TRENDOVI U HIDROENERGETICI

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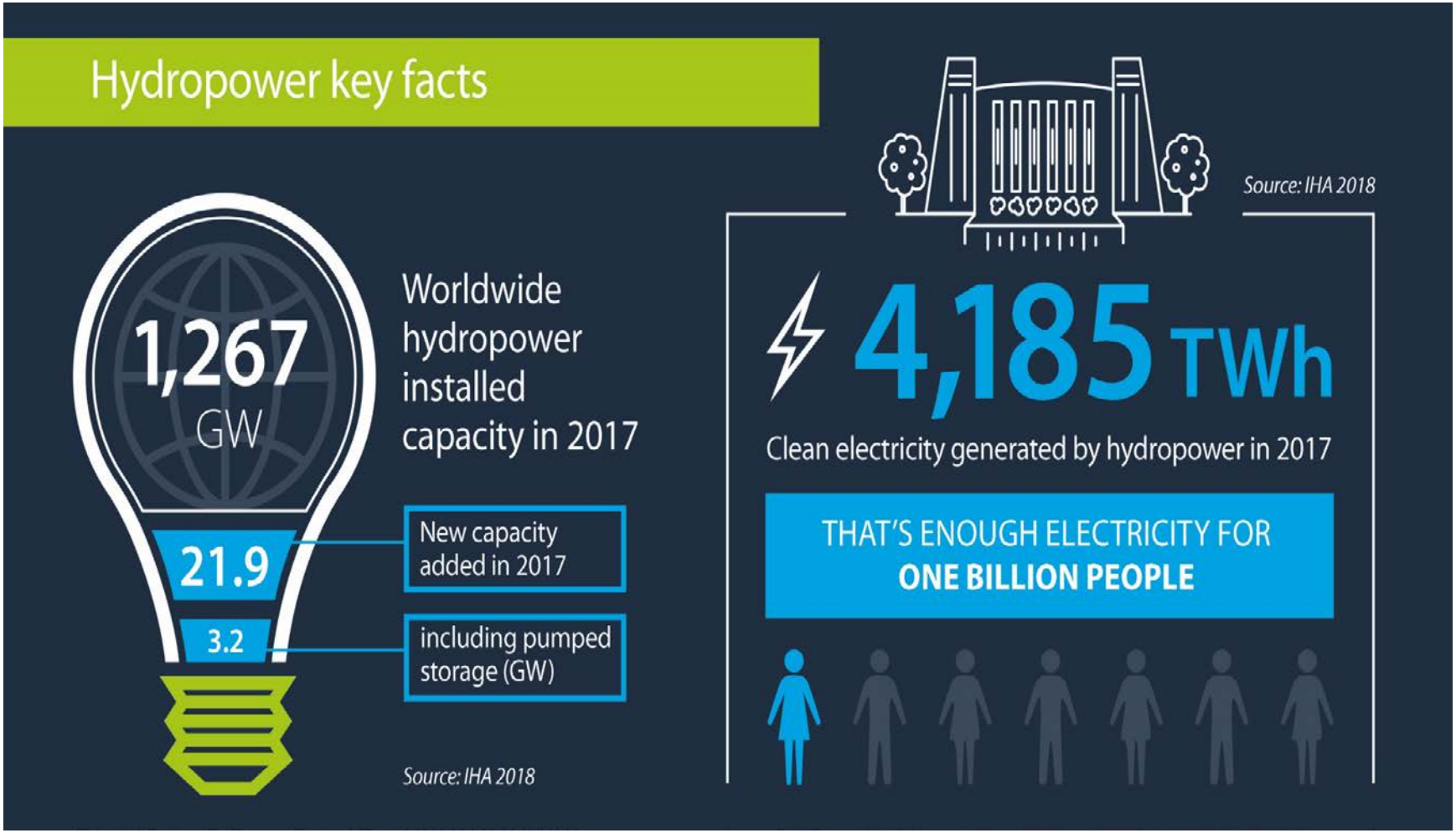
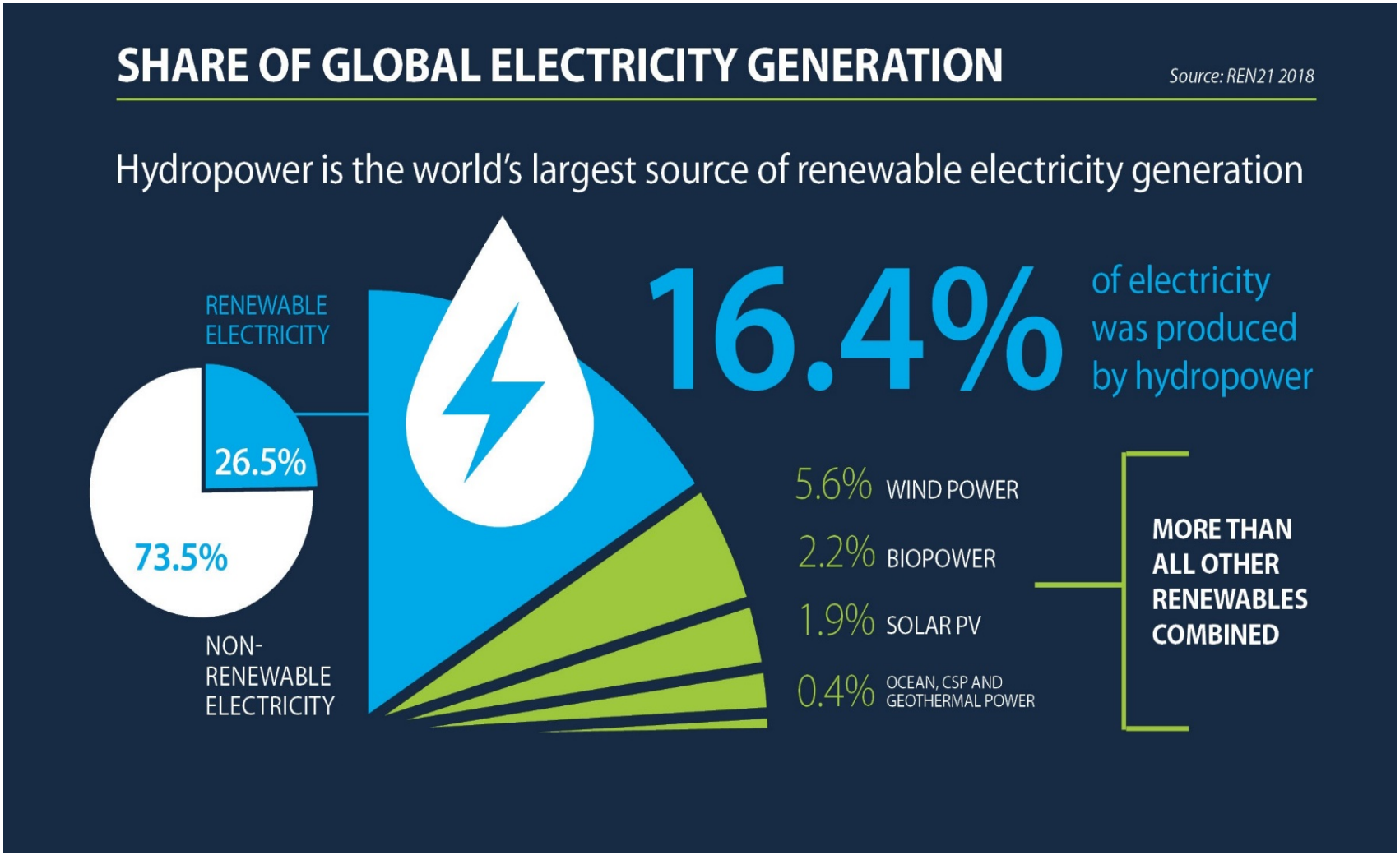


iha
international hydropower association



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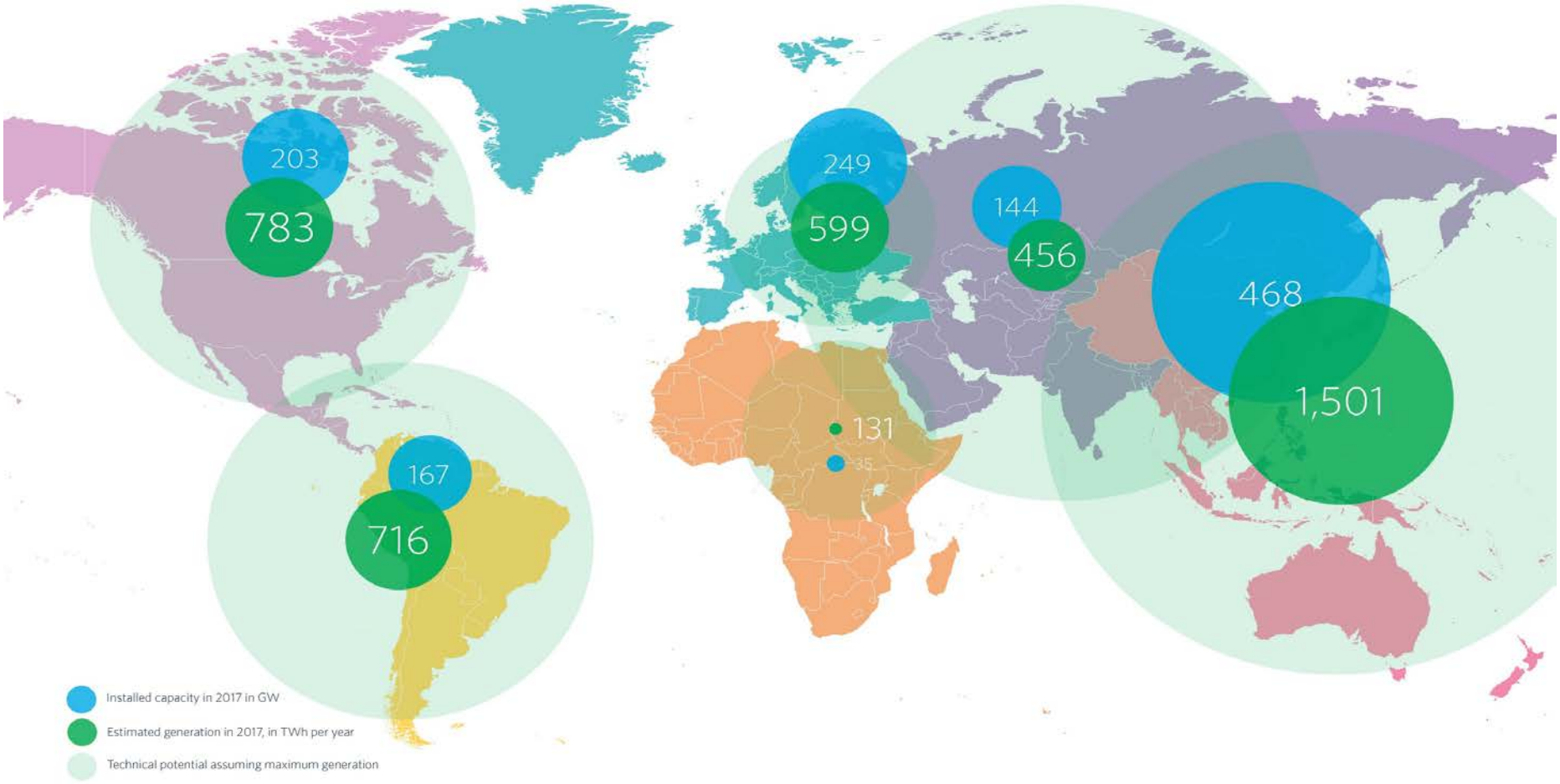
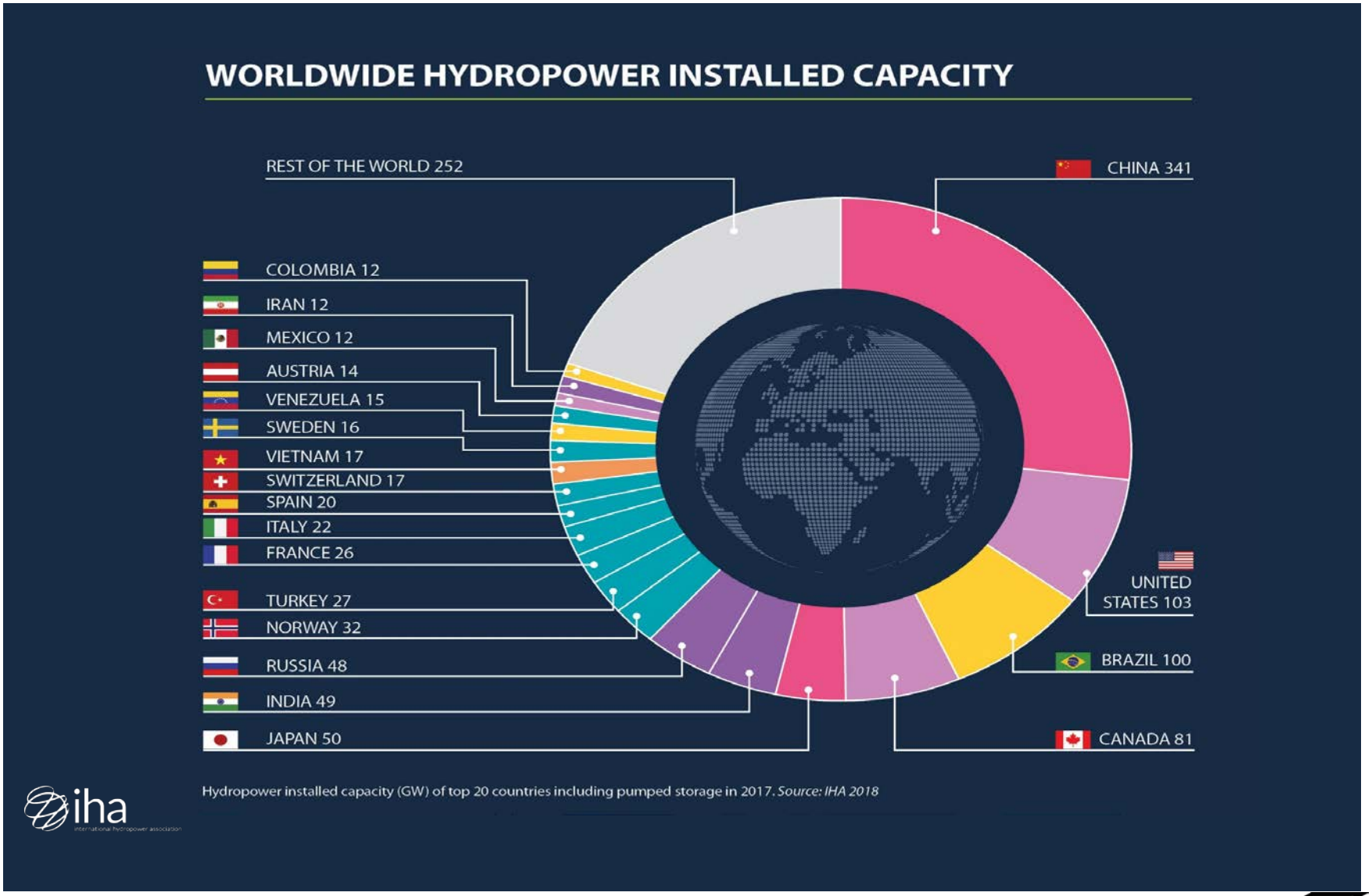
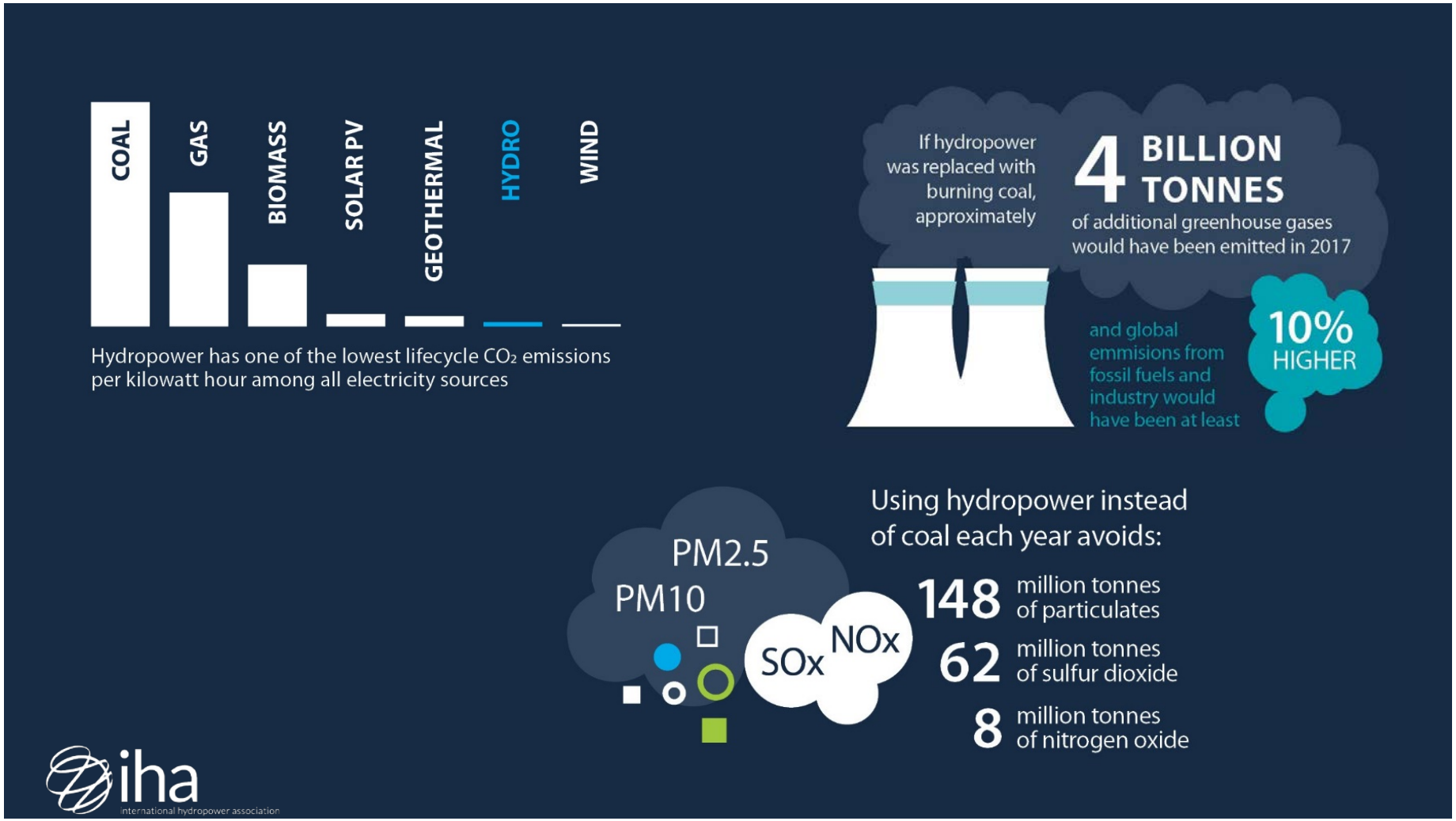


Hydropower's contribution: 1,267 GW worldwide including 153 GW of pumped hydro


WORLDWIDE HYDROPOWER INSTALLED CAPACITY
REST OF THE WORLD 252
CHINA 341
COLOMBIA 12
IRAN 12
MEXICO 12
AUSTRIA 14
VENEZUELA 15
SWEDEN 16
VIETNAM 17
SWITZERLAND 17
SPAIN 20
ITALY 22
FRANCE 26
TURKEY 27
NORWAY 32
RUSSIA 48
INDIA 49
JAPAN 50
UNITED STATES 103
BRAZIL 100
CANADA 81
Hydropower installed capacity (GW) of top 20 countries including pumped storage in 2017. Source: IHA 2018
iha
international hydropower association


COAL
GAS
BIOMASS
SOLAR PV
GEOTHERMAL
HYDRO
WIND
Hydropower has one of the lowest lifecycle CO_2 emissions per kilowatt hour among all electricity sources
If hydropower was replaced with burning coal, approximately
4 BILLION TONNES
of additional greenhouse gases would have been emitted in 2017
and global emmisions from fossil fuels and industry would have been at least
10% HIGHER
PM2.5
PM10
SOx
NOx
Using hydropower instead of coal each year avoids:
148 million tonnes of particulates
62 million tonnes of sulfur dioxide
8 million tonnes of nitrogen oxide
iha
international hydropower association

EPRI

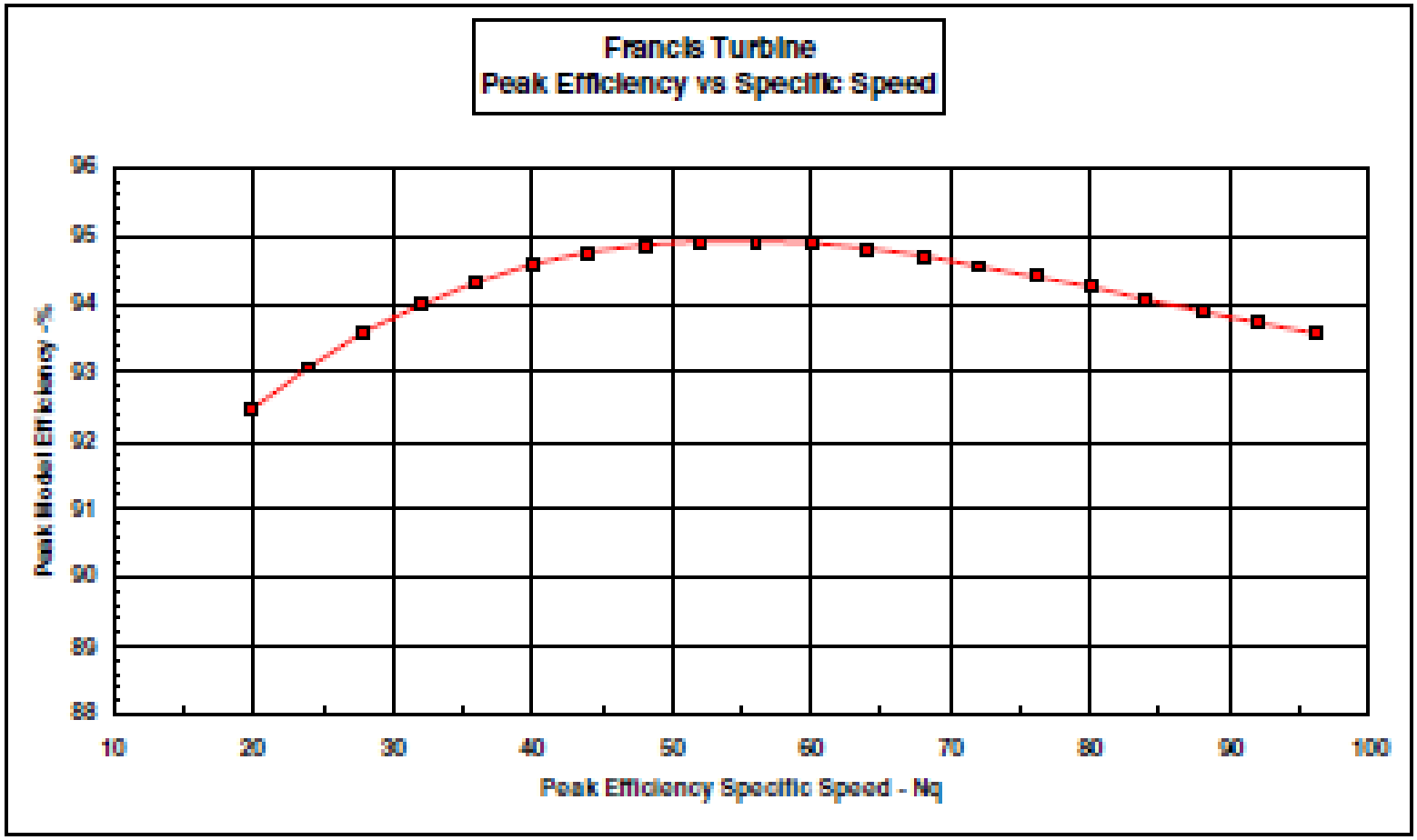


Figure 5-9
Francis Turbine
Peak Efficiency vs Specific Speed

EPRI

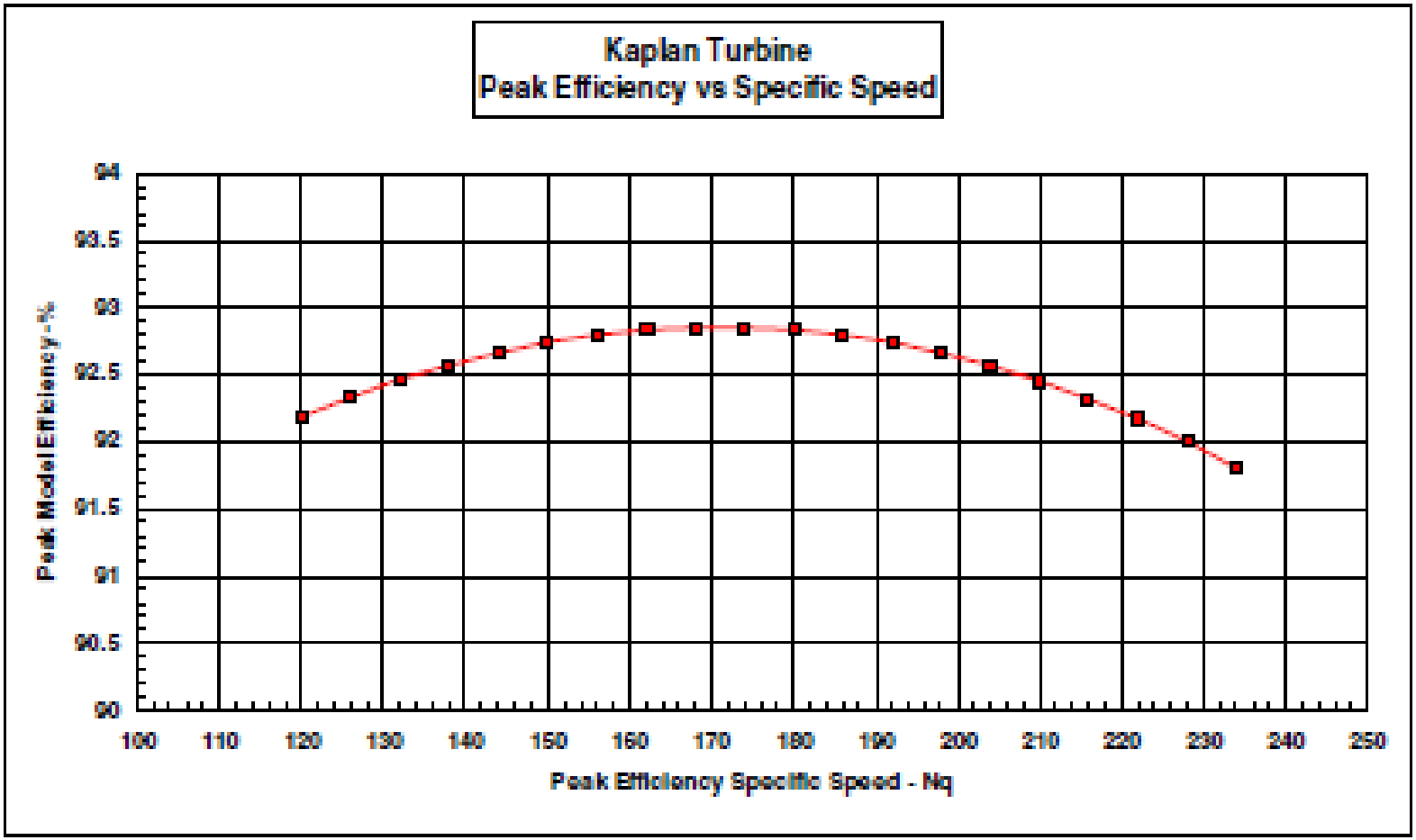
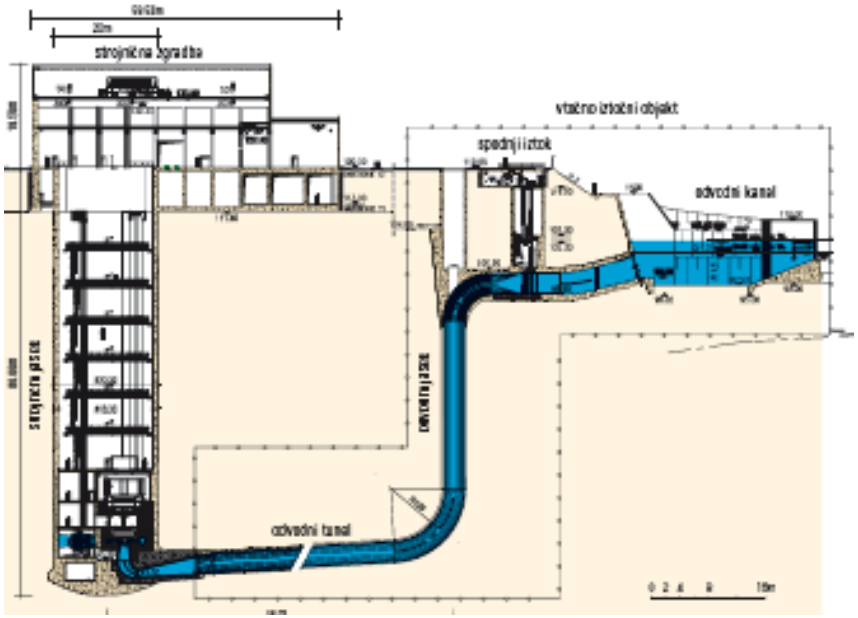
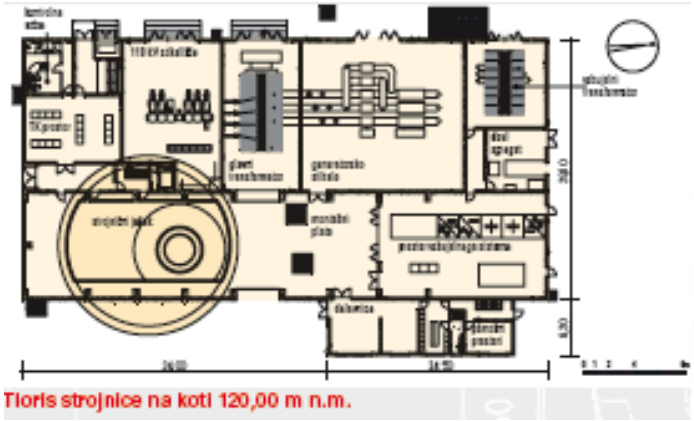
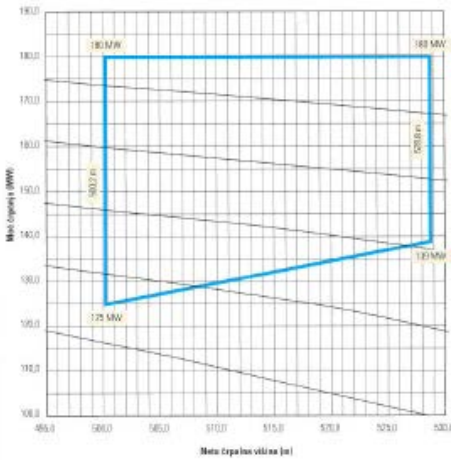


Figure 5-12
Kaplan Turbine - Peak Efficiency vs. Specific Speed



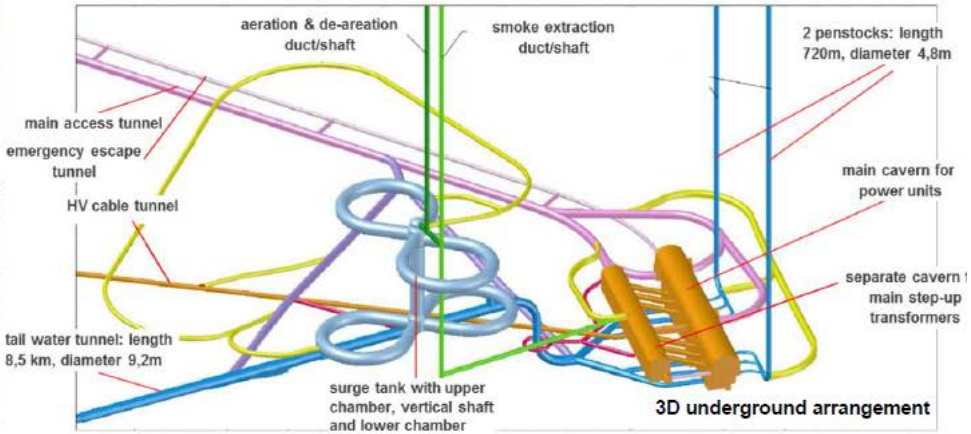

Tloris strojnice na koti 120,00 m n.m.



Basic data of the Atdorf pumped storage plant (PSP)

VOITH

- Planned power & storage capacity: 1.4 GW & 13.4 GWh
- Lifetime: 100 years with replacement of the runners and motor generator sets every 40 years
- Cost: €1.6B



HydroVision 2018, 27th June | Li-Ion vs. Pumped Storage | Dr. K. Krüger et. al. 5

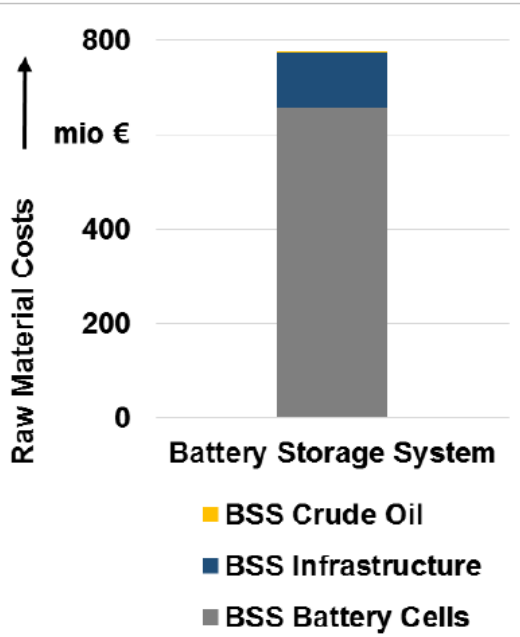
Basic data of the WEMAG battery storage system (BSS) Schwerin

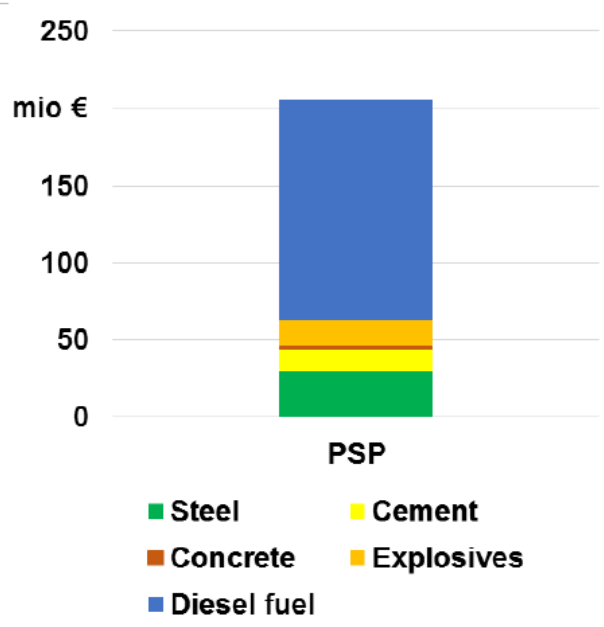
VOITH

- Power & storage capacity today: 5MW / 5 MWh expandable to 6 MW / 6MWh (6/6 used for scaling up)
- 25,600 lithium manganic oxide cells (Samsung SDI)
- 20 years of warranty on the cells if T = const. = 17°C 24/7/365
- Transformers: 5 x 1MW (480/20 kV) + 1 transf. for house load
- 10 DC/AC inverters
- Surface consumption of the building: 400m^2 (340m^2 used for scaling up)
- Costs: €6.7M including €1.3M subsidies from the German ministry BMUB

Comparison of Raw Materials Cost required for the Initial Installation (13.4 GWh)

VOITH

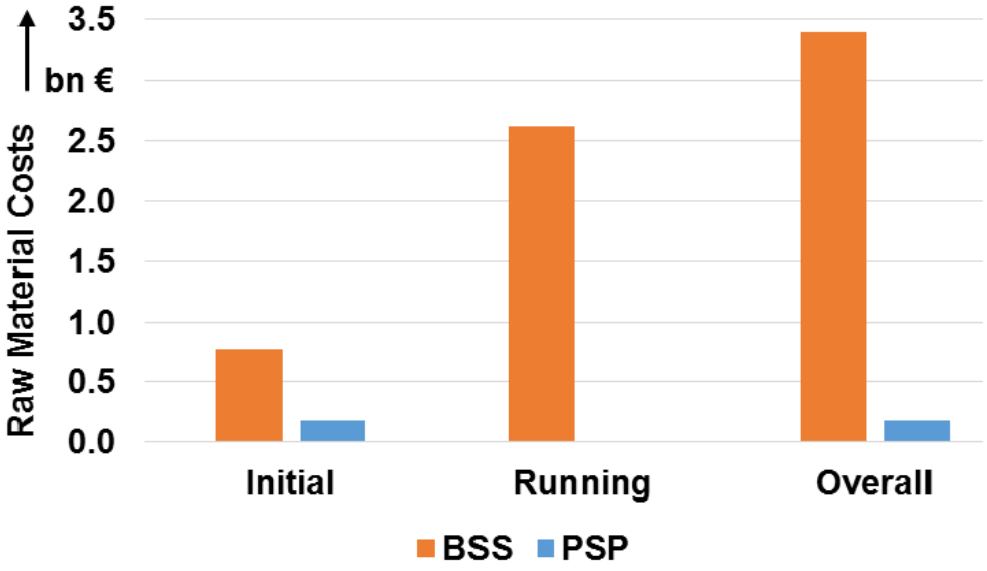




- The BSS is about 3.7 times more cost intensive considering the raw materials needs
- The dominant cost driver for BSS are the raw materials for the battery cells
- The dominant cost driver for PSP are the costs for diesel fuel during the construction process

Comparison of Raw Material Costs during the Assumed Lifetime of 100 Years (13.4 GWh)

VOITH

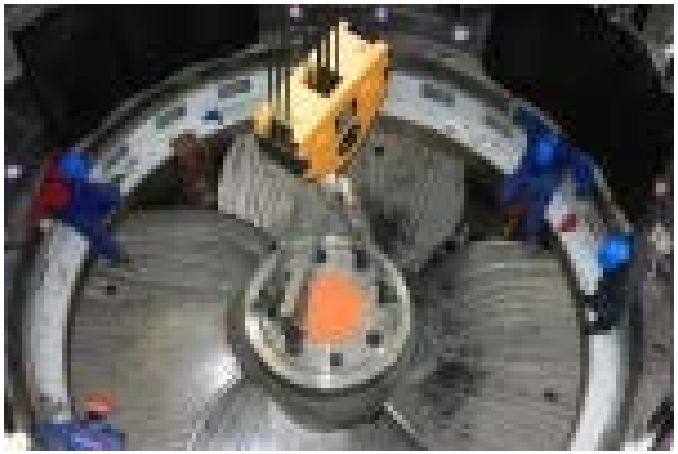


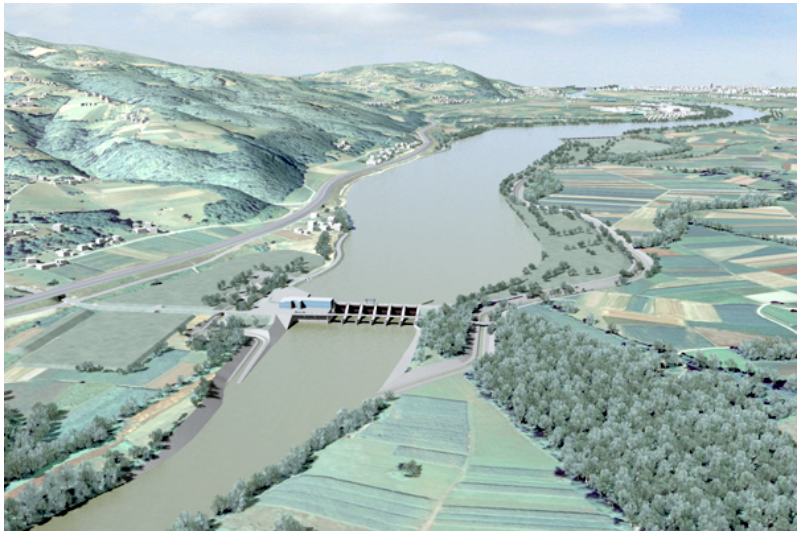
Assumptions for the comparison:

- The battery cells need to be replaced 4 times within 100 years (every 20 years)
- The runners and the motor-generator sets have to be replaced 2 times (every 40 years)

➔ The running raw material costs (excluding initial raw materials) of BSS is about 357 times more cost intensive over 100 years.

➔ Overall, over 100 years, the raw material requirements of BSS are approximately 18 times more cost intensive than PSP.





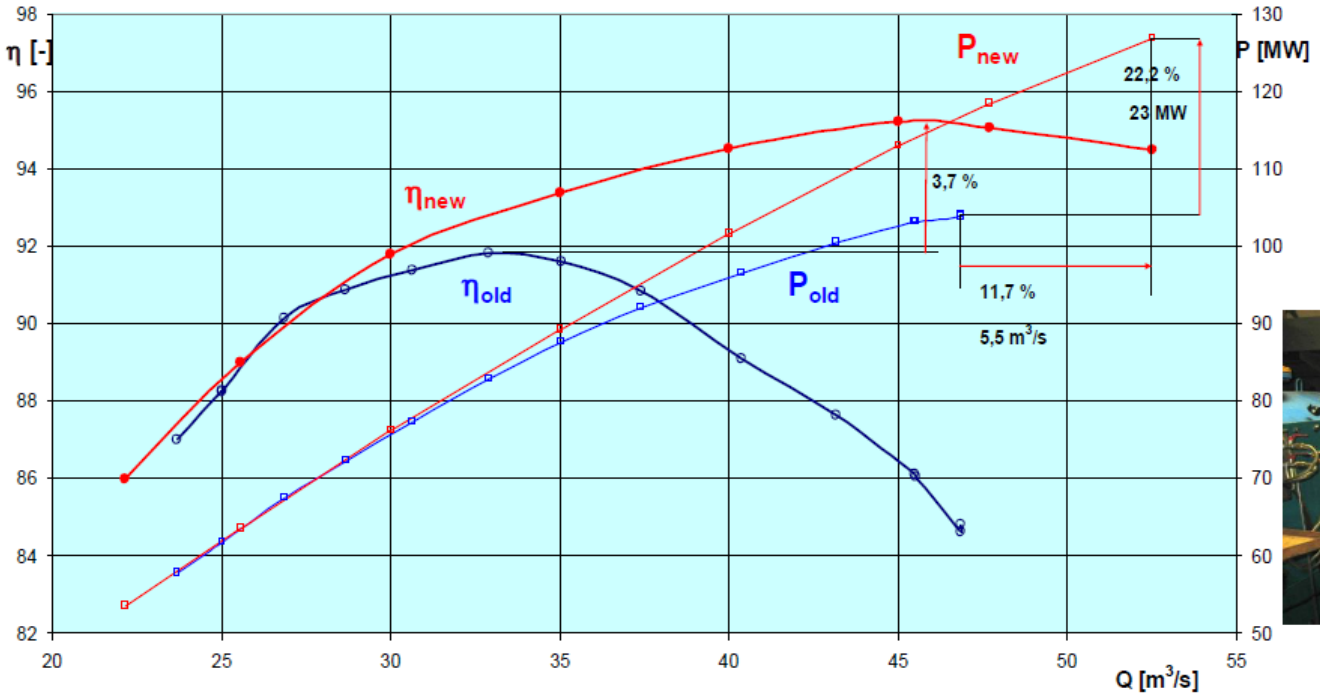
Case study turbine refurbishment – HPP DUBROVNIK, Croatia

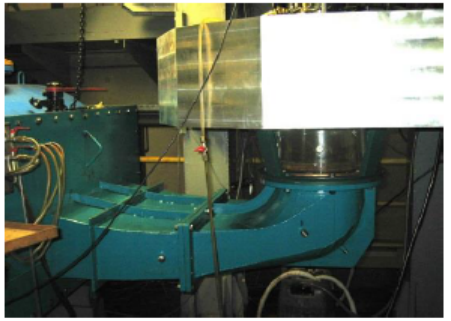
Activites:

- Model development and testing
- Transient phenomena calculation
- Turbine design for refurbishment

Results of Turbine Refurbishment:

- Increasing peak efficiency – 3,7 %
- Increasing nominal Turbine Power Output - 22,2 %
- Increasing maximum Turbine Flow – 11,7%
- Increasing of Energy production





Power plant owner:
HEP PROIZVODNJA, Zagreb,Omiš, Croatia
Turbine producer:
VOITH, , Heidenheim, Germany
ALSTOM, Grenoble, France
Consulting:
EDF, France, Paris

Kod modernog i održivog pristupa projektovanju i pripremi dokumentacije za izgradnju novih ili obnovi postojećih elektrana potrebno je koristiti suvremenu informacijsku tehnologiju sa 3D oblikovanjem i pristupom **BIM (Building information Modeling)**. Na taj način mlade generacije inženjera i konsultanata lakše međusobom komuniciraju i smanjuje se mogućnost za greške u svim fazama realizacije projekata.

Što su razine BIM-a?

Različite razine BIM-a mogu se postići za različite vrste projekata. Svaka razina predstavlja različiti skup kriterija koji pokazuju određenu razinu "zrelosti". Razine BIM-a počinju s 0 i idu na 4D, 5D, pa čak i 6D BIM. Svrha tih razina je odrediti koliko je učinkovito, ili koliko informacija se dijeli i kojima se upravlja tijekom cijelog procesa.

Razina 0 BIM

Razina 0 BIM se uopće ne odnosi na suradnju. Ako koristite 2D CAD i radite s crtežima i / ili digitalnim ispisima, možete slobodno reći da ste na razini 0.

Razina 1 BIM

Korištenje 3D CAD-a za konceptualni rad, ali 2D za izradu informacija o proizvodnji i druge dokumentacije, vjerojatno znači da radite na razini 1 BIM. Na ovoj razini, CAD standardima se upravlja prema standardu BS 1192: 2007, te elektroničkim dijeljenjem podataka koji se izvode iz zajedničkog podatkovnog okruženja (CDE) kojim obično upravlja izvođač. Mnoge tvrtke su na razini 1 BIM-a, što ne uključuje puno suradnje, a svaki sudionik objavljuje i upravlja vlastitim podacima.

Razina 2 BIM

Razina 2 BIM počinje dodavanjem dokumentacije u suradničkom okruženju. Razina 2 BIM-a zapravo je postala obvezni zahtjev u travnju 2016. na svim javno prijavljenim projektima u Velikoj Britaniji. Na razini 2 svi članovi tima koriste 3D CAD modele, ali ponekad ne u istom modelu. Međutim, način na koji dionici razmjenjuju informacije razlikuje ga od drugih razina. Informacije o dizajnu izgrađenog okruženja dijele se putem uobičajenog formata datoteka. Kada tvrtke to kombiniraju s vlastitim podacima, štede vrijeme, smanjuju troškove i eliminiraju potrebu za preradom. Budući da se podaci na taj način dijele, CAD softver mora moći izvesti u uobičajeni format datoteke, kao što je IFC (Industry Foundation Class) ili COBie (Izgradnja informacija o izgradnji operacija).

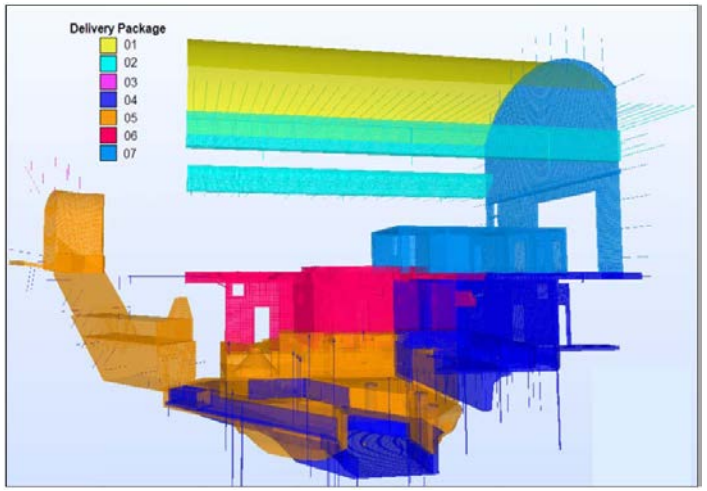
Razina 3 BIM

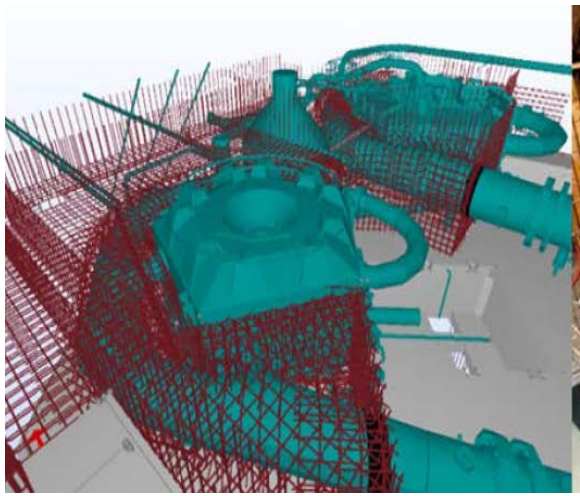
BIM razina 3 je još suradnička. Umjesto da svaki član tima radi u vlastitom 3D modelu, razina 3 znači da svatko koristi jedan, zajednički model projekta. Model postoji u "središnjem" okruženju i svima je dozvoljeno pristupiti i promijeniti. To se zove Open BIM, što znači da se još jedan sloj zaštite dodaje protiv sukoba, dodajući vrijednost projektu u svakoj fazi. Vlada Velike Britanije se čak obvezala da će razina 3 BIM-a biti preduvjet za sve projekte u nadolazećim godinama.

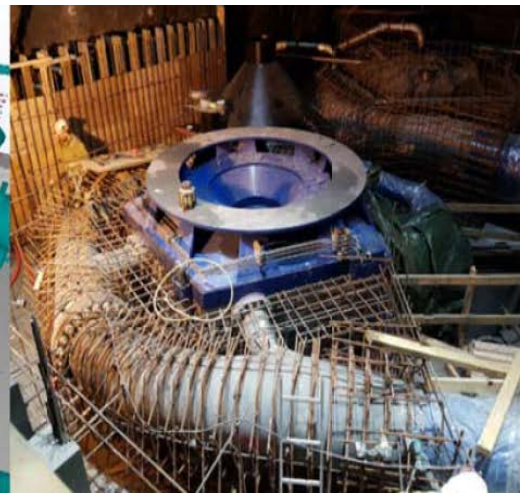
Budućnost BIM-a

Zbog jasnih prednosti, sigurno je da će BIM ostati. Ona je definirala ciljeve koji su očito korisni za sve one koji rade svoj put kroz razine. Bez sumnje, budućnost izgradnje bit će još više suradnička i digitalna. Kako BIM postaje sve sofisticiraniji, 4D (dodaje se komponenta vrijeme), 5D (dodaje se komponenta troškovi), pa čak i 6D (održavanje i vođenje već izgradjenih projekata) BIM će imati vodeću ulogu u tom procesu izgradnje. Nadalje, diljem svijeta postoji pokušaj smanjenja otpada u građevinarstvu. Mnogo toga se pripisuje neučinkovitosti opskrbnog lanca, sukobima i preradi. Surađujući u BIM okruženju, sve to postaje manje vjerojatnim, postavljajući pozornicu za bolje sutra.

Iskustvo iz projekta Smisto Hydropower Norveška pokazuje da je moguća izvedba izgradnje hidroelektrane bez 2D crteža - dokumentacije







Iskustvo iz projekta Smisto Hydropower pokazuje da je izvedba gradilišta bez 2D crteža daje koristi od poboljšane interakcije svih strana u projektu. Prevladavanjem ne samo tehničkih izazova, već i izazovi s promijenjenim metodama rada, provedbom i usvajanjem procesa baziranog na 3D modelima, doživljava se da projekt ima bolji dizajn, uzajamno razumijevanje između stranaka, fleksibilnost i ekonomičnost u poredjenju sa radom sa konvencionalnom 2D dokumentacijom.

Ključno za realizaciju je i ugovaranje projekata, večite dileme da li imati EPC contracte (ključ u ruke) odgovornost na jednom mjestu ili ih djeliti na lotove i angažovati svoje suradnike za kontrolu realizacije u cilju smanjivanja rizika na minimum?

EPC ugovori su učinkoviti, ali i osjetljivi predmeti koji zahtijevaju savjetovanje na visokoj razini i adekvatne metode upravljanja na temelju rizika.

EPC je daleko najčešće korišteni ugovorni postupak za razvoj velikih hidroenergetskih projekata.

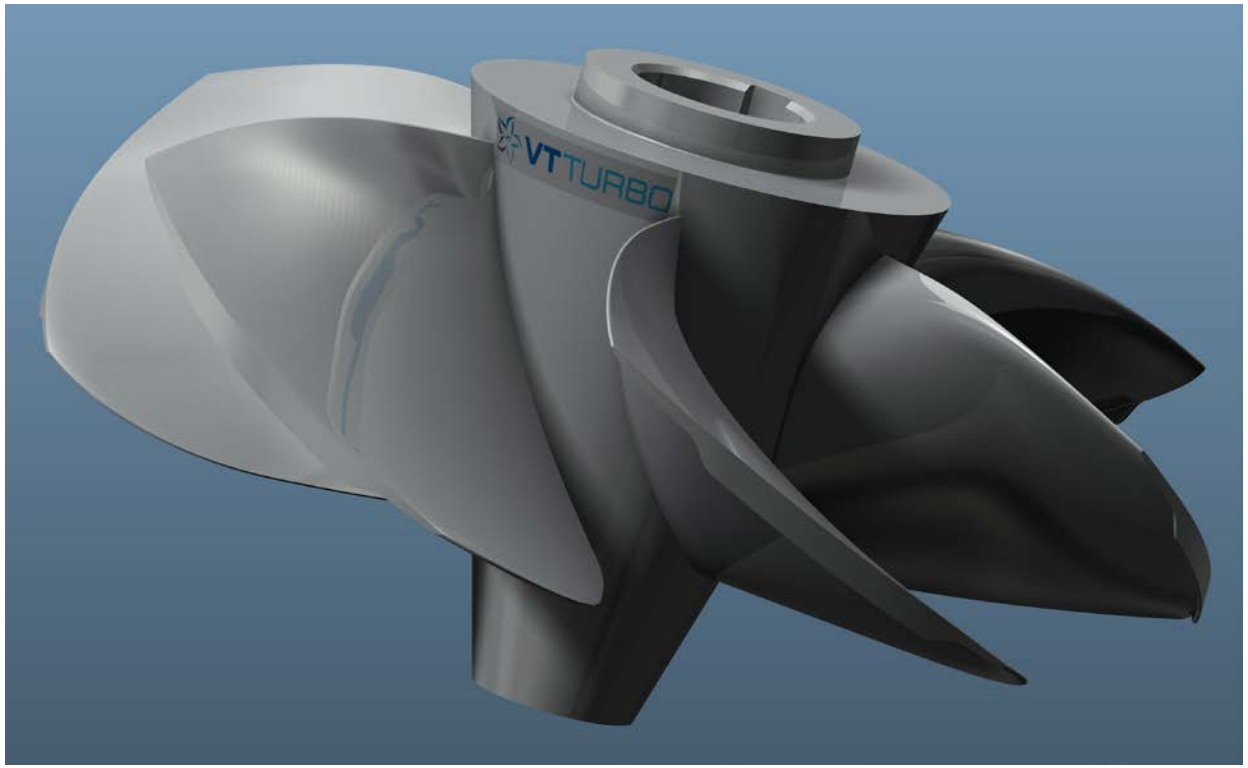
EPC ugovaranje predstavlja priliku za projekte uglavnom zbog njegove sposobnosti da minimizira trajanja projekta, kada se pravilno upravlja.

U tom smislu, korištenje FIDIC-ovog takozvanog "paketa duga" standardnih ugovora (npr. Crveni, Žuti, Srebrni, Zlatni, Zelene knjige) nudi sljedeće prednosti:

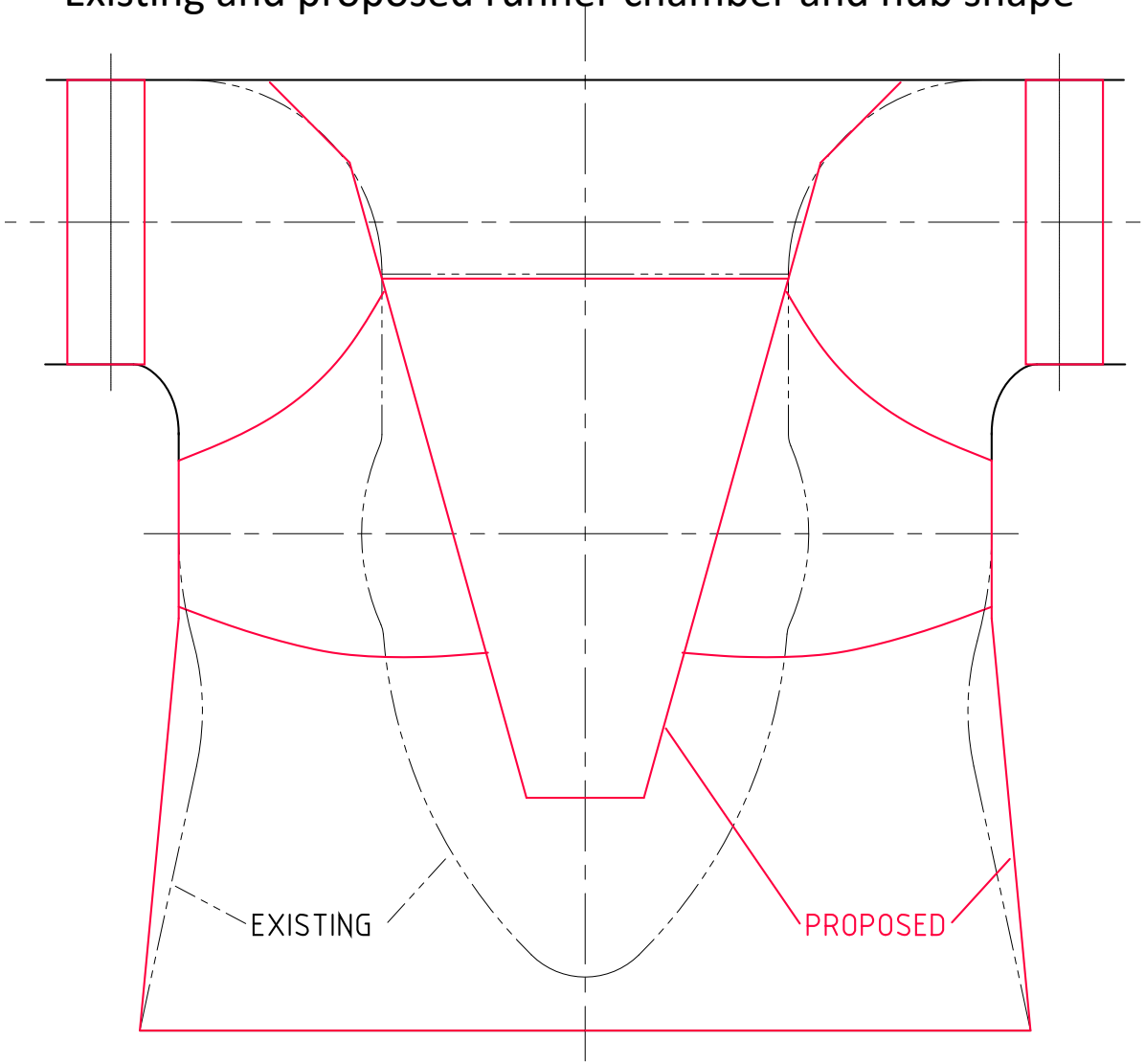
- međunarodno priznati,
- osigurava standardni okvir, stoga zajednički jezik za izvođače, poslodavce i inženjere,
- određuje opće obveze u pogledu dizajna, ponude i kvalitete,
- pravedna raspodjela rizika,
- ažurirane prakse za mehanizme rješavanja sporova,

Poseban akcenat je na modelskim istraživanjima i razvojem turbina uz primopredajna ispitivanja kako na modelu tako i na prototipu turbina.

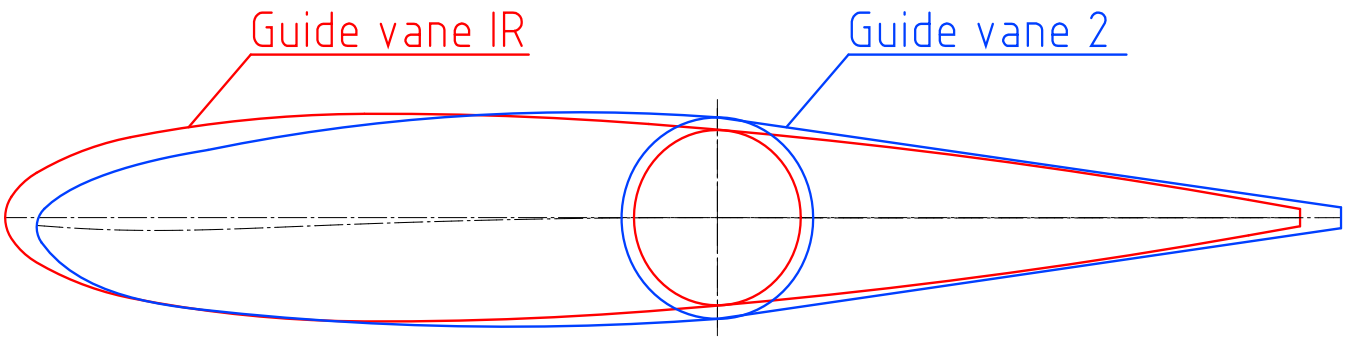
PRIMJER: IRKUTSKAYA HPP



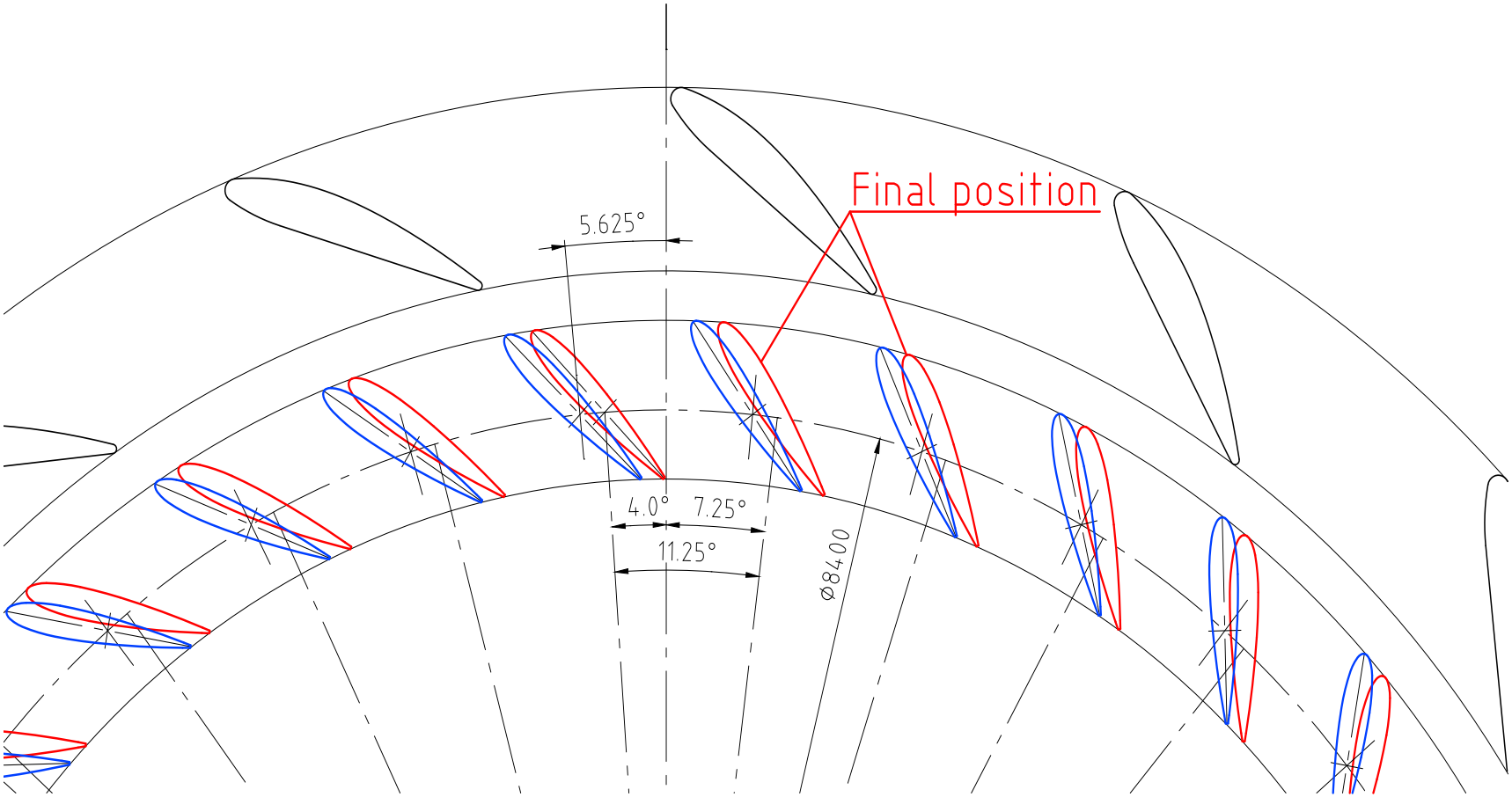
Existing and proposed runner chamber and hub shape



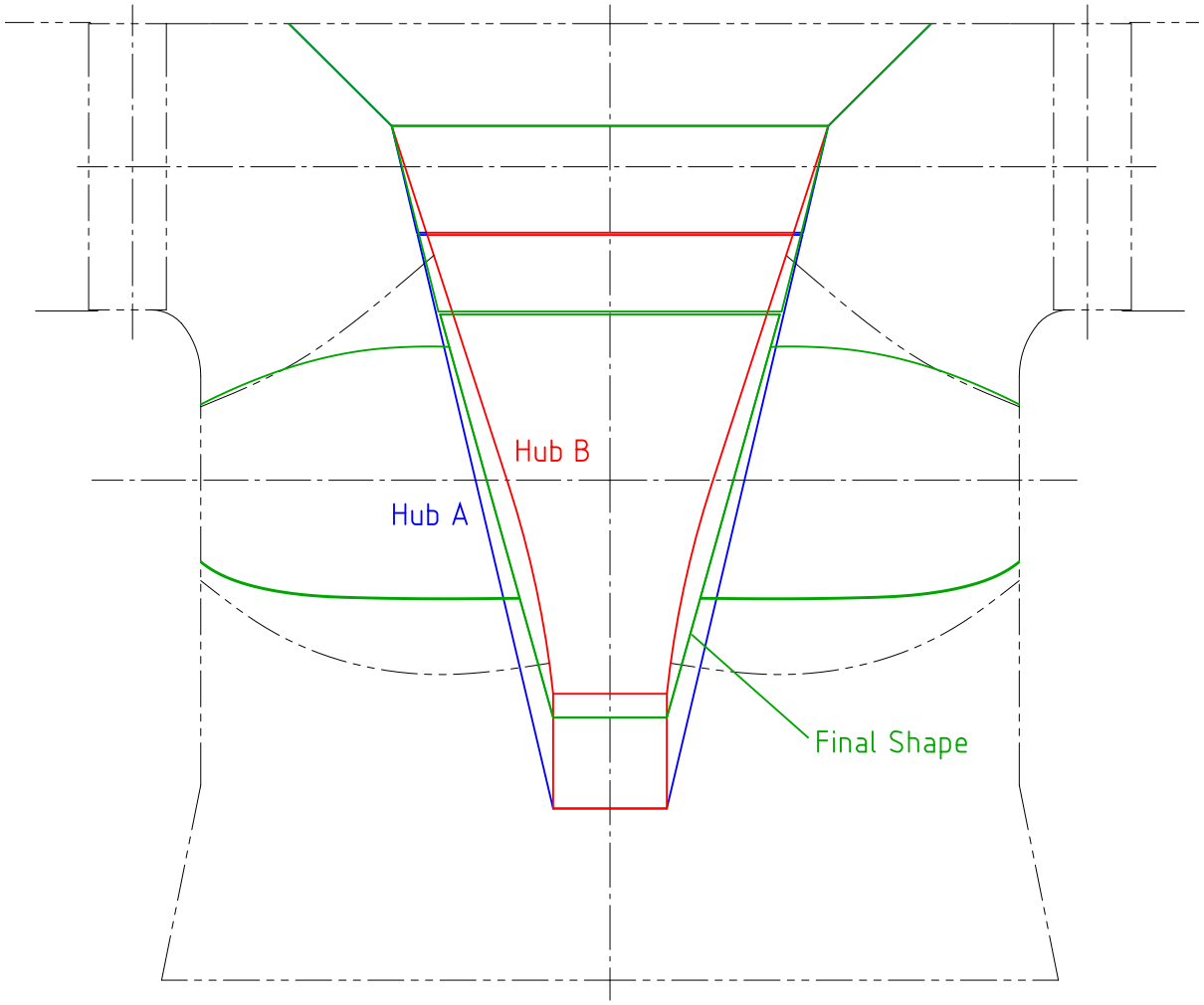
- Different camberline
- Different vane profile
- Different pivot position

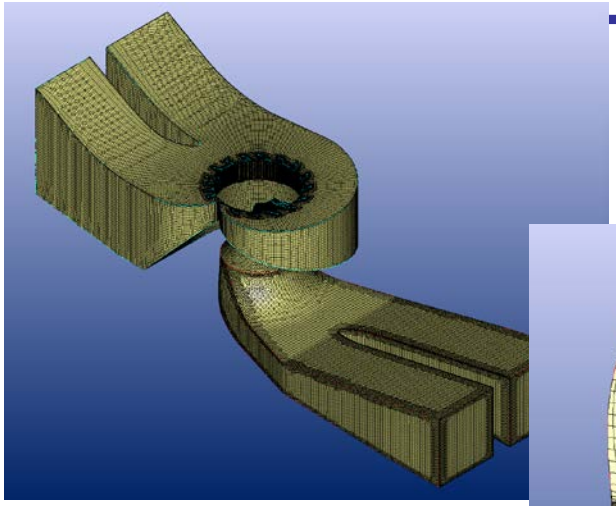


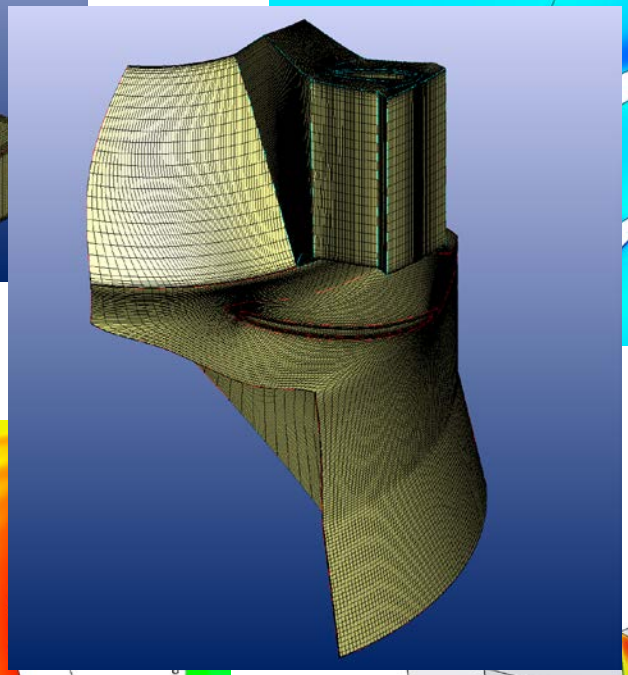
Optimized position of guide vanes

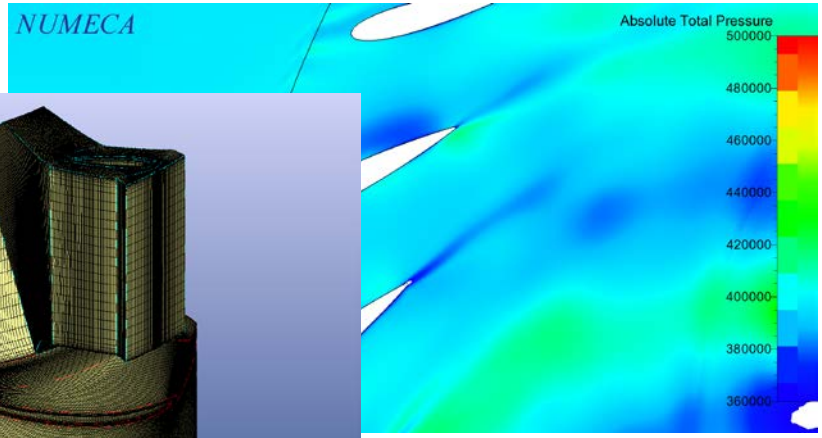


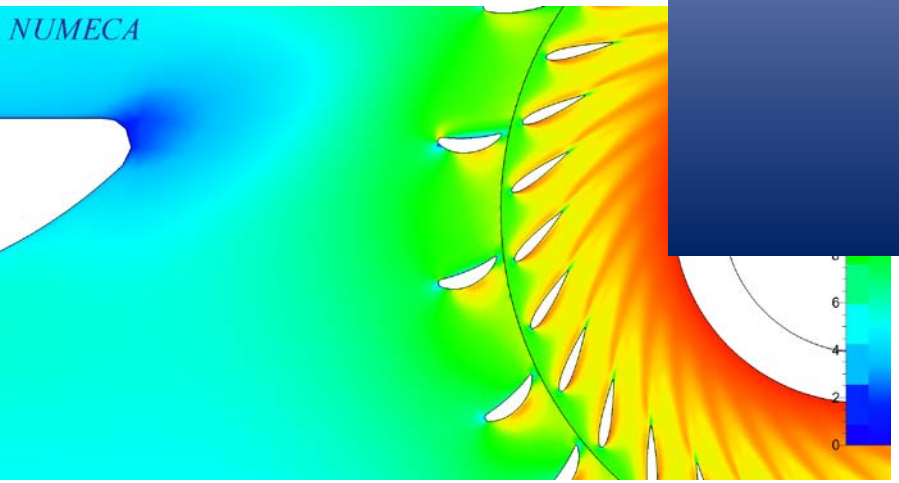
Optimization of runner hub and inner cone

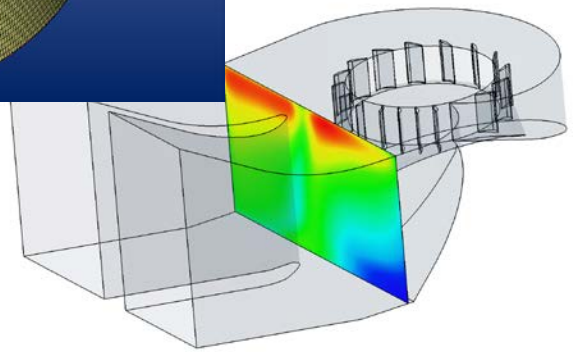


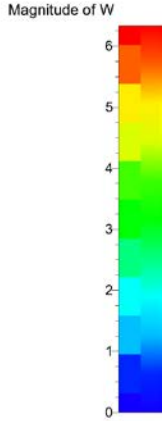


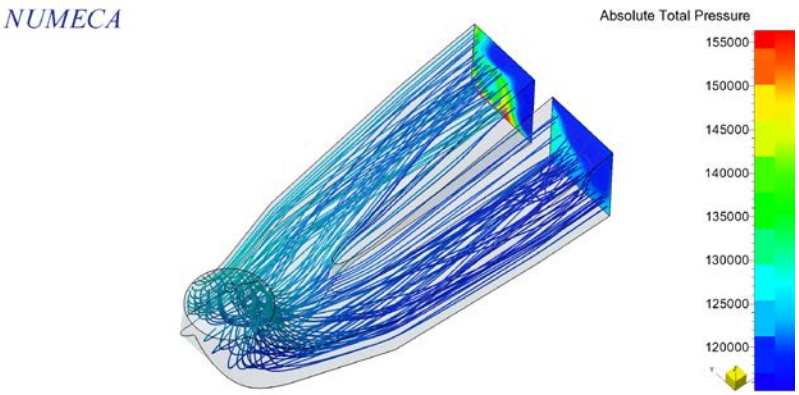



NUMECA
Absolute Total Pressure
500000
480000
460000
440000
420000
400000
380000
360000


NUMECA
6
4
2
0




Magnitude of W
6
5
4
3
2
1
0


NUMECA
Absolute Total Pressure
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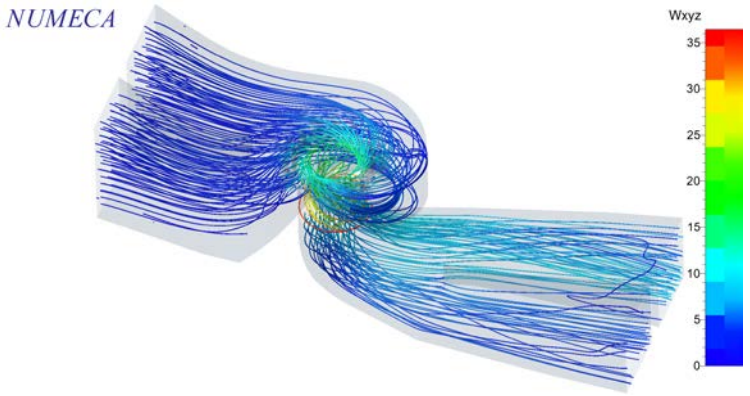
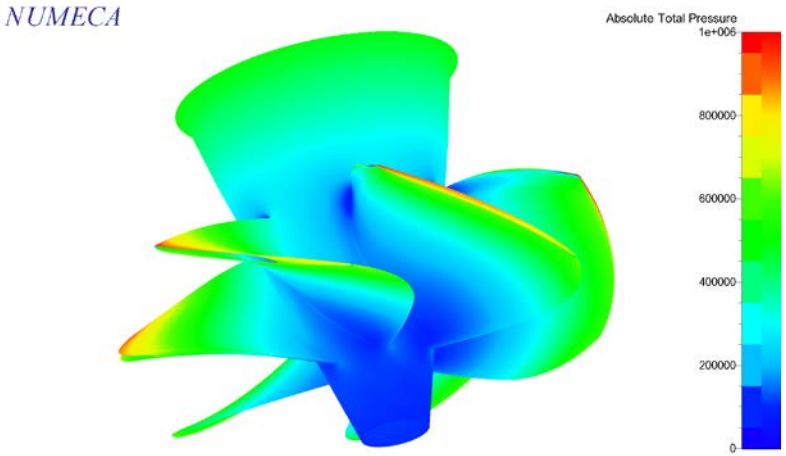
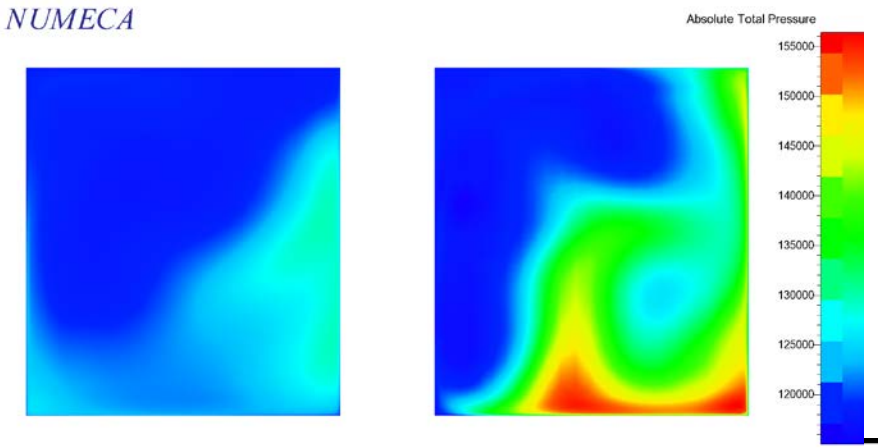
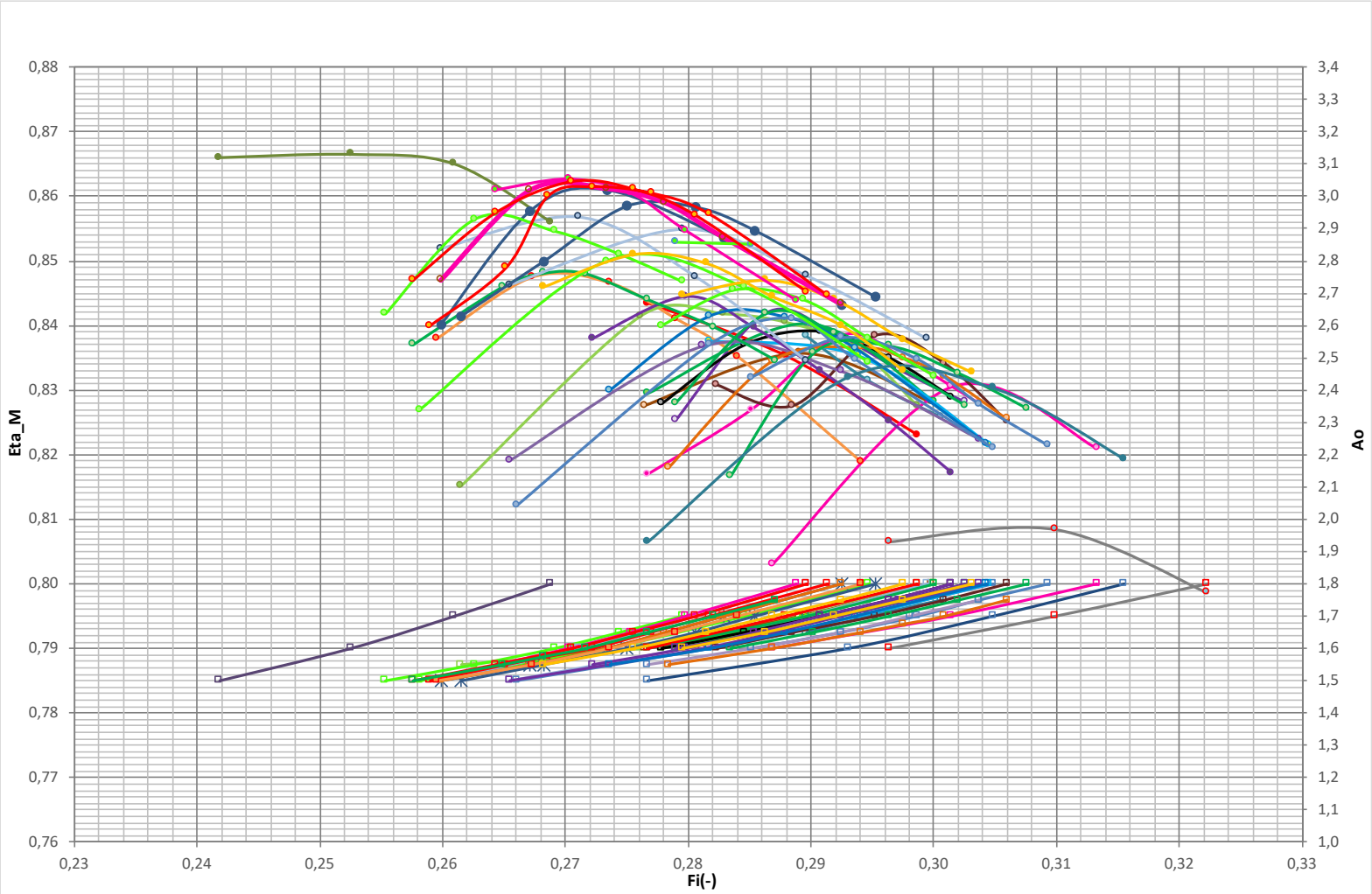
150000
145000
140000
135000
130000
125000
120000

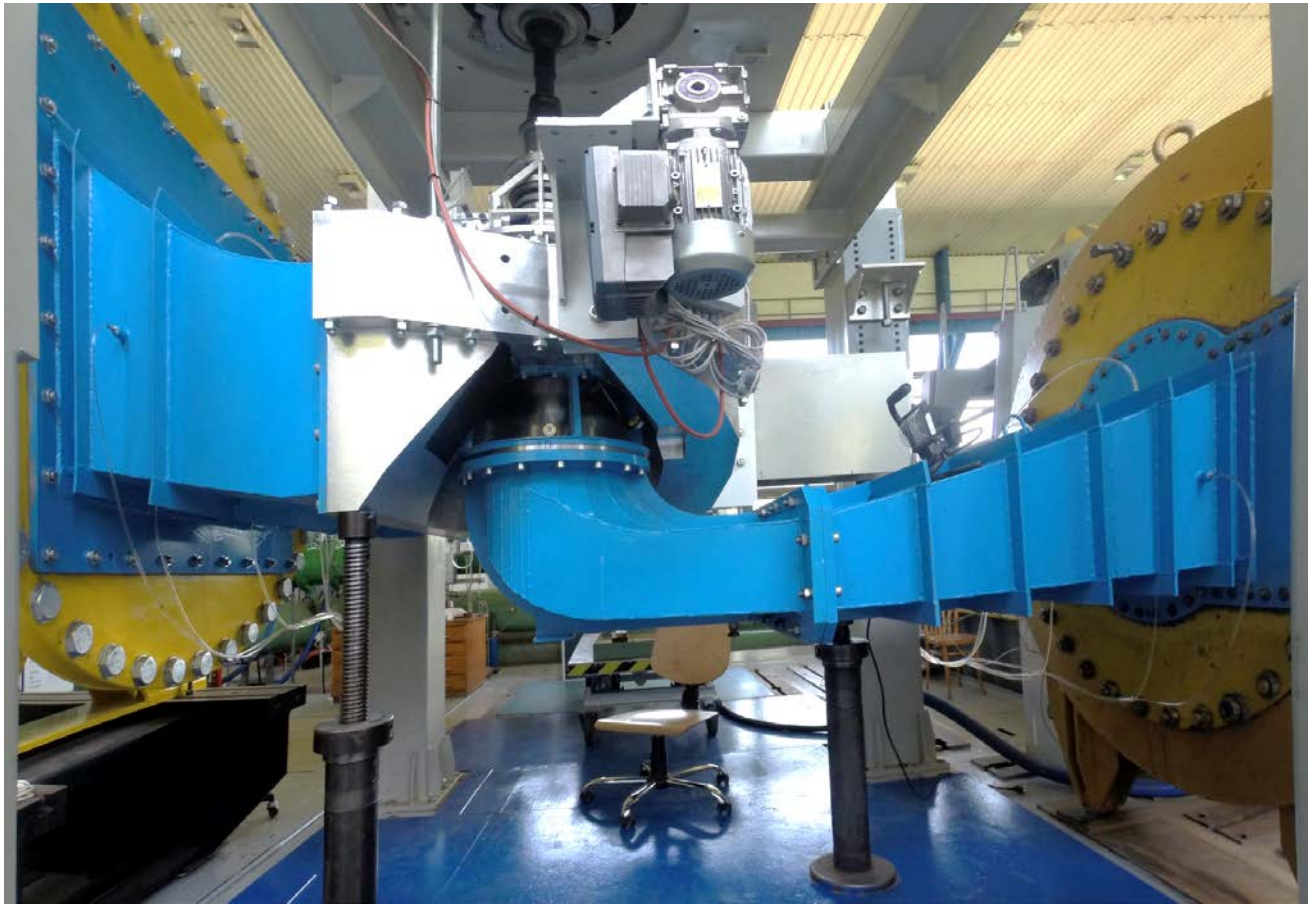

NUMECA
Wxyz
35
30
25
20
15
10
5
0

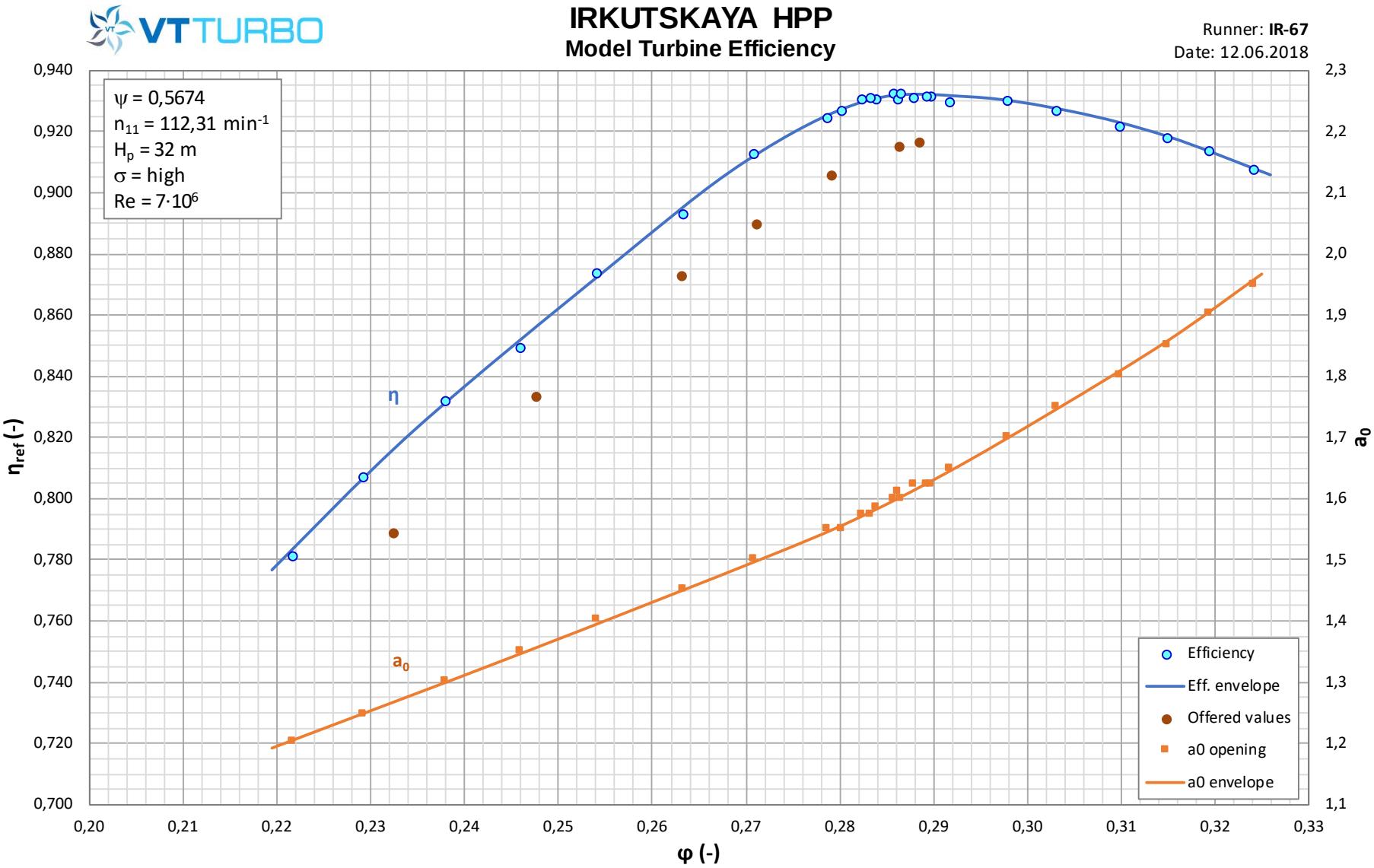

NUMECA
Absolute Total Pressure
1e+006
800000
600000
400000
200000
0


NUMECA
Absolute Total Pressure
155000
150000
145000
140000
135000
130000
125000
120000


Eta_M
Ao
Fi(-)
0,88
0,87
0,86
0,85
0,84
0,83
0,82
0,81
0,80
0,79
0,78
0,77
0,76
3,4
3,3
3,2
3,1
3,0
2,9
2,8
2,7
2,6
2,5
2,4
2,3
2,2
2,1
2,0
1,9
1,8
1,7
1,6
1,5
1,4
1,3
1,2
1,1
1,0
0,23
0,24
0,25
0,26
0,27
0,28
0,29
0,30
0,31
0,32
0,33

Model of Irkutskaya HPP installed on vertical test rig




VTTURBO
IRKUTSKAYA HPP
Model Turbine Efficiency
Runner: IR-67
Date: 12.06.2018
ψ = 0,5674
n11 = 112,31 min-1
Hp = 32 m
σ = high
Re = 7·10^6
η
a0
Efficiency
Eff. envelope
Offered values
a0 opening
a0 envelope
ηref (-)
a0
φ (-)
0,940
0,920
0,900
0,880
0,860
0,840
0,820
0,800
0,780
0,760
0,740
0,720
0,700
2,3
2,2
2,1
2,0
1,9
1,8
1,7
1,6
1,5
1,4
1,3
1,2
1,1
0,20
0,21
0,22
0,23
0,24
0,25
0,26
0,27
0,28
0,29
0,30
0,31
0,32
0,33

HVALA NA POZORNOSTI !