Sustainable Energy for Africa

2017, October 23 – 25, Brussels
International Conference organized by
the "Royal Academy for Overseas Sciences" of Belgium

Hydroelectric Energy

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(With CIGB-ICOLD

Michel de Vivo)

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RÉPUBLIQUE FRANÇAISE
Ministère de l'Écologie, du Développement durable, des Transports et du Logement

Hydro Generation

A clean renewable energy using the power of water to produce electricity.

Resource is the product of rainfall, catchments area, and vertical head

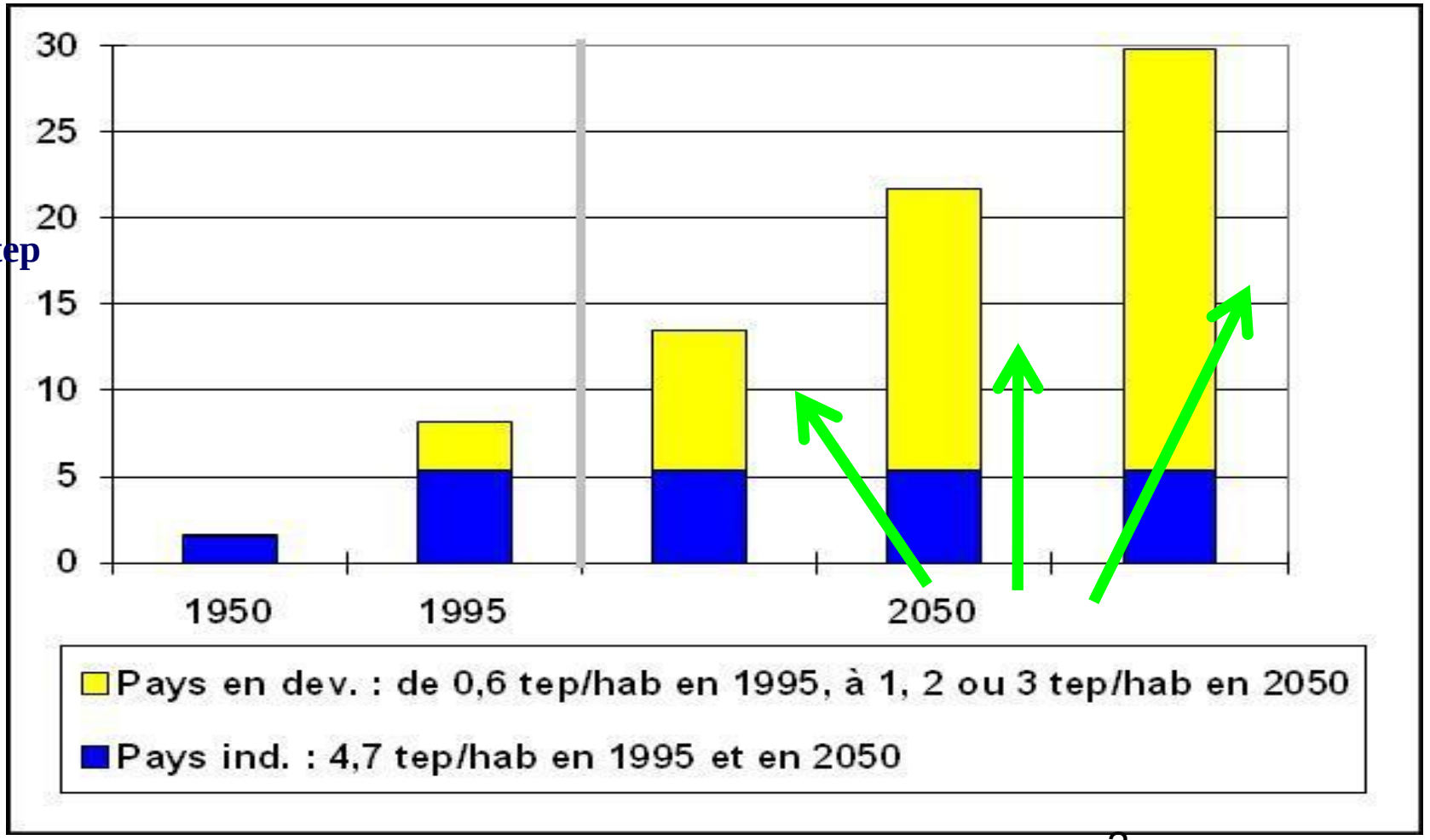
A power resource that has evolved with technology for centuries

Simple, well understood conversion of potential energy into mechanical and then electrical power

World Energy Consumption by 2050

(P. Boisson, ENERGIE 2010-2020, CGP 1998)

Developing Countries population from 4.6 billions in en 1995 to 8.1 in 2050
Industrialized Countries : from 1.15 to 1.14 Billion



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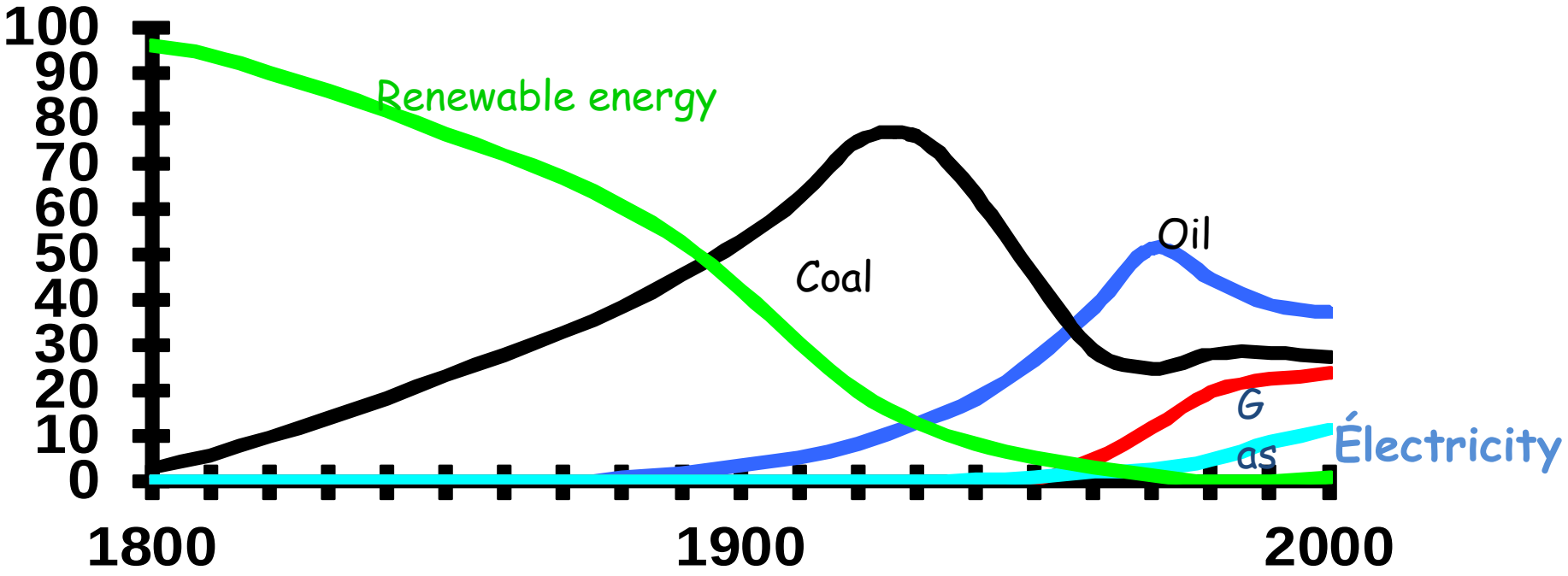
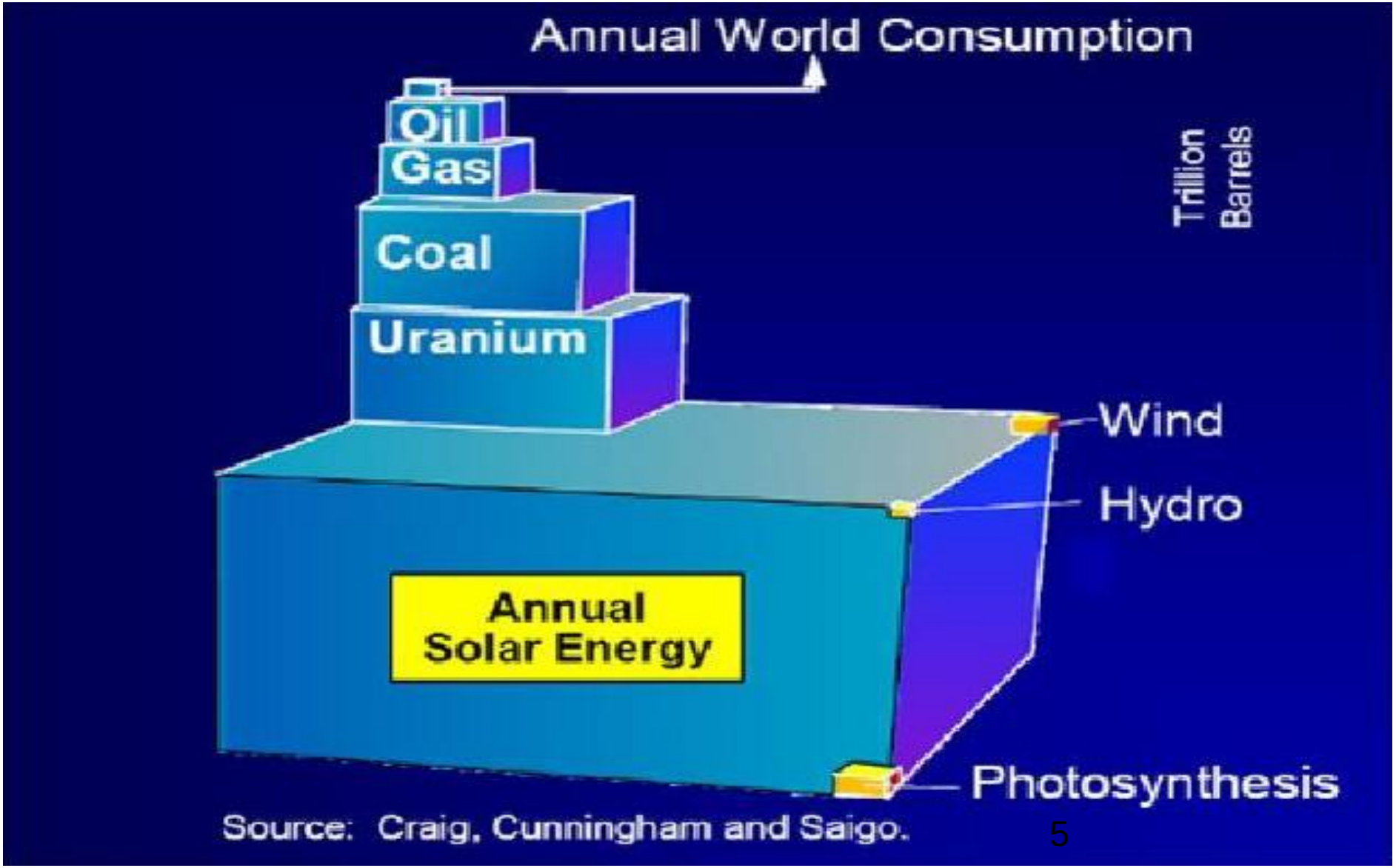
Renewable energy has dominated the history of humanity

Before 19th century : wood, water, wind, animal traction, slaves
19th century : coal, steam
20th century : oil, gas, hydropower, nuclear, renewables,



Can we go back to renewable energy?
And have power when you need it, and not when it is available

Annual Solar Energy
And Hydro comes from solar



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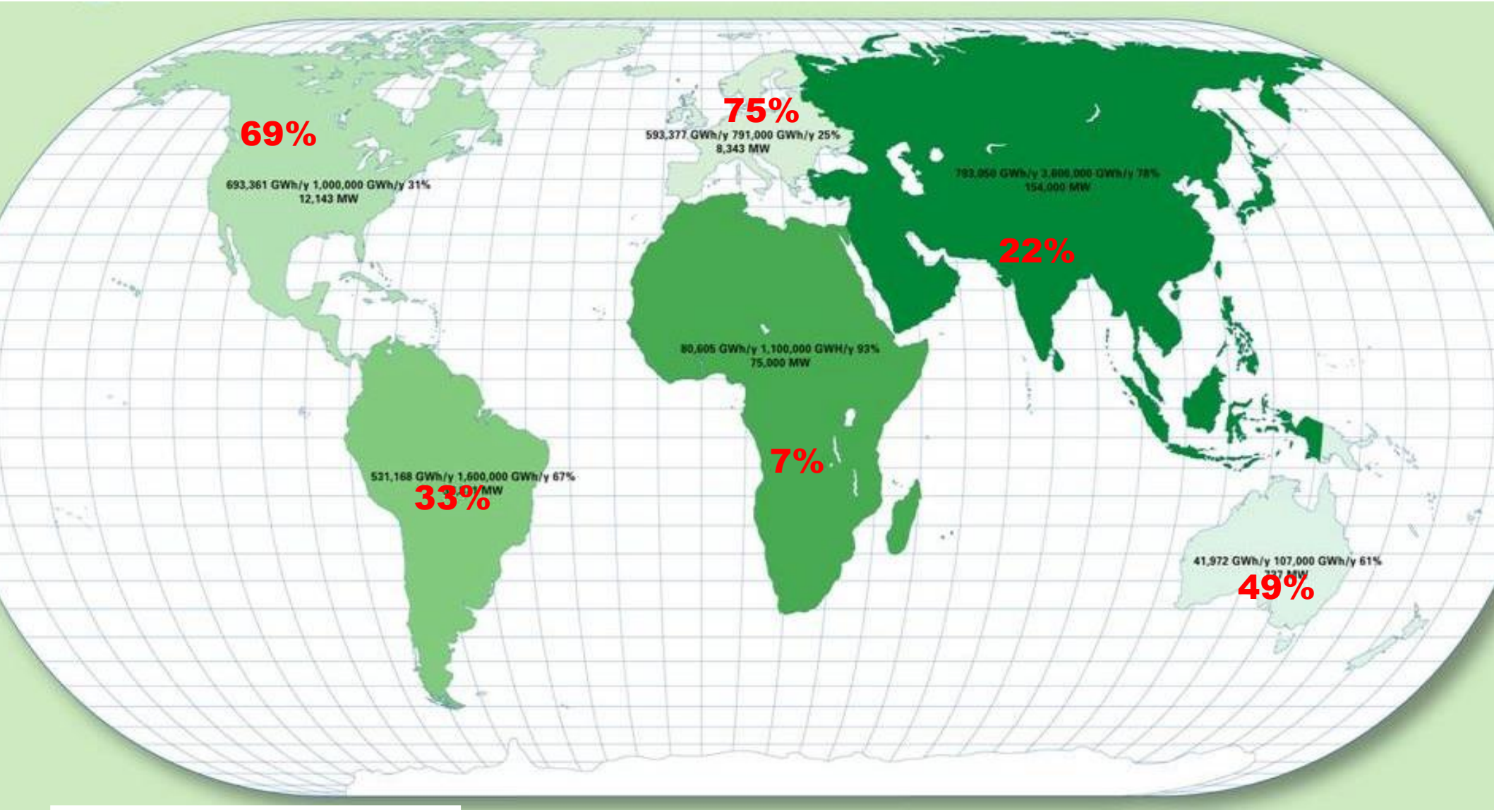
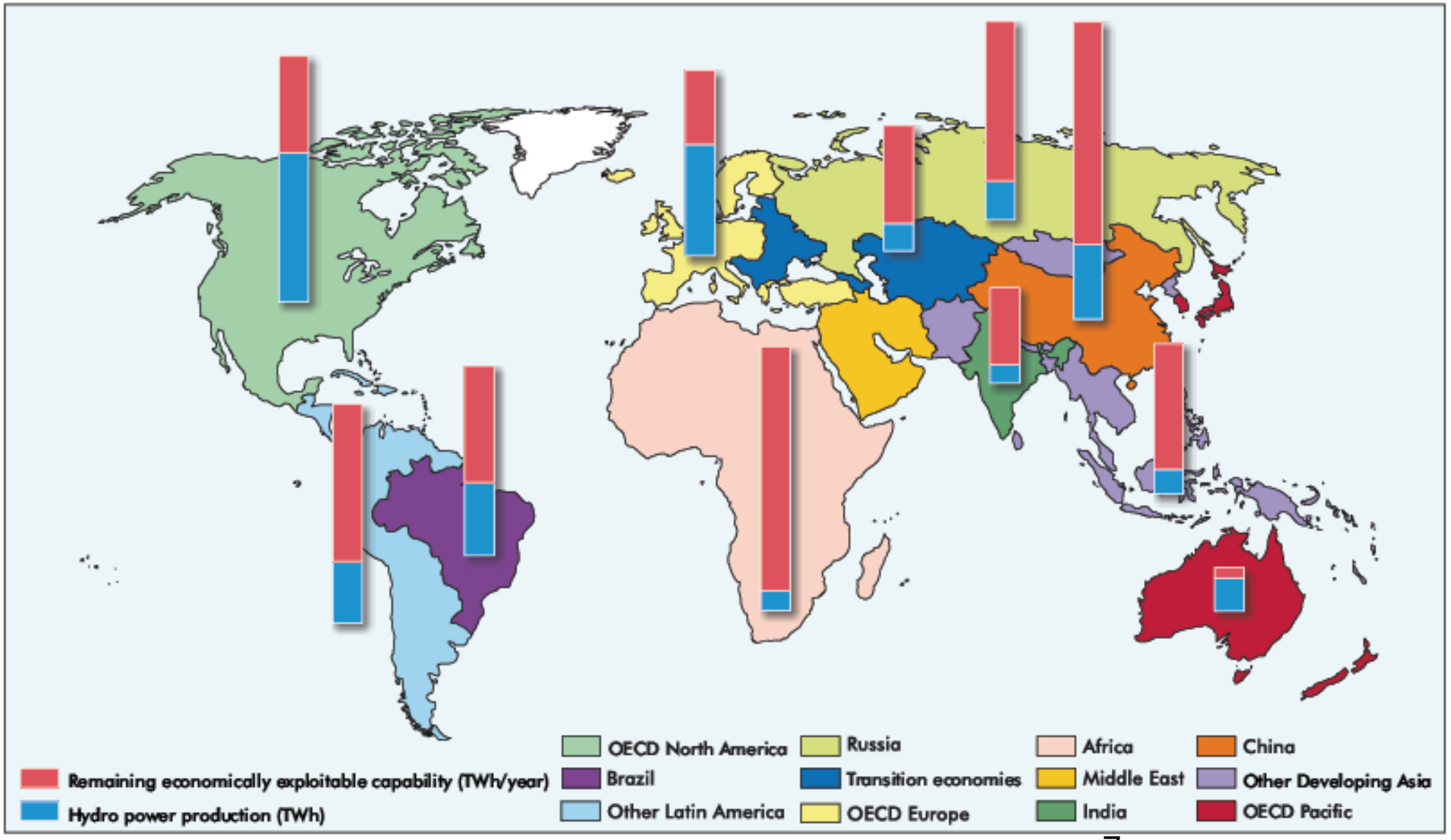
Hydroelectricity Worlwide

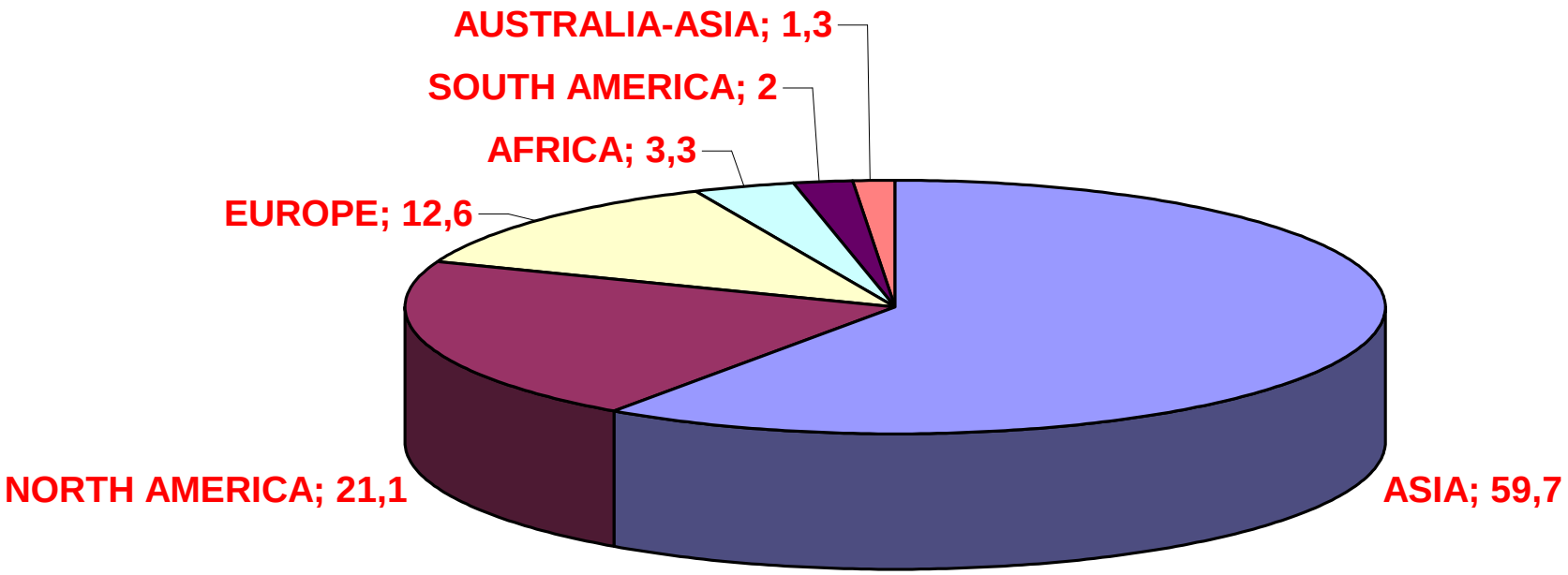


World Hydro Potential



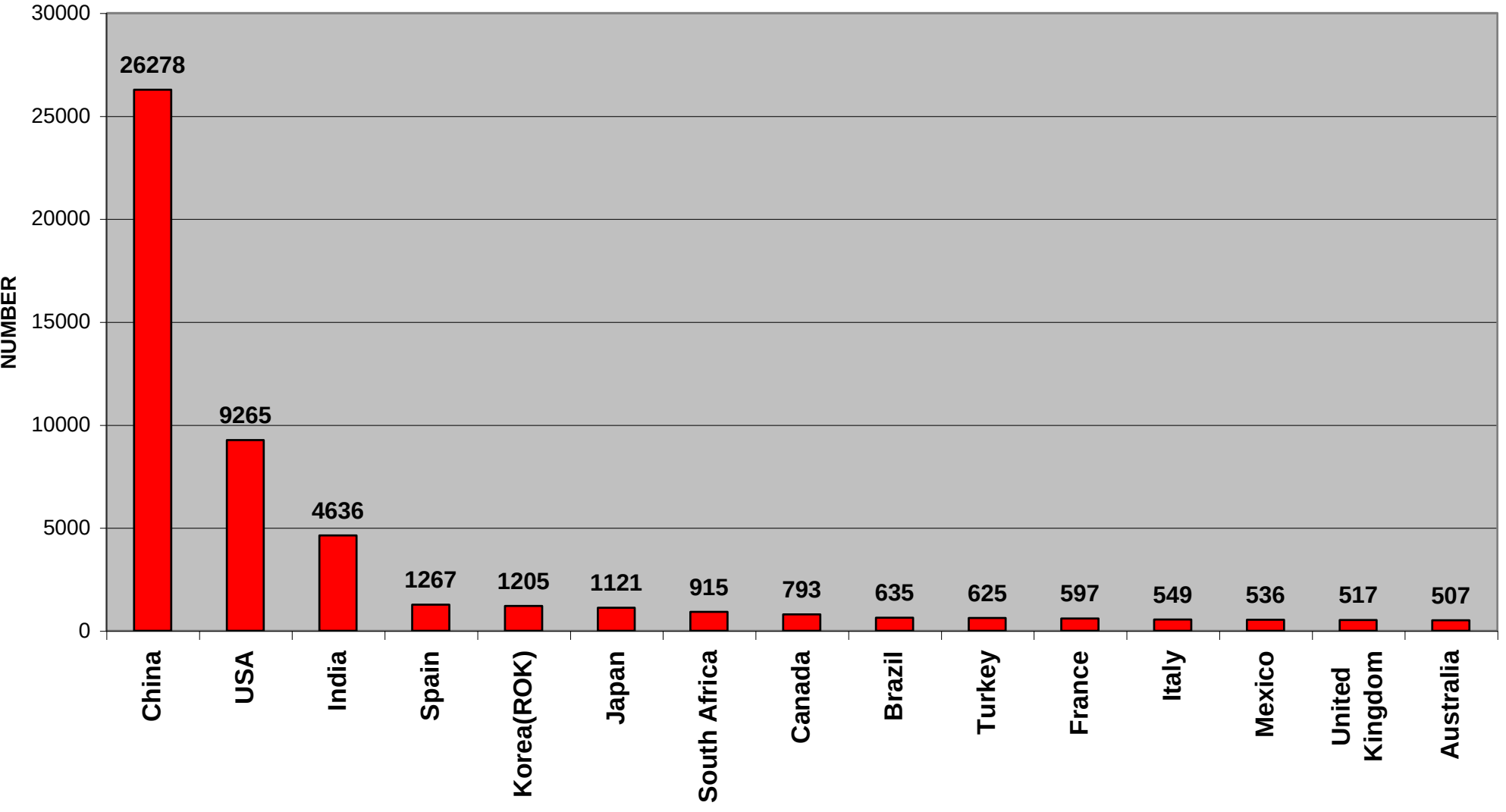
Dams in the World

LARGE DAMS %
GEOGRAPHICAL REGION



Dams in the World

LEADER´S COUNTRIES IN NUMBER OF LARGE DAMS



Dams in the World

- 60.000 Large Dams
- 1 Million Little Dams
- Total Capacity: 9.000 km3

Large dams Types of dams

Gravity dams,

Arch dams

Arc –gravity dam,

multiple-arch buttress dam.

Embankments dams,

Rock-fill dams

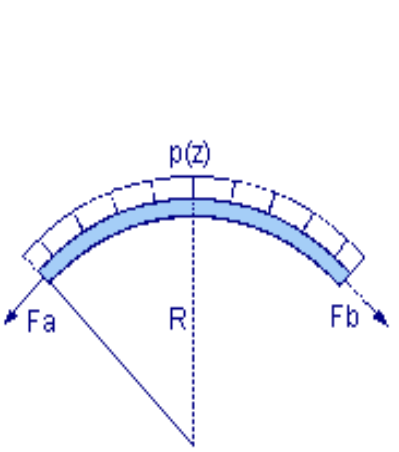
Eath Fill dams

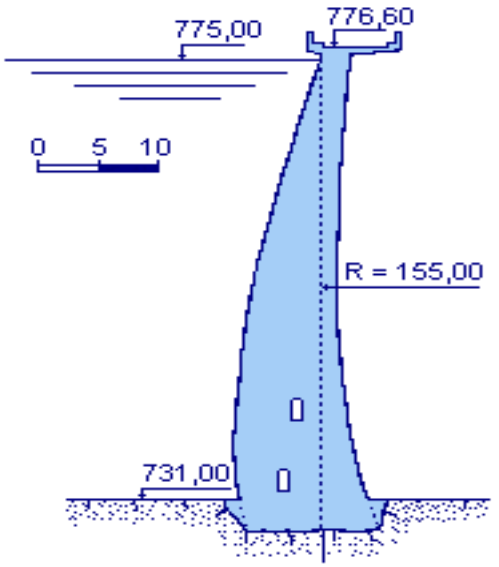
Concrete-face rock-fill dams

Arch dams

Barrage de Punt dal Gall (Suisse/Italie)

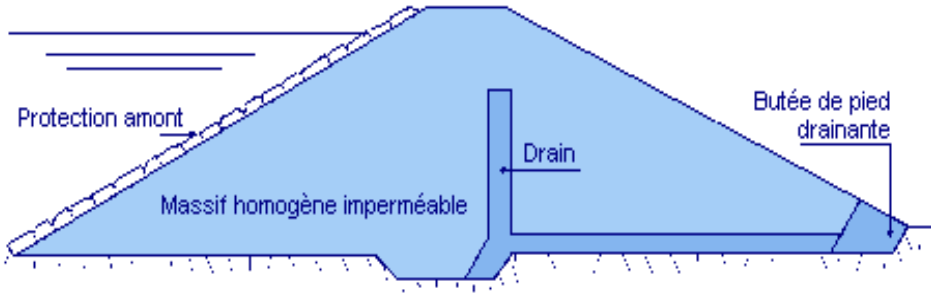
✓The arch dams are generally concrete dams whose curved shape allows a transfer of the thrust forces of the water on the rocky banks of the valley.





Homogeneous earth dams

Homogeneous earth dams are embankment dikes made up of a single loose material sufficiently impermeable to ensure both waterproofness and resistance



Dam of MATEMALE

Hydropower and dams

- *Three Gorges Dam in China*
- *Itaipu,*
- *Great Inga in DRC Congo*
- *The micropower plant of Toubkal Morroco*

Hydropower : Another great potential for competitive RE

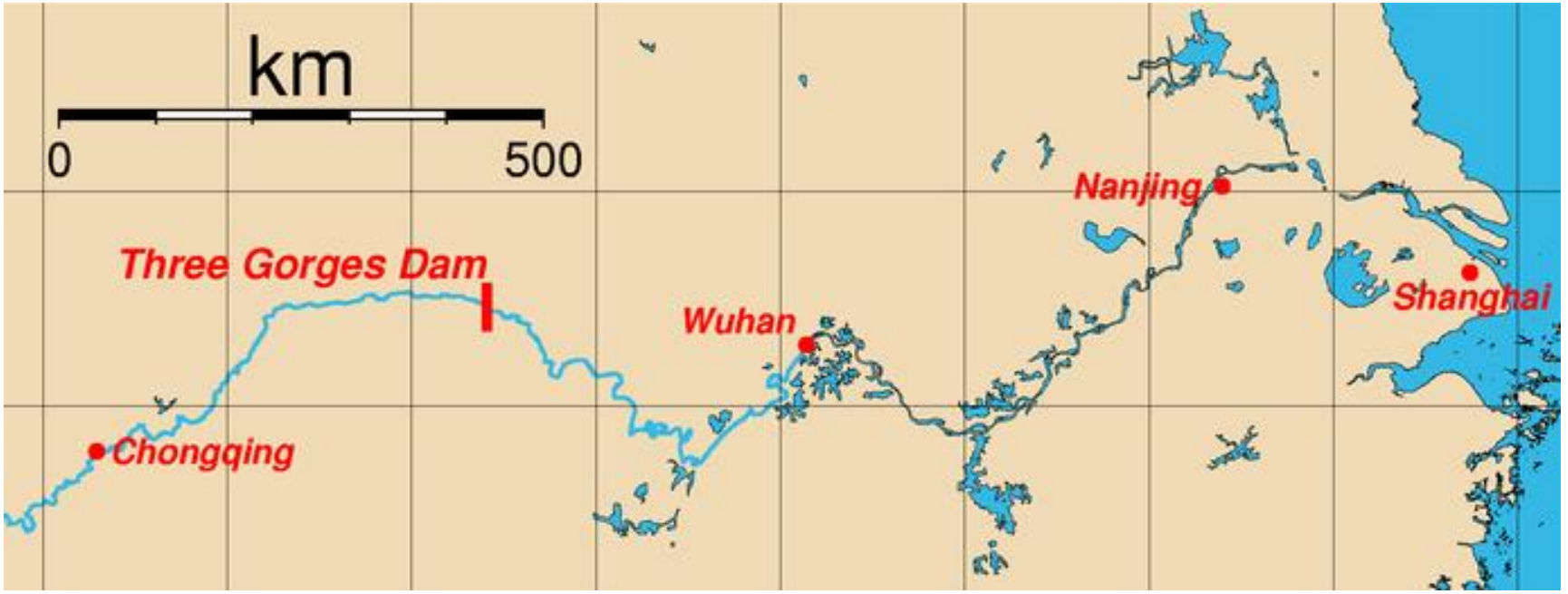
Advantages disadvantages,

Adaptation to each site and innovation

Very capital-intensive

Environmental and social acceptability

Three Gorges dam



China The new Xiluodu Dam,

The new Xiluodu Dam, a 278-meter-high arch dam, has been linked to a 13,860 MW hydroelectric power plant since 2014,

second largest hydro dam in China after the Three Gorges Dam 180,000 people were displaced

China has, by far, the largest hydroelectric potential in the world.

The Itaipu Dam

on the Parana River generates 14 GW and supplied 93% of the energy consumed by Paraguay and 20% of that consumed by Brazil as of 2005

Egypt Aswan
Temple of Abou Simbel

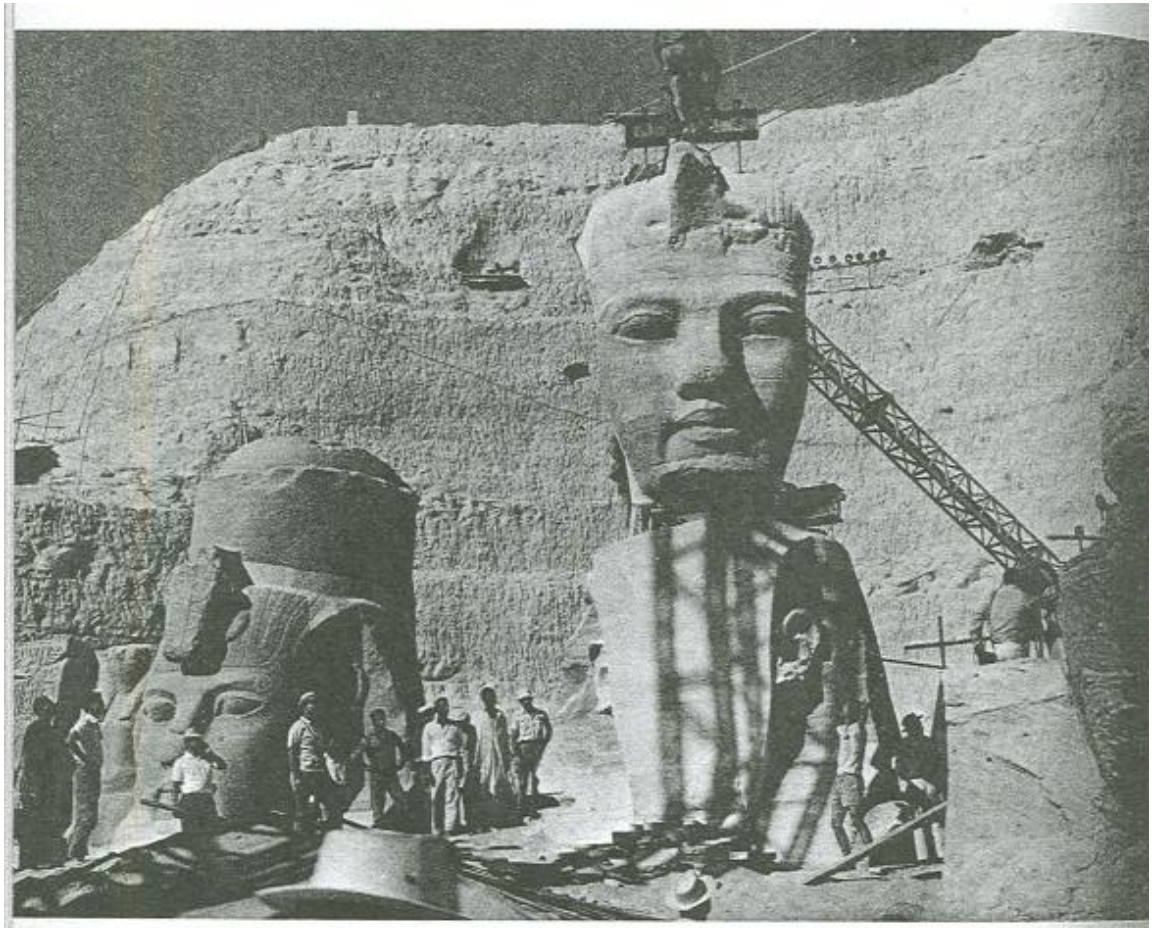


Planche VI.2 – Temple d'Abou Simbel (en cours de déplacement)

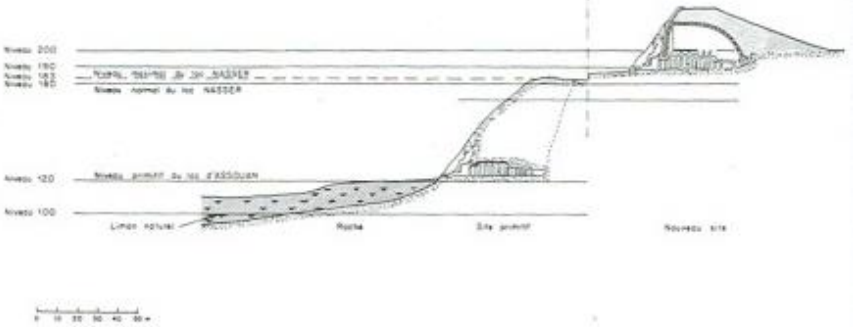
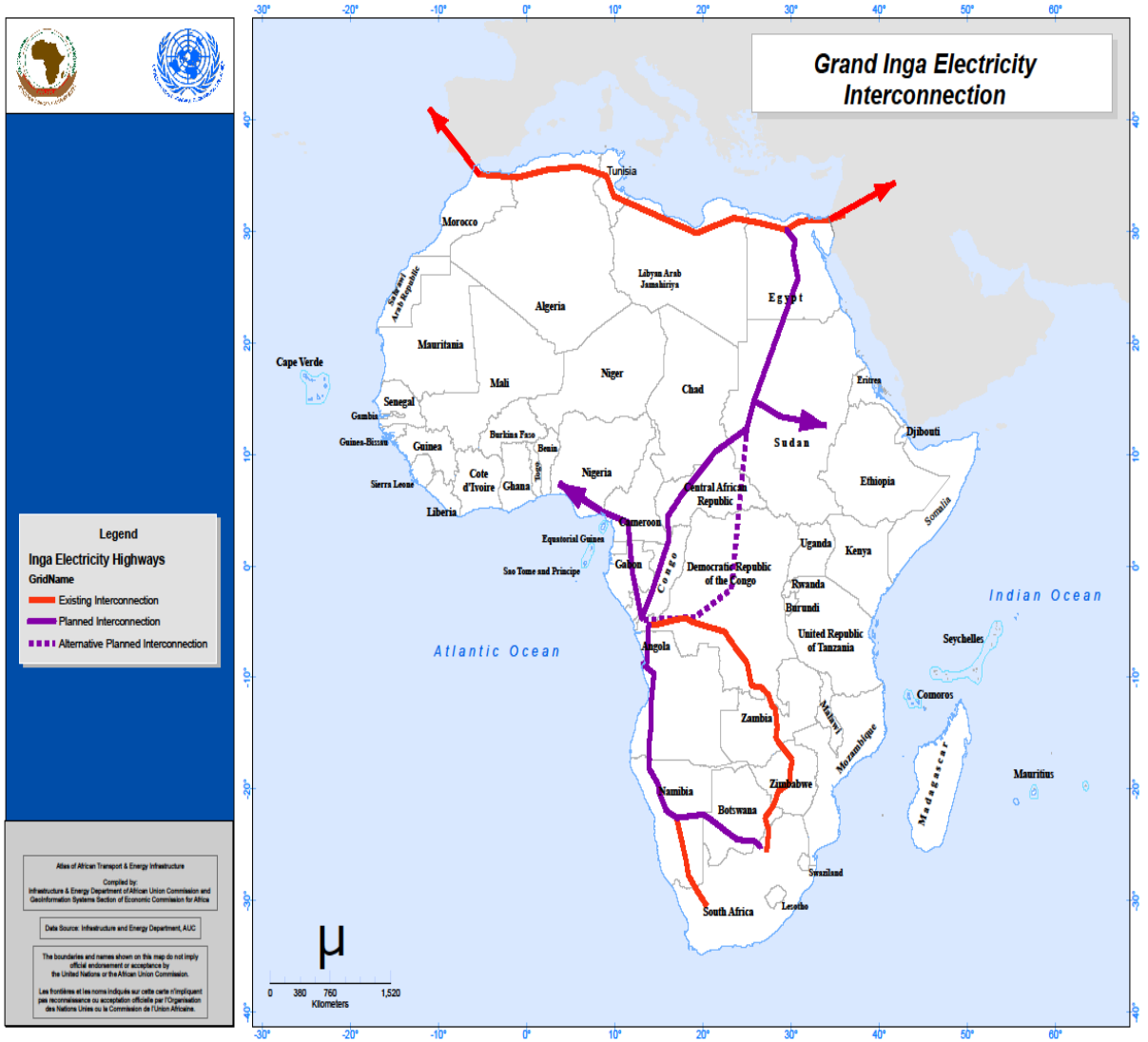


Fig. 6.05 – Déplacement des temples d'Abou Simbel : vue en coupe.

Inga (Congo River)

the biggest potential in the world

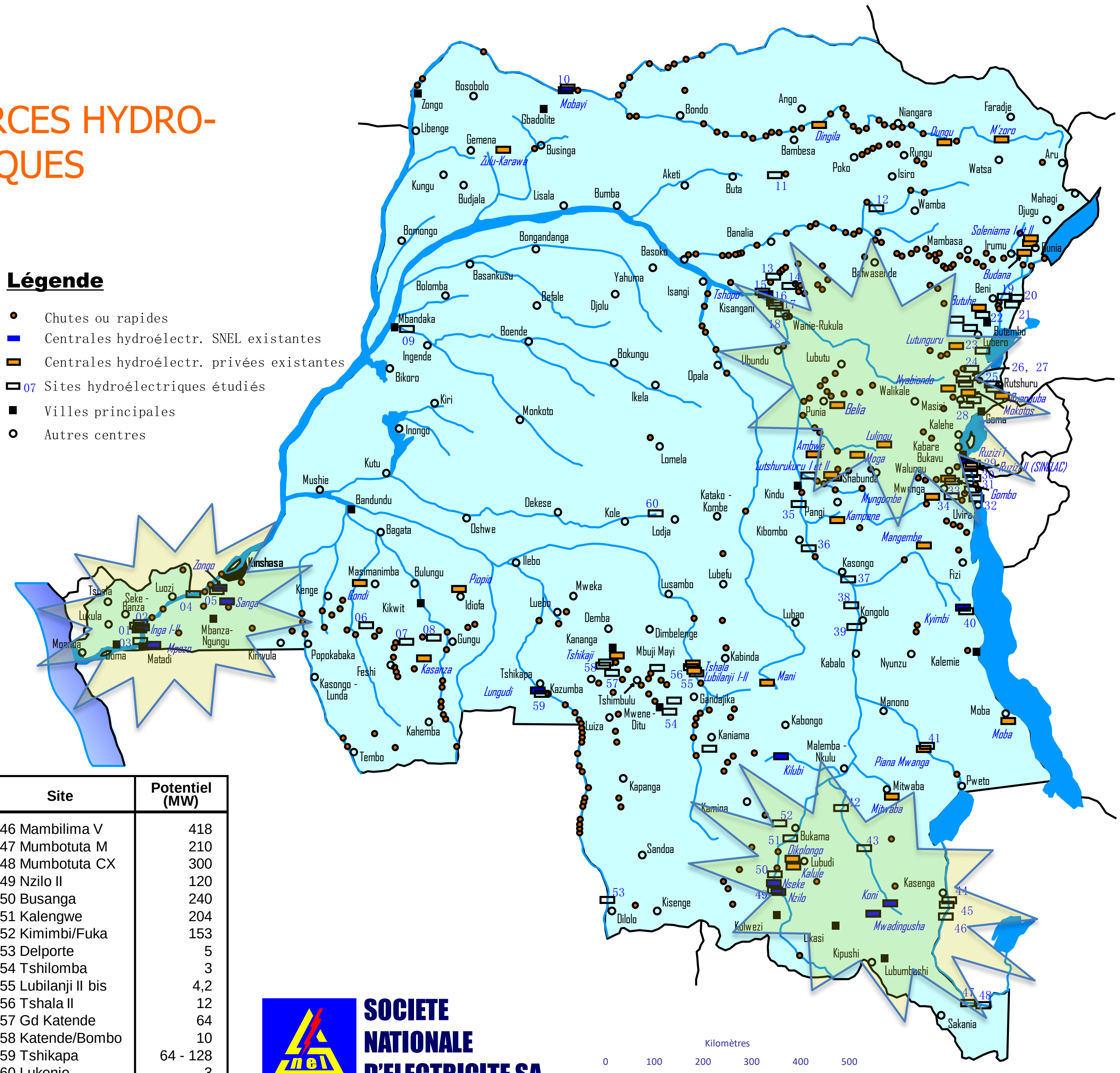


A summary of the potentials and difficulties of major African projects: INGA, 44000 MW, study of HV-DC transmission to Egypt and RSA, at a relatively low cost, competitive with nuclear and gas, even including long-distance transport.

Hydroelectric Resources of DRC

2. RESSOURCES HYDRO-ELECTRIQUES

Site	Potentiel (MW)
01 Grand Inga	43.800
02 Inga IX	1.500
03 Matadi	12.000
04 Pioka	22.000
05 Zongo II	150
06 Kitona	12
07 Bamba	12
08 Kakobola	10,5
09 Ruki	5,3
10 Mobayi II	17,5
11 Lepudungu	3
12 Nepoko	134
13 Bengamisa	15
14 Babeba	20 - 50
15 Tshopo II	17
16 Kisangani	460
17 Wagenia	20 - 50
18 Wanie Rukula	530 - 688
19 Semliki	28
20 Ruwenzori I	6
21 Ruwenzori II	6
22 Kisalala	7,5
23 Muhuma	25
24 Mugomba	40
25 Rutshuru	4
26 Ngingwe	3
27 Binza	5
28 Osso	3
29 Panzi	42
30 Sisi	205
31 Kamanyola	240 - 390
32 Kiliba	15
33 Ulindi	30
34 Mwenga	9,5
35 Kamimbi	14
36 Kibombo	13
37 Kitete	21
38 Mwanangoye	46
39 Portes d'Enfer	36
40 Kyimbi II	25,8
41 Piana Mwanga II	8,4
42 Sombwe	186
43 Kiubo	66
44 Mambilima I	124
45 Mambilima II	201



Site	Potentiel (MW)
46 Mambilima V	418
47 Mumbotuta M	210
48 Mumbotuta CX	300
49 Nzilo II	120
50 Busanga	240
51 Kalengwe	204
52 Kimimbi/Fuka	153
53 Delporte	5
54 Tshilomba	3
55 Lubilanji II bis	4,2
56 Tshala II	12
57 Gd Katende	64
58 Katende/Bombo	10
59 Tshikapa	64 - 128
60 Lukenie	3

SOCIETE NATIONALE D'ELECTRICITE SA

Grand Ethiopian Renaissance Dam

The **Grand Ethiopian Renaissance Dam** on the Blue Nile river in Ethiopia, currently under construction.

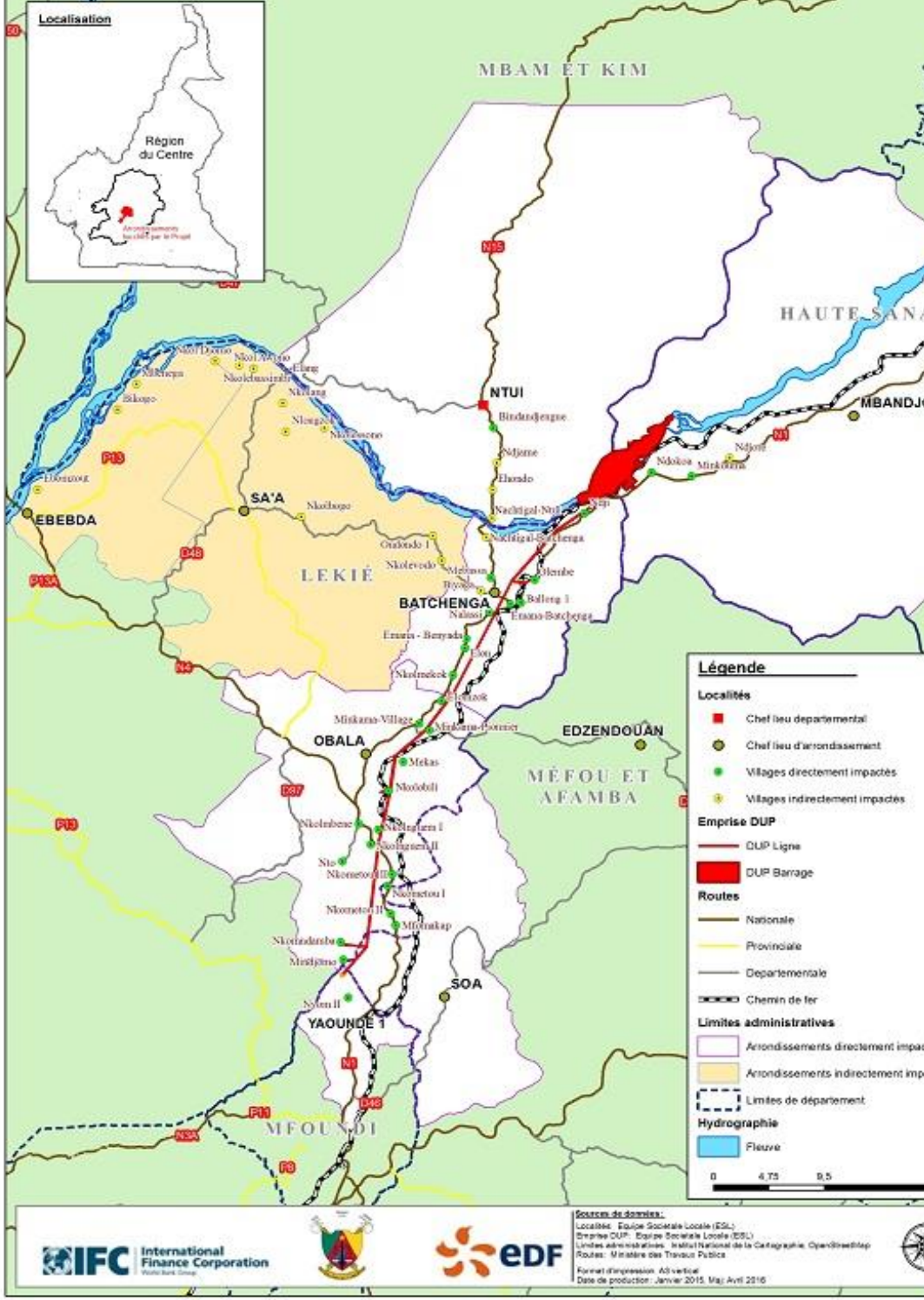
At 6,450 MW, the dam will be the largest hydroelectric power plant in Africa when completed, as well as the 7th largest in the world.

The gravity dam will be 175 m tall.

Cameroon Nachtigal Dam

420 MW, 1.1 Billion € of total project cost

On the Sanaga river



Nachtigal Hydro Power Company

Cameroonian limited company established in July 2016; 40% EDFI– 30% International Finance Corporation – 30% Cameroonian State) ; total cost of 1.1 billion euros; non-recourse project finance

420 MW, 1.1 Billion € of total project, O&M during 35 years, located 65 km north-east of Yaoundé, including 15 meter high roller-compacted concrete dams over a total length of 2,000 meters, a 3.3km long headrace channel, a power plant with seven generating units (420 MW), a 50km long 225kV transmission line;

Small Hydro
The Toubkal Micro hydro plant

Cameraman of Moroccan TV Dounya

Pelton Turbine 5 KW

The debate: the benefits and drawbacks of dams

Irrigation for food production, by irrigating land that would otherwise be desert.

Dams for a cheap and sustainable energy

Hydroelectric energy production generate electricity from a renewable source with very few CO2 emissions.

Unlike wind or solar energy, hydro energy can be stored (in reservoirs) in order to generate electricity when needed, simply by opening the gates. It is the most competitive form of power storage,

The difficult process of gaining acceptance for dams today

Dams also have downsides:

conflicts of use, risk of breach, Social aspects, the displacement of local populations, arousing opposition.

Impacts on environment biodiversity, Strong oppositions in democratic countries, Controversy, NGO opposing dams since the 1990 s, World Bank and World Commission on Dams, Complexity in the decision making process

A multidiciplinary approach is necessary

Acceptance must be found at every level, global and local

The local level is now more important than it used to be, with less central government control, and more local power devolved to “civil society”.

A Multicriteria environmental assessment is necessary. In addition to the three classic criteria of technical, economic and financial feasibility, dam projects must now meet a fourth, very demanding, criterion: that of their acceptance by the public and by elected representatives.

Dam promoters must act as mediators and educators in order to win acceptance. Special care must be taken with vulnerable ethnic groups.

Thank you for your attention

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