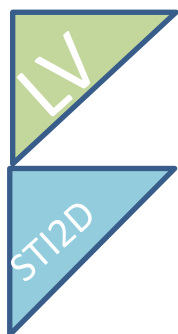


CO-ENSEIGNEMENT STI2D et LANGUE VIVANTE

Une étude de cas en Première STI2D :
PUMPED STORAGE HYDRO-ELECTRICITY



Christine Brélivet, professeur d'anglais

Pierre-Louis Corrieu, professeur de sciences et techniques

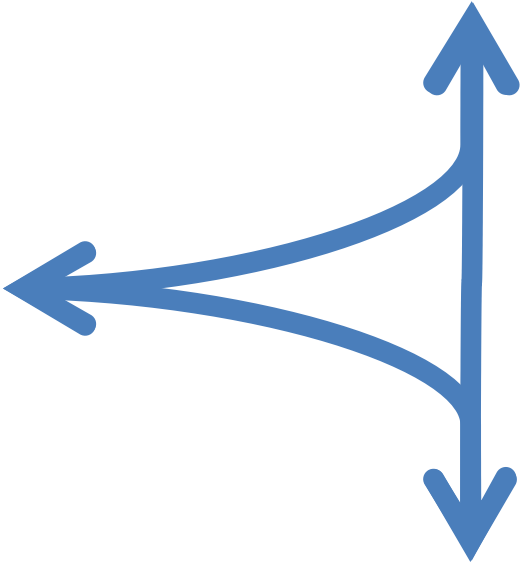
Lycée Pablo Neruda
DIEPPE



OBJECTIFS PEDAGOGIQUES TECHNOLOGIE

Société et développement durable

O1



Technologie
O4

Communication
O6

Cf référentiel STI2D

ENSEIGNEMENT CONJOINT

Notion culturelle : Idée de progrès

Pôle de connaissance : Energie et environnement

Croisement co-enseignement : Efficience énergétique

■ **Problématique technique**

Appropriation
Évaluation
Valorisation

Principe technologique

■ Progrès
Demande énergétique

Influence
réciproque

Modes de vie

« *TV pickup* »



OBJECTIFS PEDAGOGIQUES LANGUE VIVANTE

- PRE-REQUIS POUR L'ENSEIGNEMENT CONJOINT
- DIMENSION CULTURELLE
- COMPETENCES CECRL



COMPETENCES CECRL

En co-enseignement :

Activité 1

CE niveau B1 : **localiser des informations recherchées ou pertinentes pour s'informer et réaliser une tâche.**

EO niveau B1 : **restituer une information** avec ses propres mots éventuellement à partir de notes.

Activité 2

CE niveau B2 : **comprendre des instructions longues et complexes dans son domaine**

IO niveau B1 : **prendre part à une discussion** pour expliquer , commenter ,comparer et opposer .

Activité 3

CO niveau B2 : **comprendre l'essentiel d'un exposé complexe**

EO niveau B2 : **développer un exposé** de manière claire et méthodique en soulignant les éléments significatifs

Activité 4

IO niveau B2 : **développer idées et opinions** de manière précise à propos d'arguments concernant des sujets complexes ;argumenter et réagir aux arguments d'autrui.

EE niveau B2 : **écrire des lettres / écrire un rapport** qui développe une argumentation en apportant des justifications pour ou contre un point de vue particulier et en expliquant les avantages et inconvénients de différentes options.

En cours de langue : mêmes compétences que dans le cours conjoint

+ CO B2 « **comprendre un documentaire en langue standard** »,

+ CE B2 « **comprendre des articles ...sur des problèmes contemporains...** » et aux séances 5 et 6 :+

+EE B2 « **écrire des textes clairs et détaillés ...en faisant la synthèse et l'évaluation d'informations et d'arguments empruntés à des sources diverses** ».

STI2D

TECHNOLOGIE : « PRODUCTION HYDROELECTRIQUE »



En amont :

- Conversion d'énergie / réversibilité énergétique
- Machines tournantes
- Réseau électrique
- Barrage et turbinage

2.1.1 Organisation fonctionnelle d'une chaîne d'énergie			
Caractérisation des fonctions relatives à l'énergie : production, transport, stockage, transformation, modulation, variation	*	1 ^{re}	3

3.2.1 Transformateurs et Modulateurs d'énergie associés			
Adaptateurs d'énergie : réducteurs mécaniques, transformateurs électriques parfaits et échangeurs thermiques		1 ^{re} /T	2
Actionneurs et modulateurs : moteurs électriques et modulateurs, vérins pneumatiques et interfaces, vannes pilotées dans l'habitat pour des applications hydrauliques et thermiques		1 ^{re} /T	3
Accouplements permanents ou non, freins		1 ^{re} /T	2
Convertisseurs d'énergie : ventilateurs, pompes, compresseurs, moteur thermique		1 ^{re} /T	2
Éclairage		1 ^{re} /T	2
3.2.2 Stockage d'énergie			
Mécanique, hydraulique ou pneumatique : sous forme potentielle et/ou cinétique	*	1 ^{re} /T	2
Chimique : piles et accumulateurs, combustibles, carburants, comburants	*	1 ^{re} /T	2
Électrostatique : condensateur et super condensateur	*	1 ^{re} /T	2
Électromagnétique	*	1 ^{re} /T	2
Thermique : chaleur latente et chaleur sensible	*	1 ^{re} /T	2

Activité de comparaison
Sélection des critères pertinents
Ordres de grandeurs

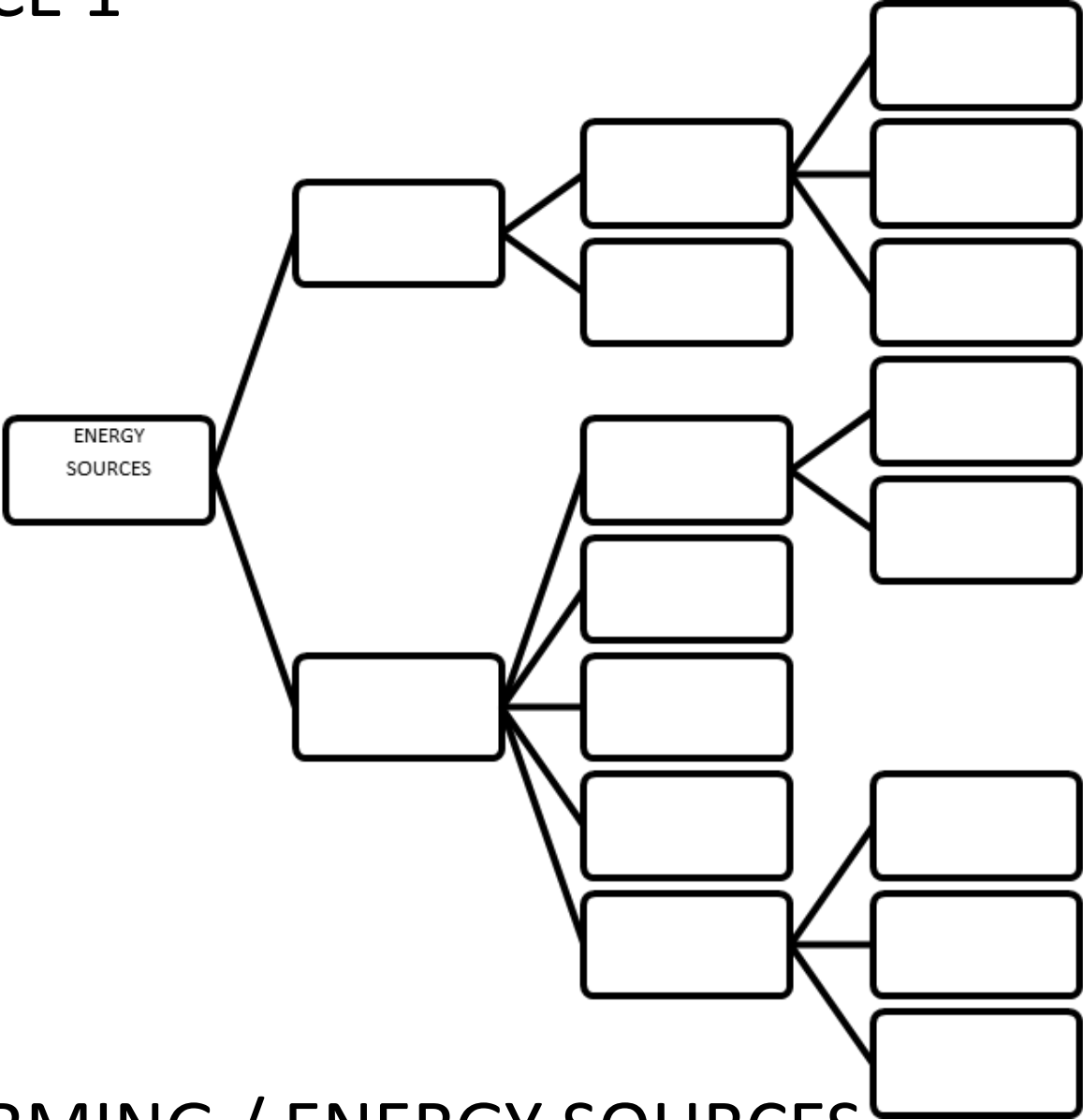
Lien avec le programme de physique

*Critères pertinents du stockage par énergie potentielle
Énergie ; puissance. / Conservation de l'énergie.*

STI2D
LV #1
LV #2
STI2D
LV #1
LV #3
LV #4
STI2D
LV #2
LV #5
LV #6

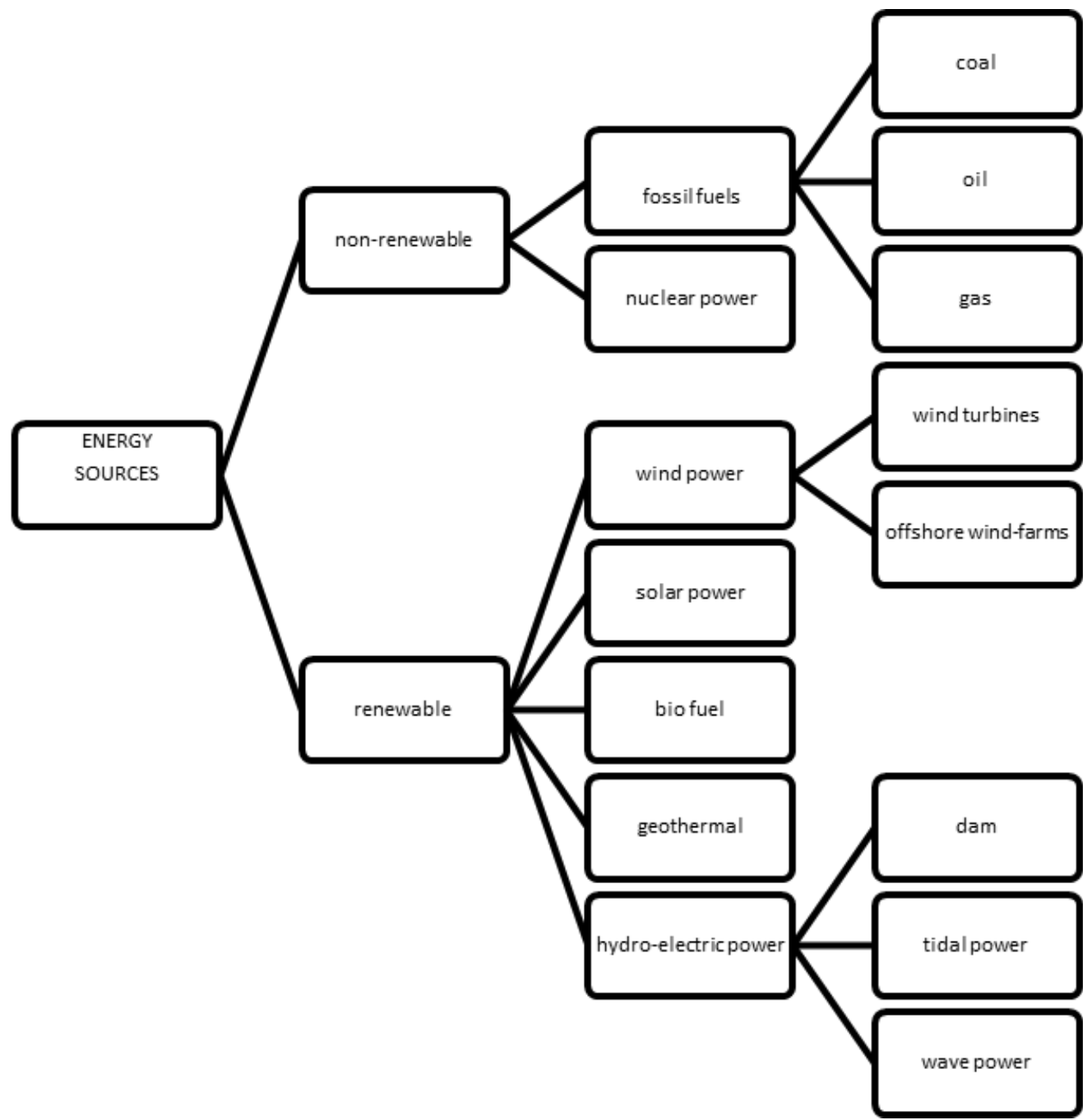
COURS ANGLAIS: 'ENERGY AND OUR LIVES'

SEANCE 1



STI2D
LV #1
LV #2
STI2D
LV # 1
LV #3
LV #4
STI2D
LV # 2
LV #5
LV #6

BRAINSTORMING / ENERGY SOURCES



STI2D
LV #1
LV #2
STI2D
LV #1
LV #3
LV #4
STI2D
LV #2
LV #5
LV #6

Séance 1

PREPARATION D'EXPOSES sur centrales nucléaires, hydrauliques et éoliennes

- Photo
- Schéma
- Différentes parties
- Fonctionnement
- Avantages
- Inconvénients
- (recherche internet cadrée)(site pré-défini)

STI2D
LV #1
LV #2
STI2D
LV #1
LV #3
LV #4
STI2D
LV #2
LV #5
LV #6

SEANCE 2



- EXPOSES
- Prise de notes et restitution par les autres groupes
- Comparaison entre modes de production d'énergie
- (Comparatifs , superlatifs)

STI2D
LV #1
LV #2
STI2D
LV # 1
LV #3
LV #4
STI2D
LV # 2
LV #5
LV #6

ENERGY SOURCES	ADJECTIVES
solar power hydro-electric power wind power fossil fuels nuclear power biomass geothermal power	safe renewable eco-friendly cost-effective polluting easy to exploit etc...

Séance 2

- VIDEO : Dinorwig
« How they do it »



- La centrale de Dinorwig



- Le phénomène du 'TV pickup'



STI2D
LV #1
LV #2
STI2D
LV #1
LV #3
LV #4
STI2D
LV #2
LV #5
LV #6

COURS CO-ENSEIGNEMENT

SEANCE 1



Activité 1: Appropriation du problème.

Structure : *groupes de 3 élèves, 1 ordinateur par groupe*

Professeur STI2D et professeur d'anglais : *en ressource mobile*

Task 1: How does a pumped storage power plant work ?

Task 2: What's the use of a pumped storage power plant ?

Etre capable d'exprimer l'utilité de l'installation . Vérification orale itinérante .

STI2D
LV #1
LV #2
STI2D
LV #1
LV #3
LV #4
STI2D
LV #2
LV #5
LV #6

activités TPWorks



COURS CO-ENSEIGNEMENT

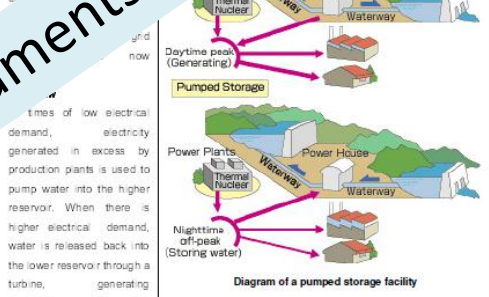
SEANCE 1

Documents ressources

Pumped-storage hydroelectricity

Pumped-storage hydroelectricity is a type of hydroelectric power plant for load balancing. The method stores energy by pumping water from a lower elevation reservoir to a higher elevation. When needed, the water is used to run the pumps. During periods of high demand, the water is released through turbines to produce electric power.

The system produces electricity during periods of low demand and stores energy for use during peak demand. The system is reversible, meaning it can pump water back into the upper reservoir when demand is low.

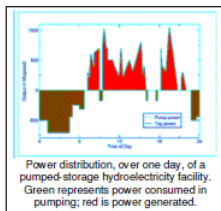


Reversible turbines/generator assemblies act as pump and turbine (usually a Francis turbine design). The system uses the height difference between two natural or artificial reservoirs.

Taking into account evaporation losses from the exposed water surface and conversion losses, approximately 70% to 85% of the electrical energy used to pump the water into the elevated reservoir can be regained. The technique is currently the most cost-effective means of storing

large amounts of electrical energy, but capital costs and the presence of appropriate geography are critical decision factors.

The relatively low energy density of pumped storage systems requires either a very large body of water or a large variation in height. For example, 1000 kilograms of water (1 cubic meter) at the top of a 100 meter tower has a potential energy of about 0.272 kWh. The only way to store a significant amount of energy is by having a large body of water located on a hill relatively near, but as high as possible above, a second body of water. In some places this occurs naturally, in others one or both bodies of water have been man-made.

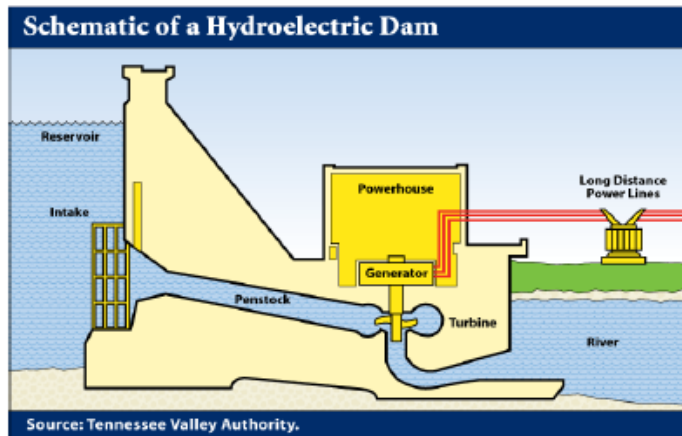
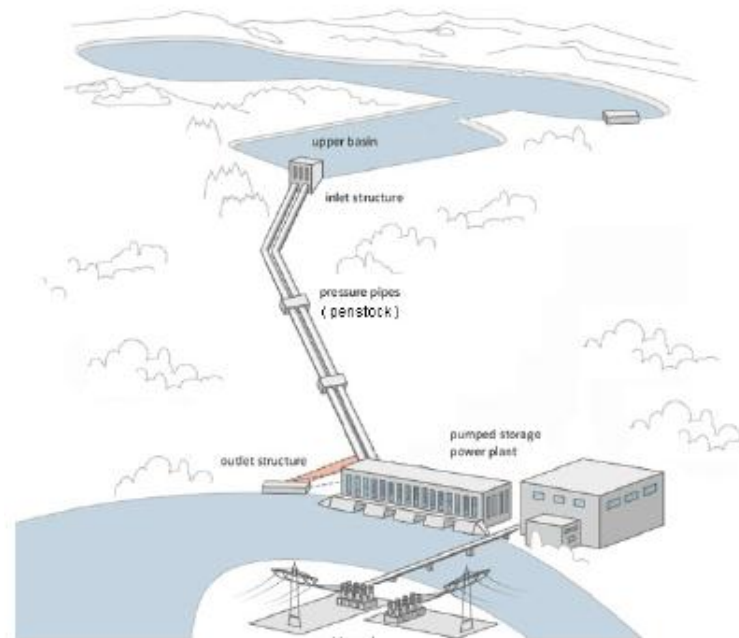


This system may be economical because it flattens out load variations on the power grid, permitting thermal power stations such as coal-fired plants and nuclear power plants and renewable energy power plants that provide base-load electricity to continue operating at best efficiency, while reducing the need for "peaking" power.

Along with energy management, pumped storage systems help control the electrical network and provide reserve generation. Thermal plants are much less able to respond to sudden changes in electrical demand, potentially causing frequency and voltage instability.

Another use for pumped storage is to level the fluctuating output of intermittent power sources such as wind or solar power plants. It is likely that pumped storage will become especially important as a balance for very large scale photovoltaic generation.

From Wikipedia, the free encyclopedia



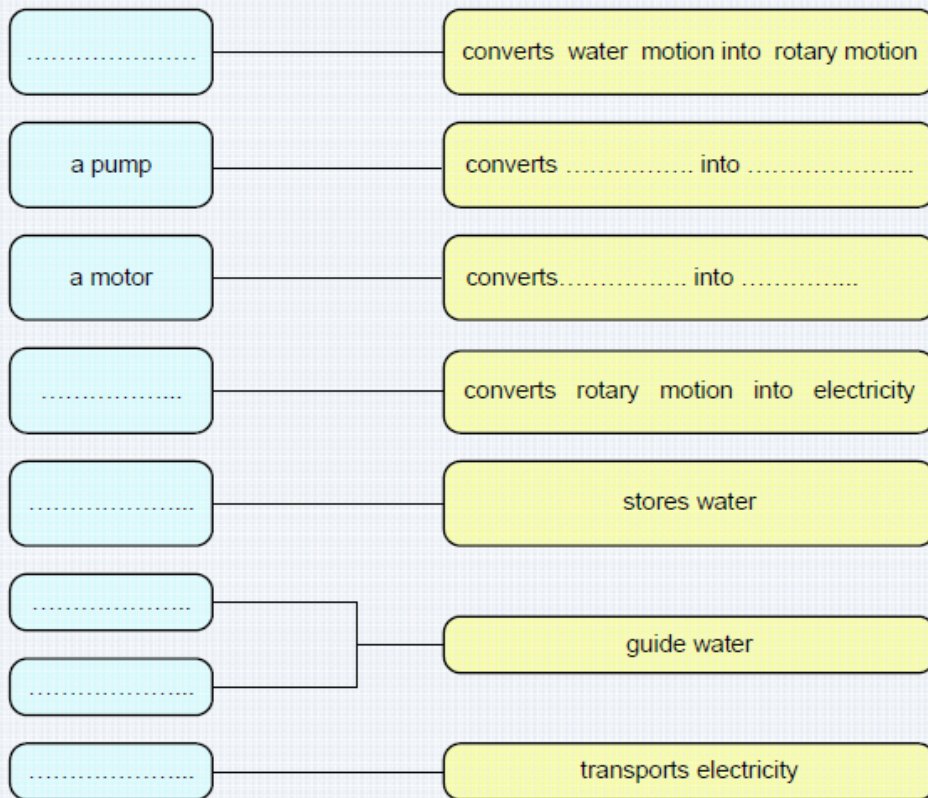
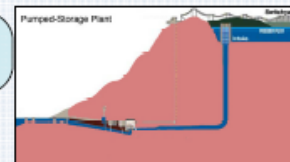
Source: Tennessee Valley Authority.

COURS CO-ENSEIGNEMENT

SEANCE 1

Document à compléter

Store and retrieve energy : pumped storage hydroelectric system



Choose terms from the list below :

a generator ; a penstock ; an electric line ; a turbine
a pump ; an alternator ; a motor ; a pipe ; a reservoir

Choose terms from the list below :

electricity ; rotary motion ; water motion

STI2D

LV #1

LV #2

STI2D

LV #1

LV #3

LV #4

STI2D

LV #2

LV #5

LV #6

COURS CO-ENSEIGNEMENT

SEANCE 1 (SUITE)



Activité 2 : Application à un cas particulier

Structure : 10 groupes de 3 élèves, organisés en 2 x 5 groupes

Professeurs : en ressource mobile

5 descriptifs d'installations



Extraire les informations pertinentes, compléter le tableau récapitulatif

Sélectionner deux paramètres significatifs (justifier)

Confrontation et harmonisation des critères et valeurs choisis

Créer un graphique sommatif (cobweb chart sur ordinateur) *

Préparer une présentation structurée de la centrale
(illustrations fournies : 1 carte , 1 photo pour chaque centrale)

STI2D
LV #1
LV #2
STI2D
LV #1
LV #3
LV #4
STI2D
LV #2
LV #5
LV #6



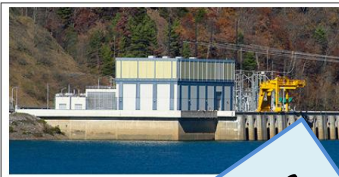
COURS CO-ENSEIGNEMENT SEANCE 1 (SUITE)

5 centres de pompage turbinage ↔ 5 x 2 groupes de 3 élèves

Bath County Pumped Storage Station

Cradled in Virginia's rugged Allegheny Mountains, the world's most powerful pumped storage generating station quietly balances the electricity needs of millions of homes and businesses across six states.

The Bath County Pumped Storage Station, which went into operation in 1985, is jointly owned by Dominion and the operating companies of the Allegheny Power System, Generation. This mammoth station was cited as one of the 1985 engineering achievements. The earth and concrete dam, 1,000 feet (305 m) high. Enormous concrete was poured to build 200 miles (322 km) of penstock.



Pumped storage hydroelectric power – Dinorwig Power Station, North Wales

Dinorwig Power Station, located adjacent to the Snowdonia National Park in Gwynedd, North Wales, is Europe's largest pumped storage hydroelectric power station. It is also one of the fastest, most dynamic power plants in the world, capable of delivering its full station output of 1800 MW in only 16 seconds. This rapid response is strategically important to the GB electricity system in helping National Grid maintain the balance of supply and demand on a second-by-second basis across the network. The system enables 9100 MWh of energy to be

electric demand is low, providing about 1000 MW of power during peak demand hours.



An overhead view of Dinorwig's lower reservoir, Llyn Peris.

Taum Sauk Hydroelectric Power S

The Taum Sauk pumped storage plant is located in the St. Francois mountain region of the Missouri Ozarks approximately 90 miles (140 km) south of St. Louis near Lesterville, Missouri in Reynolds County. The pumped-storage hydroelectric plant, operated by the AmerenUE electric company, was designed to help meet peak power demands during the day. In periods of high electric demand, electrical generators are turned by water flowing from a reservoir on top of Profit Mountain into a lower reservoir on the East Fork of the Black River. The generators and turbines at river level are reversible, and at night the excess electricity available on the power grid is used to pump water back to the mountaintop.



The two generators are each capable of producing up to 225 MW of power.

reversible pump-turbine units are each capable of generating 225 megawatts of power for

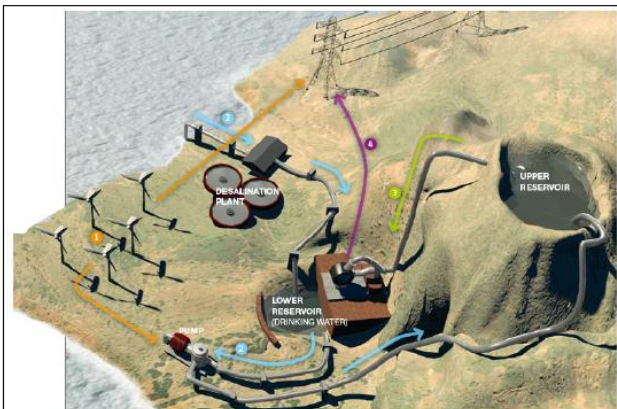
How El Hierro will achieve full energy self-sufficiency

① El Hierro's wind-powered, pumped hydro storage system will rely on five windmills to supply electricity to the island's 11,000 residents.

② At night, when winds are high and demand for electricity is low, water will be drawn from the sea through three desalination plants into a holding reservoir. The windmills then power a pump that drives the water uphill for over half a kilometer to a naturally formed volcanic crater two hundred times the capacity of an Olympic swimming pool.

③ If the windmills can't meet the energy demand during the day, the tap to the upper reservoir is opened. The water flows downhill through a turbine, releasing its energy – a total power capacity of 11.3 MW.

④ The water will generate enough electricity to keep the island running for around two days without wind. The two reservoirs also provide enough drinking water for the island's inhabitants to irrigate their crops and meet the demands of the growing number of tourists.



Water stored in the upper reservoir is used for hydroelectric generation during times of peak

Documents ressources

Tennessee Valley Authority

Visitor Center
Open daily except major holidays
9:00 a.m. to 5:00 p.m.

TVA is proud of Raccoon Mountain Pumped Storage Plant and the benefits it provides to local and regional residents. Enjoy your visit, and thank you for taking the time to learn more about TVA power plants. If you have additional questions, please see a Visitor Center staff member. Also visit www.tva.com for further information about the Tennessee Valley Authority, including annual and environmental reports, events, history, and facilities.

Raccoon Mountain

TVA

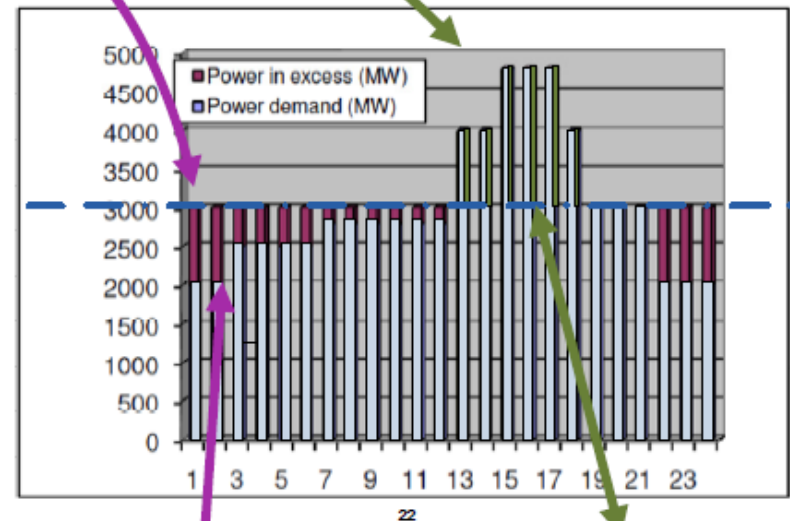
For alternate formats of this document, call 865-632-2824 and allow five working days for processing.
2016-05-01

Problématique projetée en plein écran

Is your Pumped Storage Power Plant able to cope with peaks and off-peaks in a city such as Los Angeles ?

hour of day	Total power demand (MW)	Available Power (MW)	"Peaking" power (MW)
1	2000	1000	0
2	2000	1000	0
3	2500	500	0
4	2500	500	0
5	2500	500	0
6	2500	500	0
7	2800	200	0
8	2800	200	0
9	2800	200	0
10	2800	200	0
11	2800	200	0
12	2800	200	0
13	4000	0	1000
14	4000	0	1000
15	4800	0	1800
16	4800	0	1800
17	4800	0	1800
18	4000	0	1000
19	3000	0	0
20	3000	0	0
21	3000	0	0
22	2000	1000	0
23	2000	1000	0
24	2000	1000	0

Totalized energy consumed in one day : 72,000 MWh

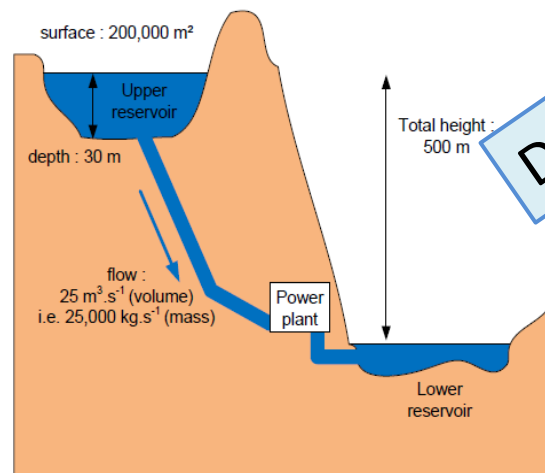


Totalized available energy (off peaks): 8350 MWh

Totalized « peaking » energy : 8350 MWh

Documents d'appui

Pumped storage : a numerical example

Total height :
500 m1. Stored volume : surface x depth = 200,000 x 30 = 6x10⁶ m³2. Mass : volume x density = 6x10⁶ x 1,000 = 6x10⁹ kilograms3. Stored energy : mass x gravity x height
6 x 10⁹ x 9.81 x 500 = 2.94 x 10¹³ Joules
2.94 x 10¹³ Joules = 8.2 GWh4. Maximum power : mass flow x gravity x height
25 x 10³ x 9.81 x 500 = 123 Megawatts5. Autonomy : stored energy / Power
8.2 x 10⁹ / 123 x 10⁶ = 6.7 hours

1 litre of water ≈ 1 kg

1 ton of water ≈ 1,000 kg

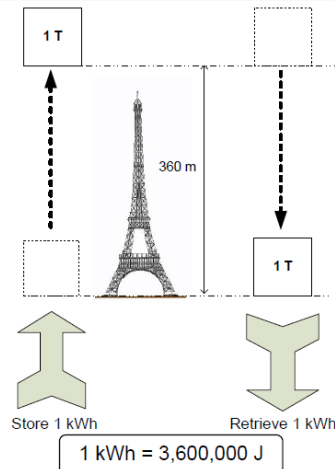
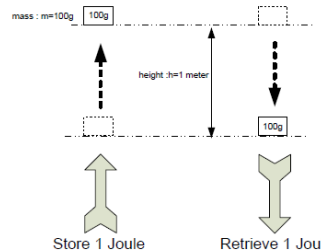
1 kWh = 3,600,000 Joules

Gravity : g = 9.81 units

Documents ressources

Lifting a mass can store energy

The energy used to lift a mass can be recovered later

Energy (in Joules) :
 $E = m \times g \times h$ m : mass in kg
g : gravity, 9.81m/s², rounded off to 10 m/s²
h : height in meters

+ TOOLBOX : « LA LANGUE DU DEBAT »



COURS CO-ENSEIGNEMENT SEANCE 1 (SUITE)

Document à compléter par chaque groupe

	Total generation power (MW)	Maximum flow (m ³ .s ⁻¹)	Height (m) (hydraulic head)	Energy capacity (GWh)	Number of turbines
Dinorwig G1					
Taum Sauk G2					
El Hierro G3					
Bath County G4					
Raccoon Mountain G 5					

STI2D
LV #1
LV #2
STI2D
LV #1
LV #3
LV #4
STI2D
LV #2
LV #5
LV #6

1 US gallon = 3.78541178 litre

1 foot = 0.3048 metre

1 acre = 4 046 m²

	Total generation power (MW)	Maximum flow (m ³ .s ⁻¹)	Height (m) (hydraulic head)	Storable energy (GWh)	Number of turbines
Dinorwig G1	1,800 MW		530 m	9,100 GWh	6
Taum Sauk G2	450 MW		240 m 800 feet	3,45 GWh	2
El Hierro G3	12,5 MW		700 m	1 GWh	
Bath County G4	3,000 MW	850 cubic m/sec	380 m	35 GWh	6
Raccoon Mountain G 5	1,600 MW		990 m	35 GWh	4

1 US gallon = 3.78541178 litre

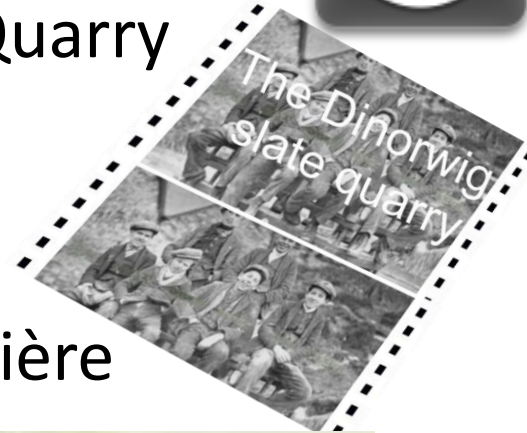
1 foot = 0.3048 metre

1 acre = 4 046 m²

SEANCE 3



- VIDEO TRAILER : The Dinorwig Slate Quarry



- Récapitulatif chronologique de la carrière



STI2D
LV #1
LV #2
STI2D
LV #1
LV #3
LV #4
STI2D
LV #2
LV #5
LV #6

- Opposition passé / présent (used to, didn't use to)
(comparaison des conditions de travail)



Vision diachronique du progrès

SEANCE 4



- Texte TV Pickup

TV pickup

From Wikipedia, the free encyclopedia

TV pickup is caused partly by the simultaneous mass use of [electric kettles](#)

Television pickup is a phenomenon affecting the [British National Grid](#) electricity transmission network. As the British public tend to watch the same [TV](#) programmes and take advantage of breaks in these programmes to operate electrical appliances (particularly kettles) they cause large, synchronised surges in electricity consumption. National Grid staff devote considerable resources to predicting and providing electricity supply for these events which typically impose an extra demand of around 200-400 [megawatts](#) (MW) on the Grid. Short term supply tends to be found from [pumped storage reservoirs](#), which can be quickly brought online, backed up by the slower fossil fuel and nuclear power stations. The largest ever pickup was on 4 July 1990 when a 2800MW demand was imposed by the ending of the [penalty shootout](#) in the [England v West Germany FIFA World Cup semi-final](#).^{[1][2]} In addition to pickups the Grid also prepares for synchronised switch-offs during remembrance and energy awareness events



Cause

TV pickups occur during [breaks](#) in popular television programmes and are a surge in demand caused by the boiling of [kettles](#) and the opening of fridge doors by millions of people.^[2] The phenomenon is particularly pronounced in the UK as the British people, more than any other, traditionally watch the same television programmes.^[1] The introduction of a wider range of TV channels is mitigating the effect but it remains a large concern for the National Grid operators.^[1] There are typically several large peaks in energy use caused by TV pickup during each day dependant on TV schedules, the day of the week and weather.^[1] The largest pickup of the day is usually at 21.00 when several popular TV programmes end or go to commercial breaks.^[1] The most popular programmes, hence those giving the greatest pickup are [soaps](#), sporting events, [reality tv](#) and [royal weddings](#).^{[1][3]} A typical TV pickup imposes an extra demand of 2-400 [megawatts](#) with larger soap storylines bringing around 7-800 MW.^[1]

- Habitudes des britanniques (are used to , usually)

STI2D
LV #1
LV #2
STI2D
LV #1
LV #3
LV #4
STI2D
LV #2
LV #5
LV #6

COURS CO-ENSEIGNEMENT

SEANCE 2



Activité 3 : Mise en commun

Résolution problématique

Structure : 2 demi-classes

Professeurs : *supervisent et régulent les échanges*

- **Présentation en groupe du travail réalisé à l'activité 2**

5 groupes de 3 ↔ 5 exposés de 5 mn + 3 mn de questions = 40mn

- **Résultat attendu** : dire si les contraintes sont satisfaites

« our plant is called ... » « is located ... »

« the production capability of our plant is ... »

- **Tâches des groupes auditeurs :**

Noter les informations transmises par les orateurs (objectif : valorisation différentielle)

COURS CO-ENSEIGNEMENT

SEANCE 2



Activité 4 : Valorisation

Structure : 2 *demi-classes*

Permutation activités après 40 mn

4.1 Production orale avec l'assistante

Structure : demi-classe soit 5 groupes = 15 élèves

Professeur d'anglais :

évalue la prise de parole par grille critériée

Task: « Vendre » votre centre de stockage à l'assistante ('investor') au cours d'une table ronde ; 15 élèves face à l'assistante

Utilisation de comparaisons numériques (STI)

Utilisation de comparaisons et superlatifs(LV)

COURS CO-ENSEIGNEMENT

SEANCE 2



Activité 4 : Valorisation

Structure : 2 demi-classes

Permutation activités après 40 mn

4.2 Production écrite par groupes de 3

Structure : demi-classe soit 5 groupes = 15 élèves

Professeur de STI2D : *aide à la rédaction*

Task : Communiquer par écrit avec un investisseur : rédiger un courrier électronique de valorisation et une fiche technique récapitulative (publicité comparative admise) .

+ Toolbox « emailing »

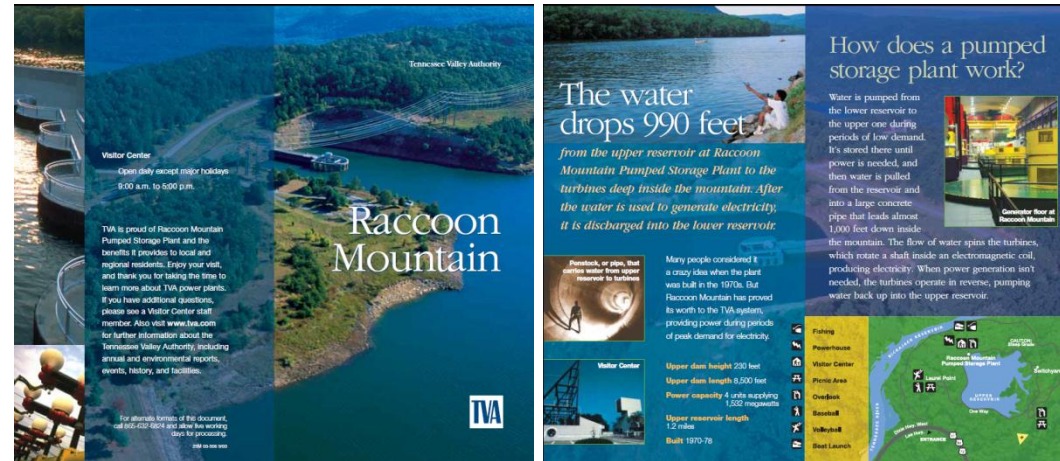
Le travail écrit est ramassé et évalué à la fin de la séance par les 2 professeurs.

SEANCE 5



• TÂCHE FINALE

TRAVAIL EN GROUPE AU CDI



CREATION D'UNE BROCHURE TOURISTIQUE SUR LA CENTRALE ET SON ENVIRONNEMENT CULTUREL

- Réinvestissement contextualisé des connaissances technologiques
- Elaboration d'un historique du lieu
- Ouverture sur l'aspect touristique et culturel
- Travail sur la forme spécifique de la brochure

STI2D
LV #1
LV #2
STI2D
LV # 1
LV #3
LV #4
STI2D
LV # 2
LV #5
LV #6

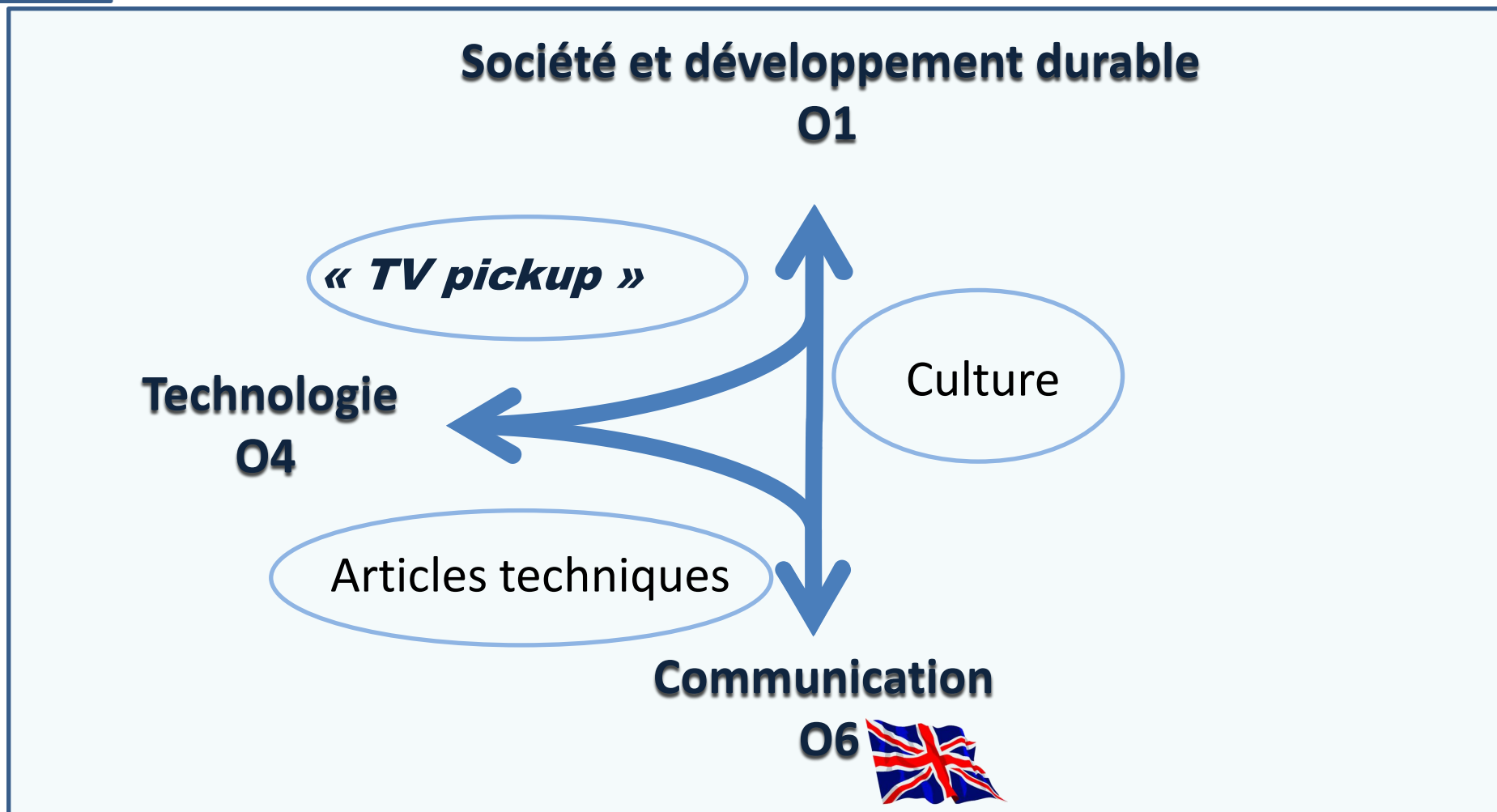
SEANCE 6

- Evaluation finale
- Ecrire un article de presse de type informatif sur leur centrale et son environnement touristique et culturel
- 200 mots
- Comparaison - habitude - passé/présent

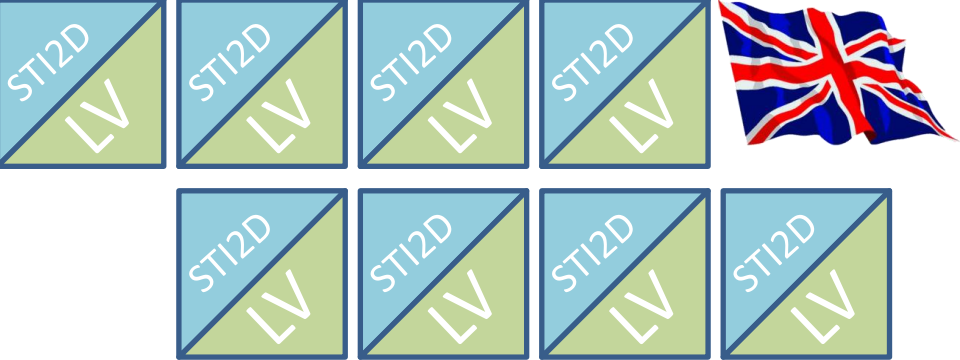
STI2D
LV #1
LV #2
STI2D
LV # 1
LV #3
LV #4
STI2D
LV # 2
LV #5
LV #6



CONCLUSION



Humaniser la relation à la technique par la dimension culturelle LV
Alternance des approches cognitives STI2D/ langue vivante



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