ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

SYSTÈMES TRIPHASÉS

INTRODUCTION

LEÇON 1

Électrotechnique II

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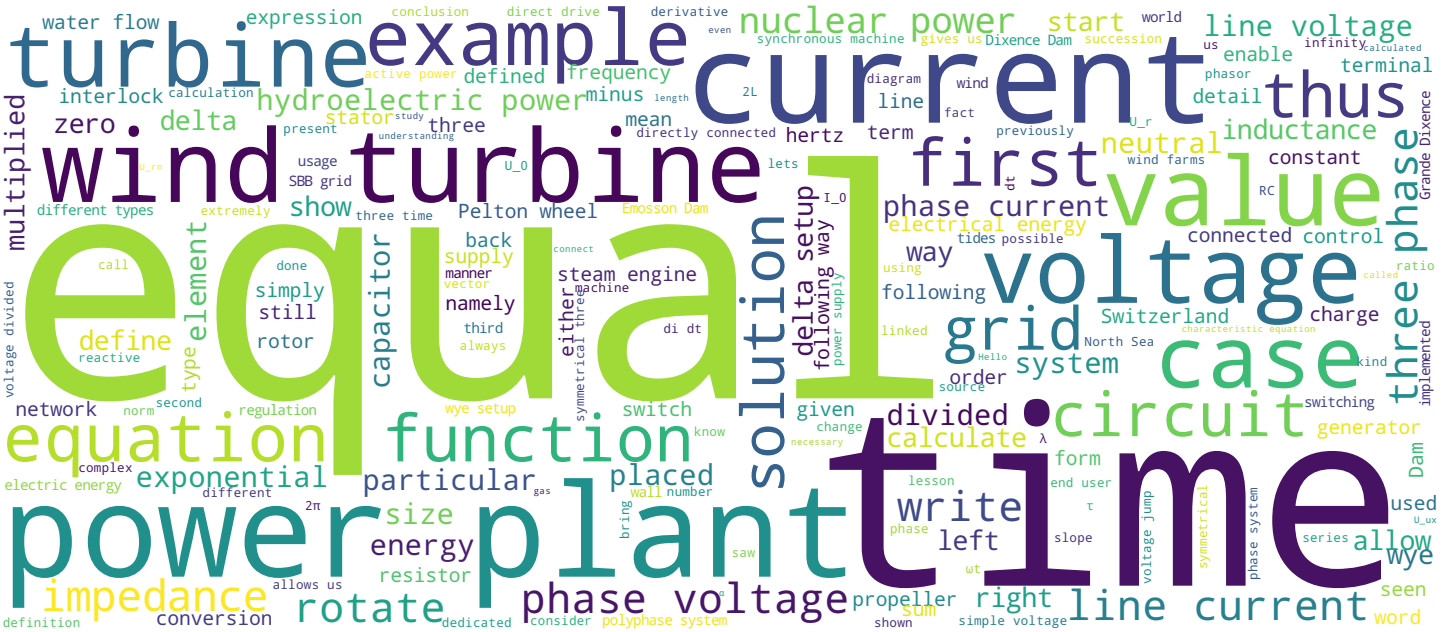


Video

INTRODUCTION

- Introduction
- Exemples de génération de l'énergie électrique
- Conclusion

Electrotechnique II

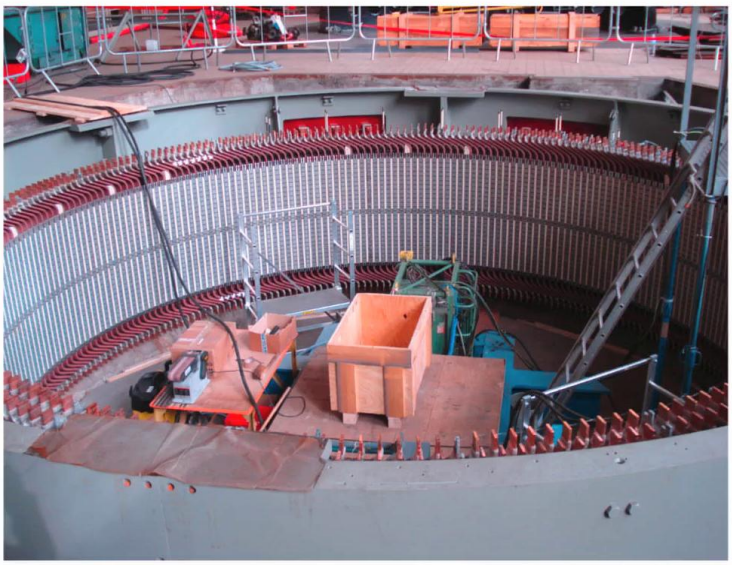
Hello Ladies and Gentlemen. Welcome to the electrotechnique 2 course. Throughout these different lessons we will study three-phase sinusoidal rating circuits as well as all the theory that will allow the understanding of transitional effects in electrical networks In this first lesson we shall give a general introduction on networks how, with a few examples, we can produce electrical energy in particular here with a synchronous generator, motor or anything else linked to some form of electromechanical conversion. I will start here with an example.

Notes

Summary

0m 04s

STATOR D'UNE TURBINE



Barrage de Marèges, France

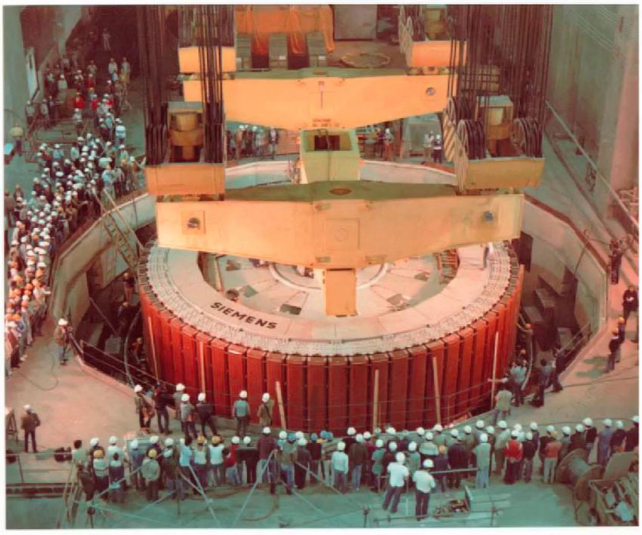
Source: Central hydraulique de Marèges

An example where you can see the stator of a turbine. This turbine can be rotated due to several effects. Heat and steam, essentially, a steam engine Or a hydraulic turbine, where we rotate the turbine using water pressure or we can also use a wind turbine, or a nuclear power plant. You can see here the size of such a stator that shows you that to currently generate Europe's electrical grid it is necessary to have increasingly bigger generators. Here you can see the the generator of the Marèges Dam in France.

Notes

Summary

0m 45s



Central hydroélectrique de Itaipu, Brésil

Source: BBC

Another example of gigantism is shown in this photo, you can see in one of the hydroelectric power plants of Itaipu, Bresil one of the biggest hydroelectric power plants in the world. The rotor of this machine, with around the stator, the staff that allowed the construction of this power plant. We can see here the size of the workers compared to the size of the rotor that you can see here being placed by an overhead crane. This is quite exceptionnal for the Itaipu Dam This allows the supply of electricity to a large quantity of households and thus a large part of the country.

Notes

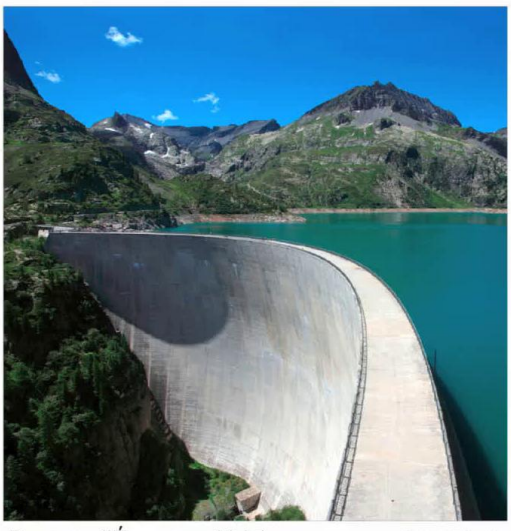
Summary

1m 28s

CENTRALE HYDROÉLECTRIQUE

Barrage de la Grande Dixence, Valais

Source: http://grande-dixence.ch



Barrage d'Émosson, Valais

Source: The ark

Electrotechnique II

Let's go back to Switzerland We have here two typical examples of a grid or grids, in the case of Switzerland. On the left you have the Grande Dixence Dam, in Valais famous for the length of its lake but also for the hight of its wall, one of the tallest in world and on the right you have the Emosson Dam in Valais which is an arch dam. These two dams have the particularity of producing, both, electrical energy by accumulating water and finally by using the waterfall, pressure and water flow to rotate the generator downstream but these two dams do not supply electrical energy at the same frequency. We will see that the Grande Dixence Dam helps provide the grid that can be called "urban" available for everybody, in other words at a frequency of 50 hertz while the Emosson Dam on the right only supplies 16 2/3 hertz, a second parallel grid in Switzerland, used for the Swiss Federal Railways, the SBB's, grid. So we have, in Switzerland, different dams that are dedicated to either the urban grid at 50 hertz, or the SBB grid for transports at 16 2/3 hertz.

Notes

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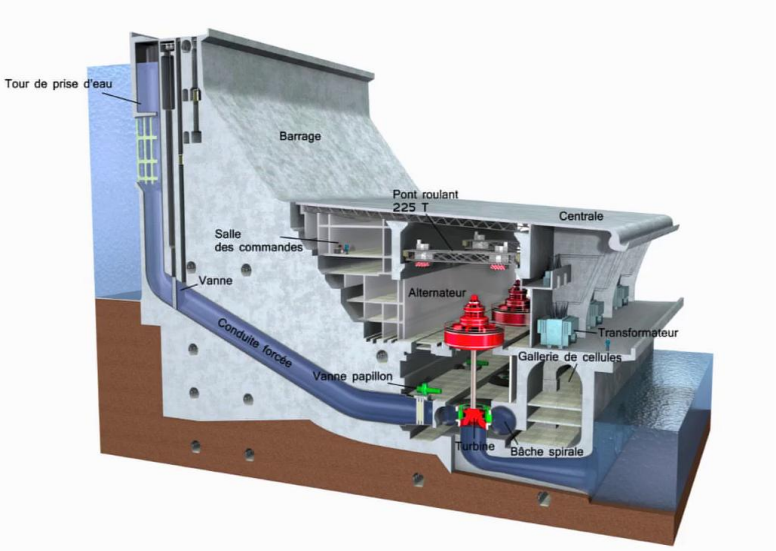
2m 12s

CENTRALE HYDROÉLECTRIQUE



Source: CNR

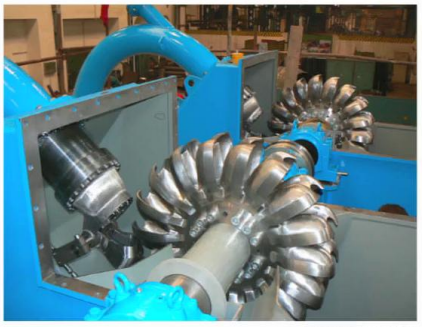
How does a hydroelectric power plant work ? You have here a sectional view of a standard power plant On the left, there is the accumulated water the wall that retains this water mass and finally a water collum or penstock that brings water, in this case, pressurized at very very high pressures which allows us to have a very high flow rates and rotate a propeller a turbine, we shall see later different types of turbines connected here to an alternator, generally a synchronous machine which enables the conversion of the mechanical power given by the water flow into electric power and the rotation speed of the rotor here enables a very precise control of the frequency injected in the grid. Afterwards, a distribution system must be organised to bring this energy to the end user.

Notes

Summary

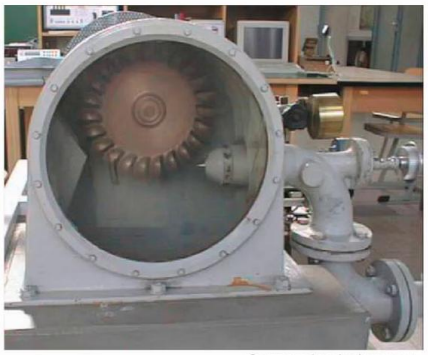
3m 36s

TURBINE PELTON



Source: hydrolink

Source:EEP



Source: micro hydro power

Electrotechnique II

Here are several examples of turbines in particular for the first, the Pelton wheel, these turbines function in the following way, they are logically realised using small cups wherein in fact, the injector with pressurised water arrives hits the cup and rotates the turbine.

Notes

Summary

4m 39s

TURBINE FRANCIS ET KAPLAN

Turbine Francis

Source: Voith Hydro

Turbine Kaplan

Source: Voith Hydro

Electrotechnique II

You have here different shapes of cups which more or less allow to control the wear that there is here which can be relatively high if the water is not perfectly free of impurities or here also, another Pelton wheel type turbine There are also other types of turbines, we won't go into the details here but, on the left you have a Francis turbine, on the right a Kaplan turbine that are used for different types of power plants Run-of-the-river power plants or other types of power plants where the water flow can be variable or for example control of the tides to also produce electricity using the back and forth of the tides.

Notes

Summary

5m 00s

ÉOLIENNE

Éolienne située près du col du Nufenen, Valais

Source: 20 minutes

Éolienne située près de San Francisco, CA

Electrotechnique II

A relatively new factor in the past ten year in our countries is the usage of wind with wind turbines and therefore more and more wind turbines are now placed in Europe with a peculiarity compared to dams. Dams enable us to debit water on demand and thus, produce energy on demand whereas in the case of wind turbines the electricity producer is always tributary to the local wind where the wind turbine is placed. Therefore behind all this is an analysis for the energy storage for when the wind occurs to enable it to be distributed at the time of usage at the right time, at the right place.

Notes

Summary

5m 40s

Mer du Nord

Source: lemarin.fr

Parc éolienne de London Array

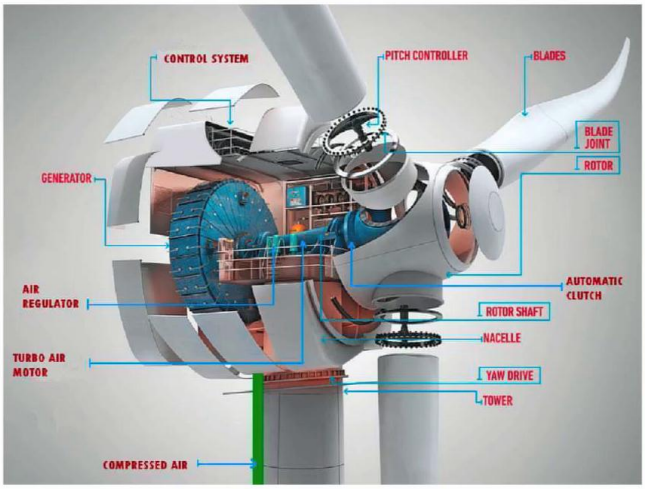
Source: London Array

In the Nordic countries, Denmark in particular, there is a high sensitivity to now use wind farms. You have here offshore wind farms in the North Sea. Another farm here, the London Array where you can see the sea being literally covered by wind turbines and you can also see the size of the turbines with the small boat that is present here on the sea and you can see that the diameters can reach several tens of meters to generate, to produce this energy.

Notes

Summary

6m 25s



Source: smartplanet.com

Moteur synchrone intégré à l'éolienne

Source: pole-medee.com

Mer du nord

Of course, we must connect all of these wind turbines on dry land to be able to tap into this energy and afterwards redistribute it to the end user you have here another photo of the North Sea that shows you better the dimensions of a wind turbine compared to a boat and in the most recent improvements made on wind turbines there are direct drives that were implemented where the synchronous machine, in other words the generator, is directly incorporated inside the wind turbine itself. Therefore, we greatly save energy by eliminating a gear train that would be placed between a generator placed at the bottom of the wind turbine and the propeller at the top Thus, wind turbines are increasingly produced in the following way with a direct drive therefore, the generator is directly connected to the propeller.

Notes

Summary

6m 58s

CENTRALE NUCLÉAIRE

Centrales nucléaires de Leibstadt, AG Source: RTS INFO

Central nucléaire de Mühleberg, BE Source: IFSN

Centrales nucléaires Suisse Source: lapresse.ca

Let's not forget nuclear power plants, even if two thirds of the energy in Switzerland is produced by hydroelectricity we still have nuclear power plant which also allow the production of electric energy using the same system. A nuclear power plant, using nuclear fission, heats water and it is then used just like a steam engine to rotate a generator of the same kind that you could find in a hydroelectric power plant. With, however, a major disadvantage compared to a hydroelectric power plant, the regulation of the energy. The regulation in a nuclear power plant can only be done very slowly. The fission reaction being implemented over several days and thus cannot be changed or modified significantly in a few minutes. In the case for hydroelectric installations it is possible to start, or stop them extremely fast since we have control over the water falling directly on the Pelton wheel and thus the alternator.

Notes

Summary

7m 59s

CONCLUSION

- Il existe plusieurs façons de générer un réseau électrique à partir d'un moteur synchrone :
  - Force hydraulique
  - Force éolienne
  - Machine à vapeur dont la chaleur est produite par combustion ou fission

Electrotechnique II

In conclusion we can see that there are several ways of generating electric energy in a grid by using a synchronous motor. The first way that we saw is the hydraulic force through a dam the accumulation of water, a turbine is then directly connected to the grid wind power which enables the conversion of energy from wind the wind's mechanical energy Steam engines whose heat can be produced either by coal plants or gas or nuclear plants and yet a number of other elements for which we do not want to go into details here.

Notes

Summary

9m 07s