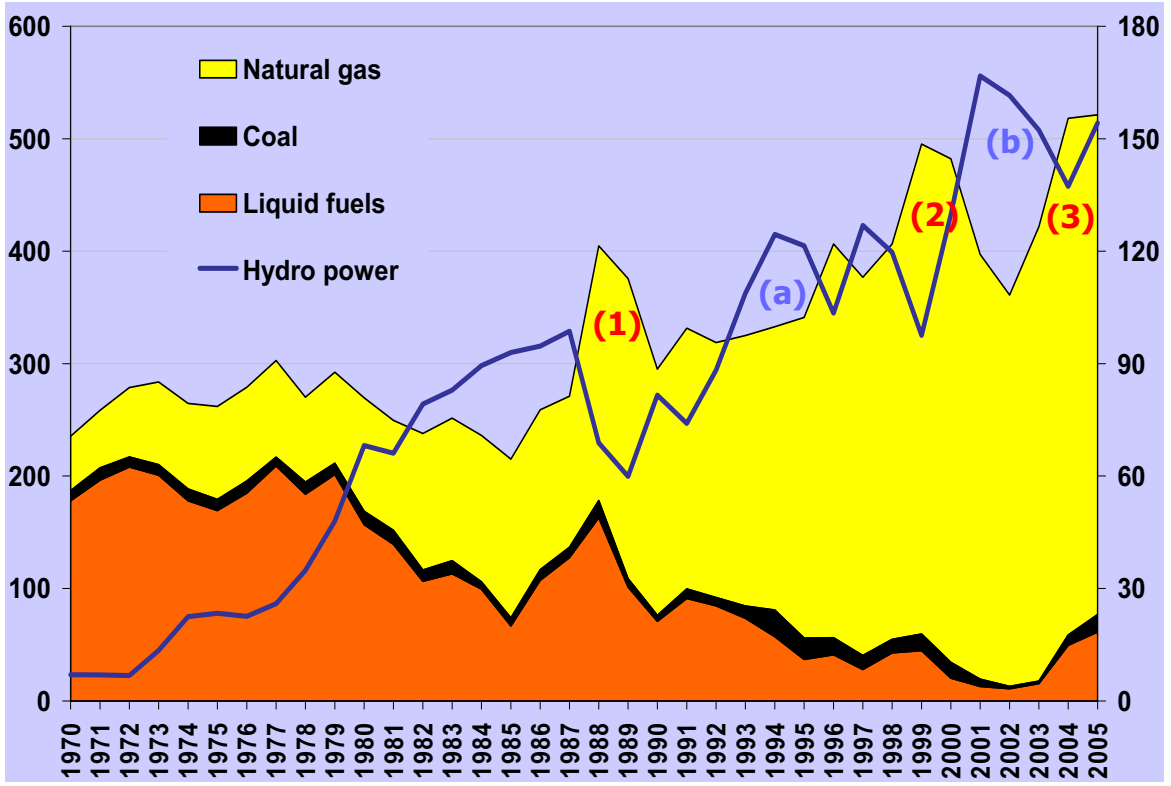
Hydropower generation is the energy source that is most likely to be affected by climate

Low hydro
(1)-(2)-(3)

High hydro
(a)-(b)

Hydro & fossil thermal are coupled by the power balance

Thermal power compensate the hydropower in dry years while hydropower regulates a more economical supply.



Hydropower electricity production and fuel consumption by thermal power plants (Coppari et al., 2008)

These variations of fuel consumption by thermal power plants constitute the cause for the fluctuations in past emissions.

Sensitivity to Current Climate

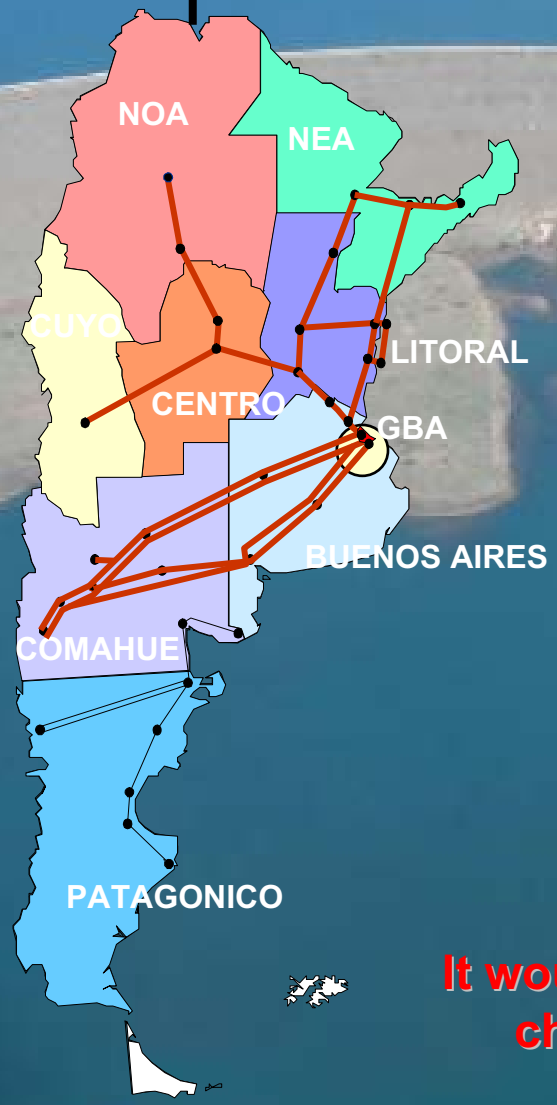
Electricity demand & supply

Low temperatures in winter affect the energy supply due to residential heating demand (Gas lack)

Heatwaves affect the working of the system due to consumption increase. (Sensitivity of peak electricity demand to higher temperature)

The precipitation modifies the volume of the river flow affecting the hydropower generation as well.

Hydroelectricity Generation in the Comahue Region



6 hydropower plants → Limay river basin
Neuquén river basin

~26% Argentine installed capacity

~43% Argentine hydroelectricity generation

Mixed rain-snow precipitation regime

Maximum in spring and summer as a result of the snow melting of the Andes mountain range

Comahue Region has a large reservoir used mainly in the winter season

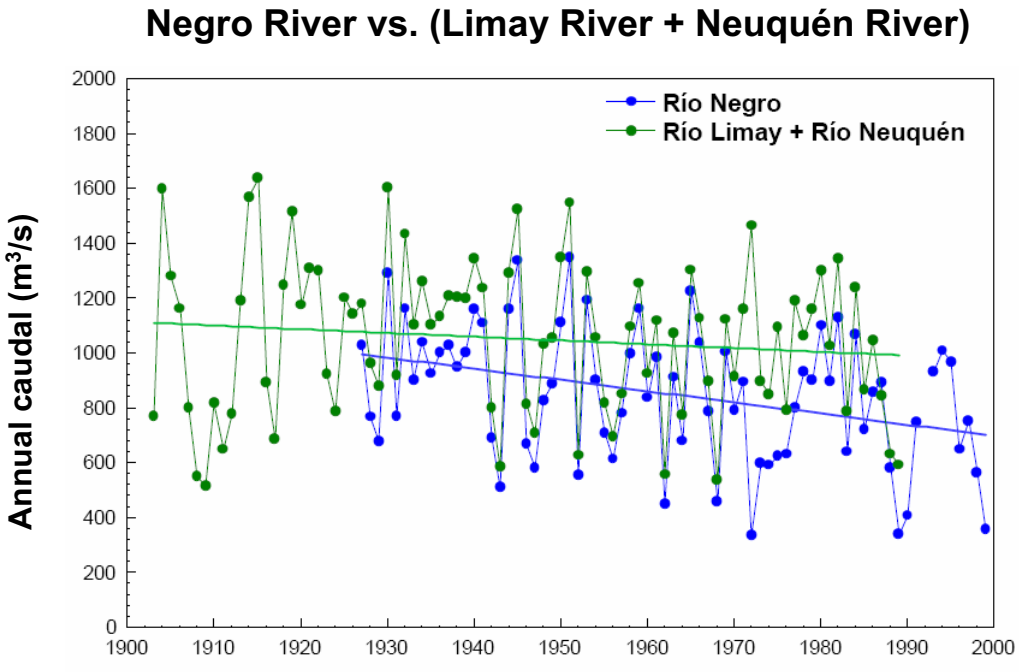
It would be important to anticipate the possible future changes in precipitation for a careful planning.

Hydrological Trends in the Comahue Region

Negative trends in the rivers of the north and central Patagonia, after 1970.

Limay river decreased about
175 m^3 s^{-1} from 1903
- 22 % in 100 years -

due to **significant reduction in the snowy and rainfall periods.**

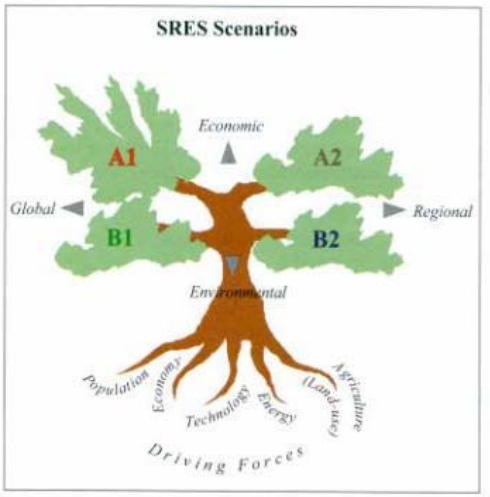


Variation of the annual mean streamflow in the Limay River (CMNUCC, 2006)

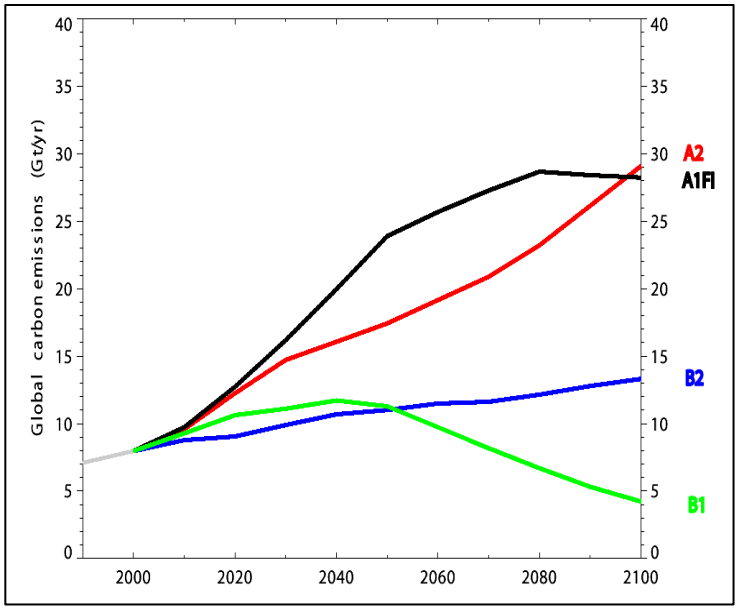
Changes in precipitation produce similar changes in the streamflow

Reduction in the hydropower generation

Emissions Scenarios



The Climate change scenarios in Argentina are developed based on **Special Report on Emission Scenarios (SRES) IPCC, 2000**



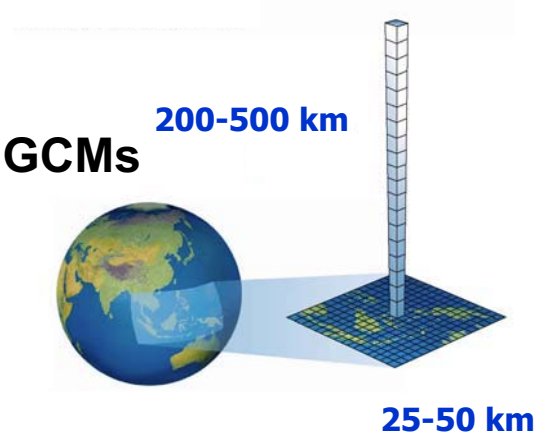
Global emissions scenarios of CO_2 (IPCC, 2001)

Global Climate Models produce climate projections by using emission scenarios

Representations of the Climate system T, pp, HR, …

A key limitation of GCMs is the fairly coarse horizontal resolution ~ 300km

Regional Climate Scenarios



Whereas the Climate change is a GLOBAL problem …

… The impacts of the Climate change are REGIONAL AND LOCAL…

Regional Climate change Scenarios for Comahue region → **DOWNSCALING techniques**

finer scale

To produce local to regional scale climate information, from coarse-resolution global-scale climate models (temperature, precipitation, …)

Regional Projections

Downscaling by simple interpolation

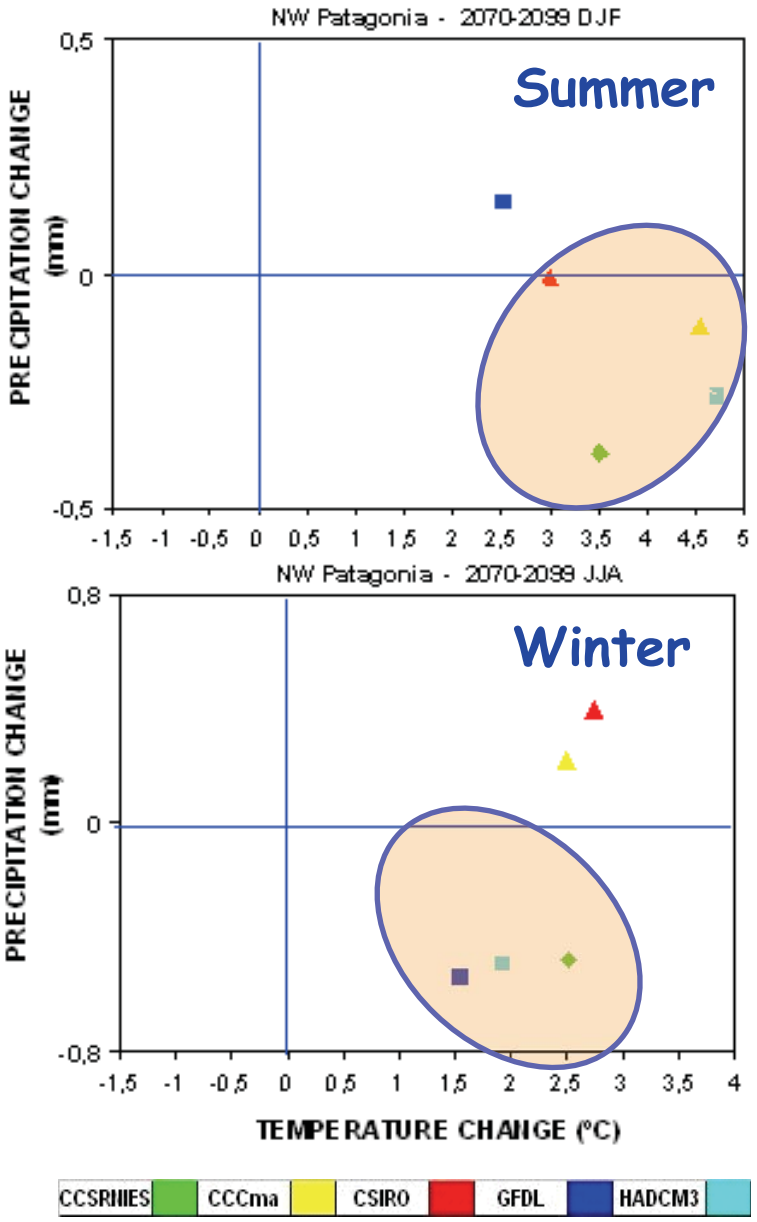
Global Climate Models

- Global climate projections
  5 models (IPCC SRES A2)
- Low resolution (~ 250-500 km)
- Baseline (1961-1990)
  Future (2070-2100)

Scatter plot illustrating the range of anomalies simulated by different GCM

Comahue region

Increase of temperature
Decrease of precipitation in winter and summer ~30%



Scatter diagrams show projected changes in summer and winter temperature and precipitation for a 30-year period (2070-2099) relative to 1961-1990

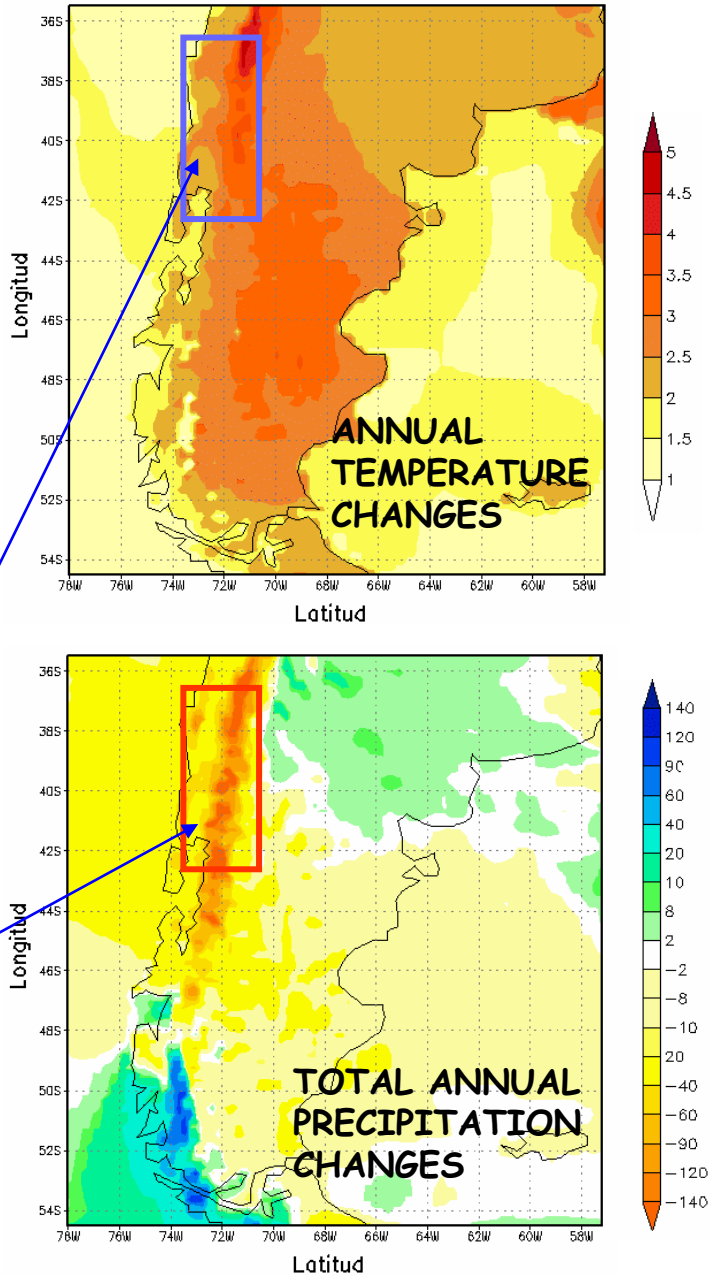
Regional Projections

Dynamical Downscaling

PRECIS Regional model

Providing REgional Climates for Impact Studies
Hadley Centre

- Global climate projections HadCM3
- Low Resolution ~250km
- Baseline (1961-1990)
- Future (2070-2080) SRES A2 (IPCC)
- Higher Resolution ~ 25 km.



Comahue region

Increase of temperature
Decrease of precipitation ~ 80%

Projected changes in annual temperature (ºC) and total precipitation (mm/y) for (2070-2080) relative to (1961-1990)

Regional Projections

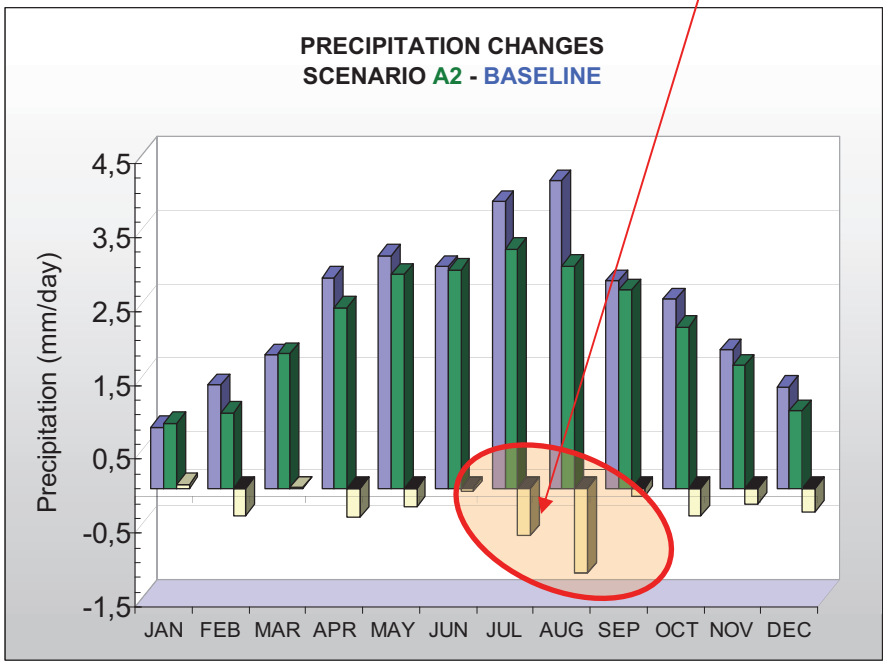
Dynamical Downscaling

Decrease in precipitation specially in winter season ~ 30%

PRECIS Regional model

Providing REgional Climates for Impact Studies
Hadley Centre

- Global climate projections ECHAM4
- Low Resolution 300 km
- Baseline (1961-1990)
- Future (2010-2040) SRES A2 (IPCC)
- Higher Resolution ~ 25 km.



Projected changes of monthly precipitation (mm/d) for (2010-2040) relative to (1961-1990) SRES A2

Comahue region

This could represent an important decrease of hydro generation that would affect the electric power system.

Vulnerability

The climate scenarios indicate that the impact of Climate change on the hydropower generation in this region will be important.

The Argentine hydro-electrical sector is vulnerable and that vulnerability can increase with time.

The problem of droughts can affect electricity generation

The climate scenarios show a decrease of precipitation in the Comahue region, one of the major hydro electricity sources in the country.

Energy planning requires medium and long time horizons

Argentine Electrical System Expansion

Energy planning

… it is necessary to supply the demand at low cost without compromising either the supply of the future generations or the environment.

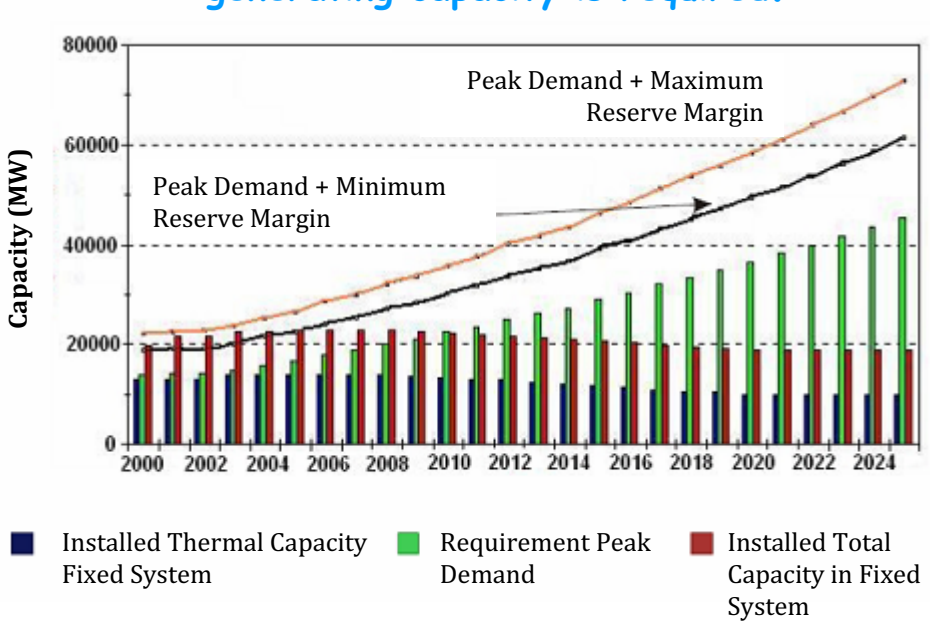
Annual Demand Growth ~5%

IN THE PAST …

- **In the 80's a centralized State planning:**
  Short term measures were not taken into account, nor were the hydro cycles.
  Investments were not made.
  1988-89 big drought crisis.

- **Since the 90's decision was in private hands:**
  Long term was neglected.
  Strong investments in thermal generation.
  Argentina is not plenty of gas, is a country with gas.
  Intensive use of natural gas was verified
  2004 gas crisis ⟶ 2004 drought crisis

An incorporation of 35000 MW of new generating capacity is required.



Installed and projected capacity and peak demand diagnosis to satisfy the demand without risk (Rey, 2005)

Discussion

Population growth and the economic development in Argentina in the last years have generated an **increase on the demand** for electricity

⇒ **increase** of the **GHG emissions**

Mitigation options in this sector are those which allow a strong **reduction in the burning of fossil fuels**.

In cases like Argentina, which is not rich in coal, **the same way** that **leads to energy solution** can also lead to **Climate change mitigation**.

Discussion

But, while we are mitigating ... Climate change and its consequences are already being felt and some of them are inevitable.

It is necessary to begin to work on **adaptation** of the impacts that the Climate change could lead in the hydroelectrical sector.

The **Argentine Electrical System is vulnerable** and that vulnerability can increase with time.

Conclusions

The future supply of the electricity demand in the medium and long term time must be done by a **reduction** share of **fossil fuels**.

The **contribution of nuclear power** should help configure a sustainable energy matrix, to give **major stability** to the electrical system and at the same time to **decrease the growth of GHG emissions**.

It is important to accompany with strategies of **energy efficiency.**

It could be convenient for Argentina to **increase** share of **nuclear power**, in order to guarantee more reliability and stability in power supply.

Thank you for your attention