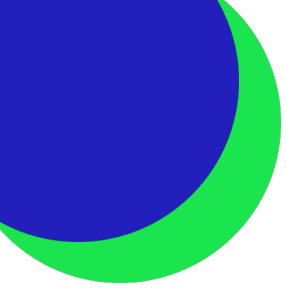


Mida õppida suurte tuumajaamade ehituste tähtaja- ja eelarveületustest?

Fermi Energia

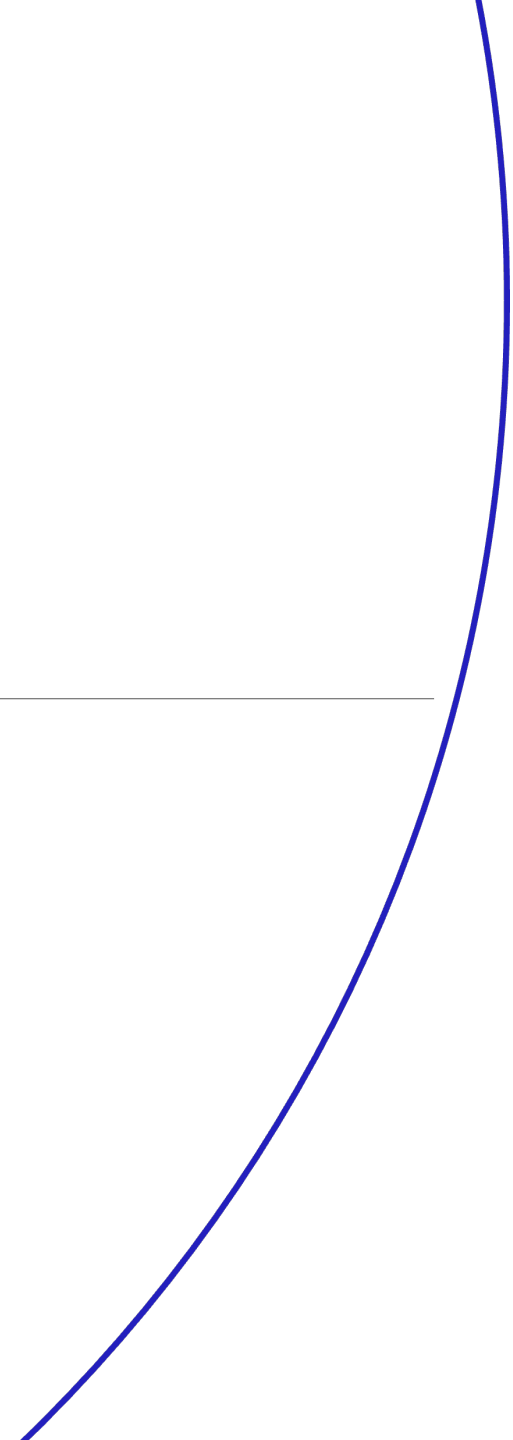
Merja Pukari

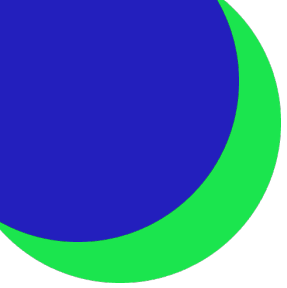
07.02.2024



KAS TUUMAENERGIA ON ALATI KALLIS?

IS NUCLEAR ENERGY IS ALWAYS EXPENSIVE?





[kUSD/kW]

14

12

10

8

6

4

2

0

USA
Vogle
3&4

Prantsusmaa
Flamanville
3

Soome
Olkiluoto
3

UK
Sizewell
B

AÜE
Barakah
1-4

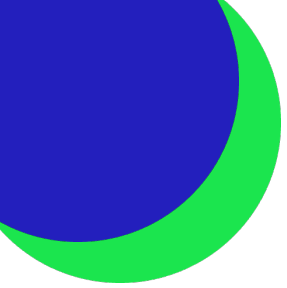
Jaapan
3 reaktorit

Venemaa
2 reaktorit

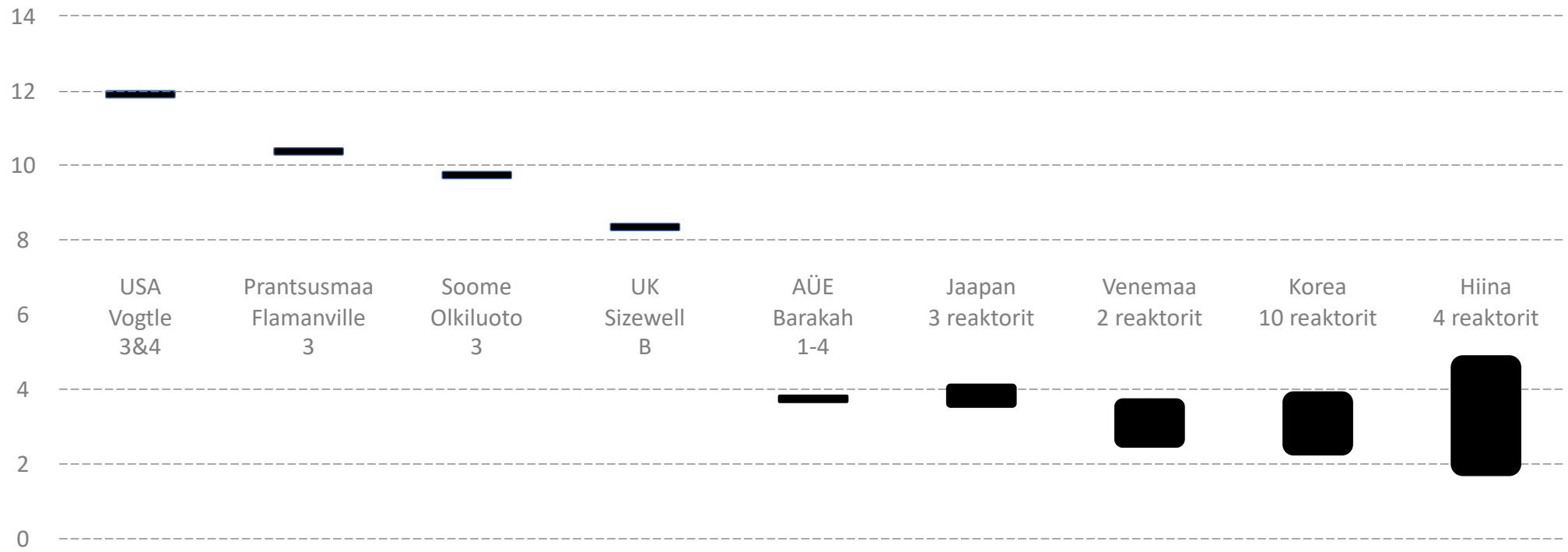
Korea
10 reaktorit

Hiina
4 reaktorit

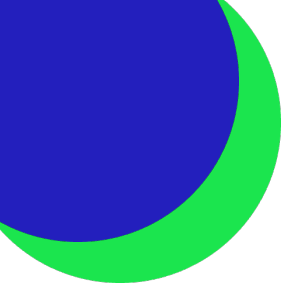
KAPITALI KOGUKULU VALIKU REAKTORITE PUHUL / TOTAL CAPITAL COSTS FOR A SELECTION OF POWER PLANTS



[kUSD/kW]



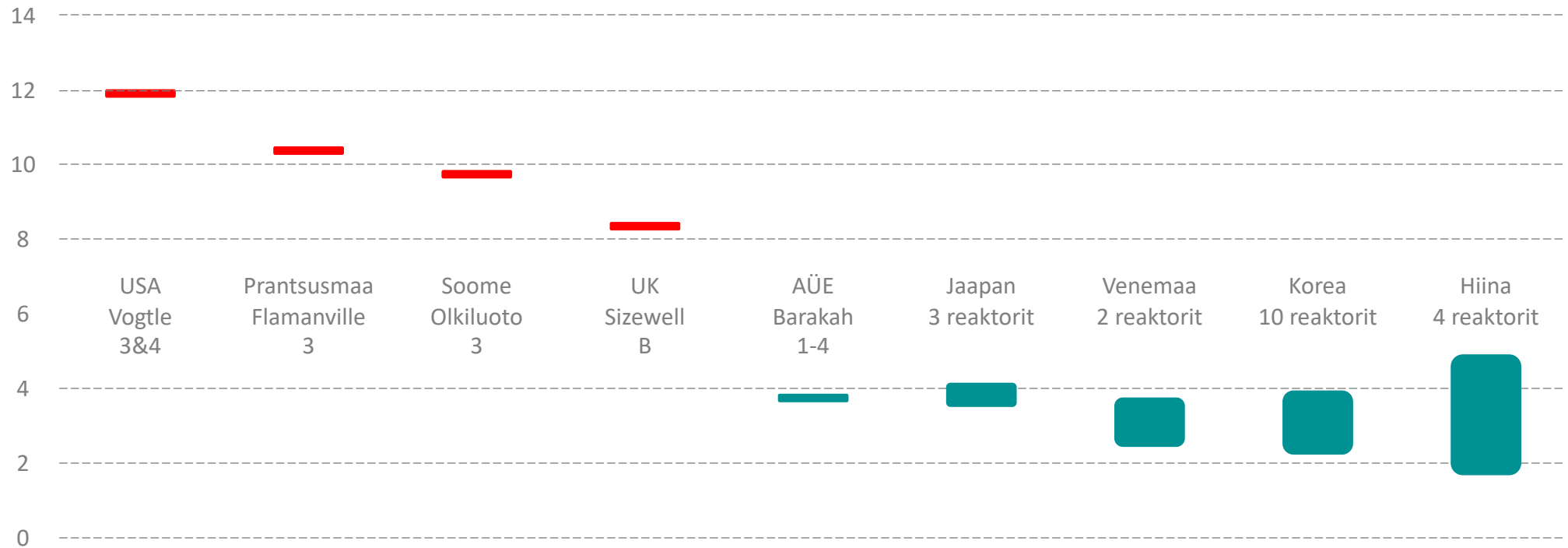
KAPITALI KOGUKULU VALIKU REAKTORITE PUHUL / TOTAL CAPITAL COSTS FOR A SELECTION OF POWER PLANTS



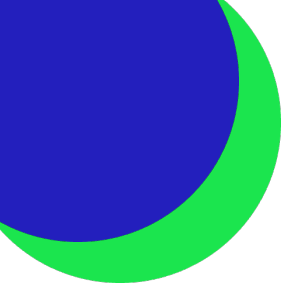
KALLID JAAMAD / EXPENSIVE STATIONS

TASKUKOHASED JAAMAD / AFFORDABLE STATIONS

[kUSD/kW]



KAPITALI KOGUKULU VALIKU REAKTORITE PUHUL / TOTAL CAPITAL COSTS FOR A SELECTION OF POWER PLANTS



KALLID JAAMAD / EXPENSIVE STATIONS

TASKUKOHASED JAAMAD / AFFORDABLE STATIONS

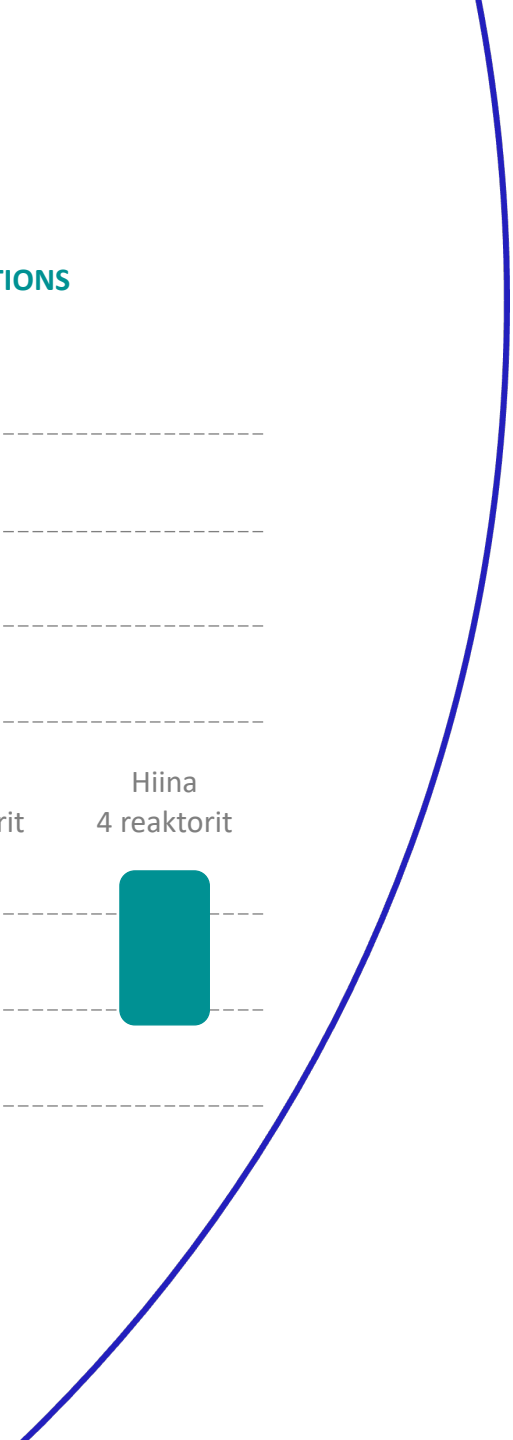
[kUSD/kW]

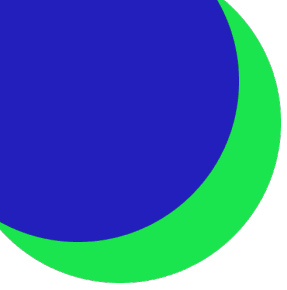
14
12
10
8
6
4
2
0

Geograafia, poliitiline süsteem ja tööjõukulud on sekundaarse tähtsusega faktorid
Geography, political system and labour costs are factors of secondary importance

USA Vogtle 3&4
Prantsusmaa Flamanville 3
Soome Olkiluoto 3
UK Sizewell B
AÜE Barakah 1-4
Jaapan 3 reaktorit
Venemaa 2 reaktorit
Korea 10 reaktorit
Hiina 4 reaktorit

KAPITALI KOGUKULU VALIKU REAKTORITE PUHUL / TOTAL CAPITAL COSTS FOR A SELECTION OF POWER PLANTS

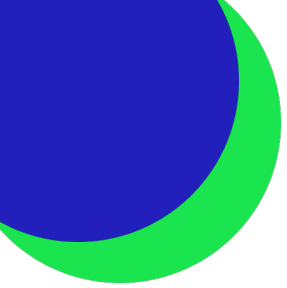




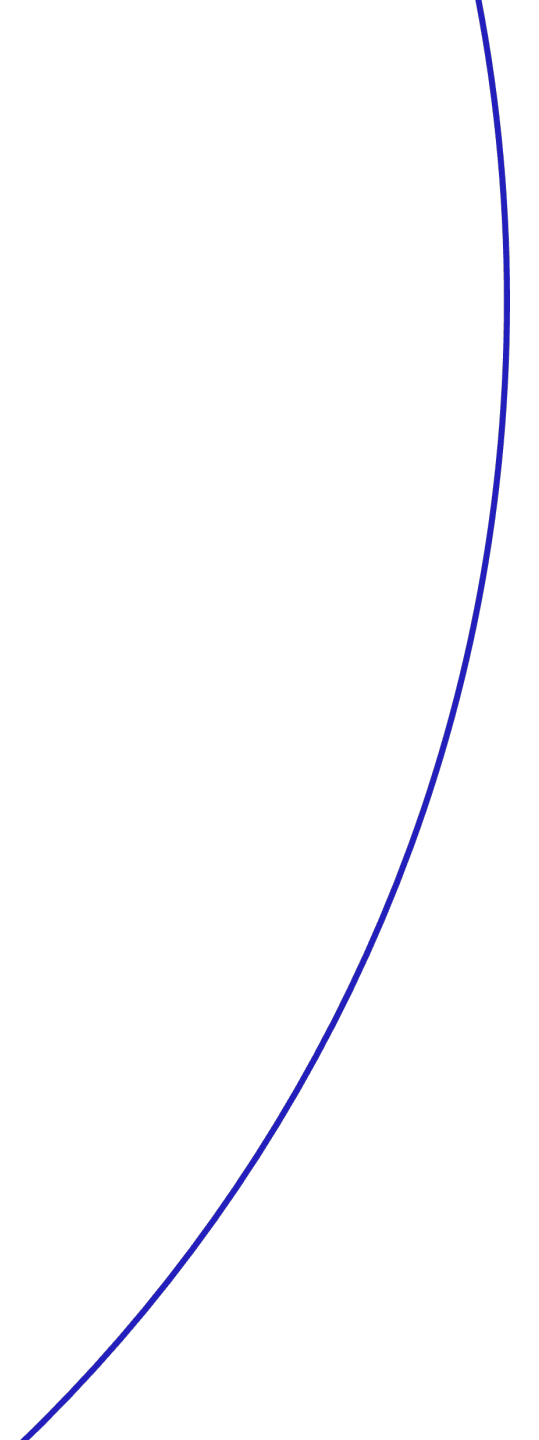
TUUMAJAAMA LIHTSUSTATUD ELUTSÜKKEL

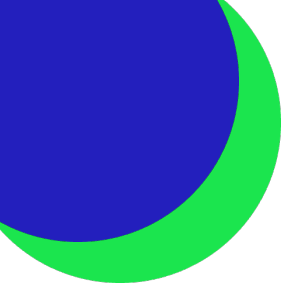
SIMPLIFIED LIFE CYCLE OF A NUCLEAR POWER PLANT





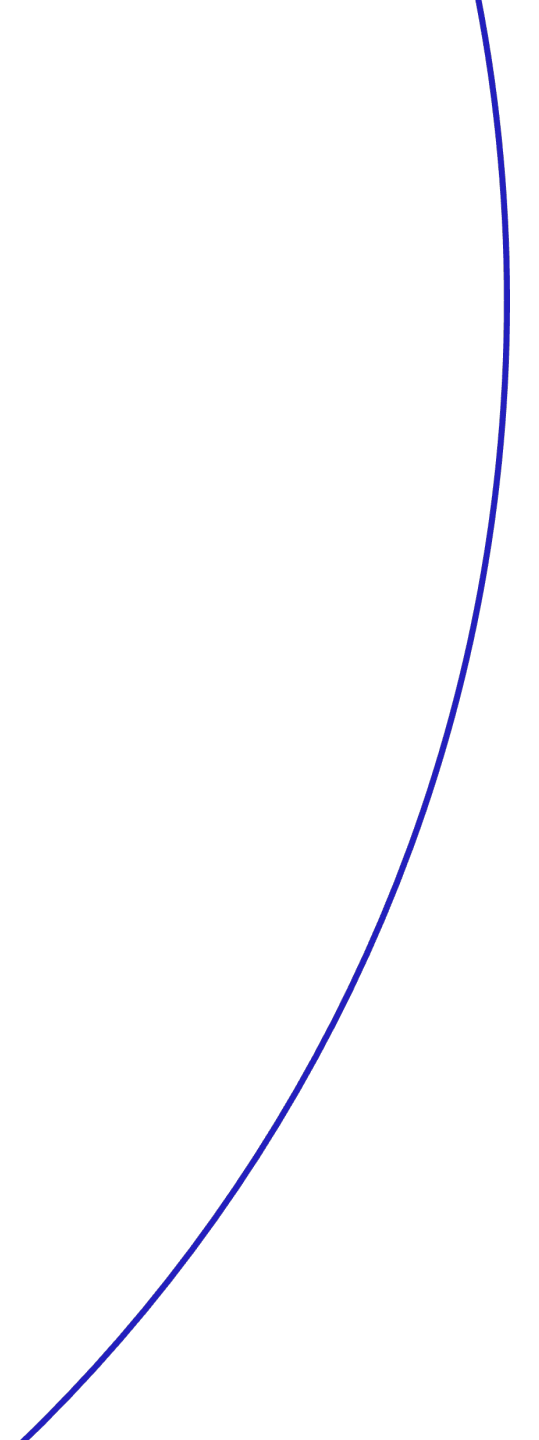
KONSTRUKTSIOON / ENGINEERING

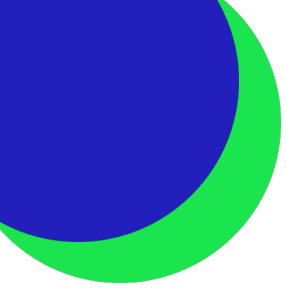




KONSTRUKTSIOON / ENGINEERING

TARNEAHEL / SUPPLY CHAIN



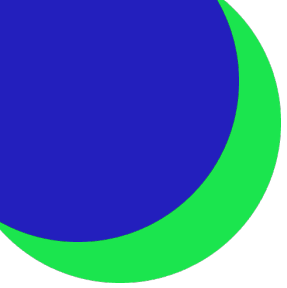


KONSTRUKTSIOON / ENGINEERING

TARNEAHEL / SUPPLY CHAIN

EHITUS / CONSTRUCTION





KONSTRUKTSIOON / ENGINEERING



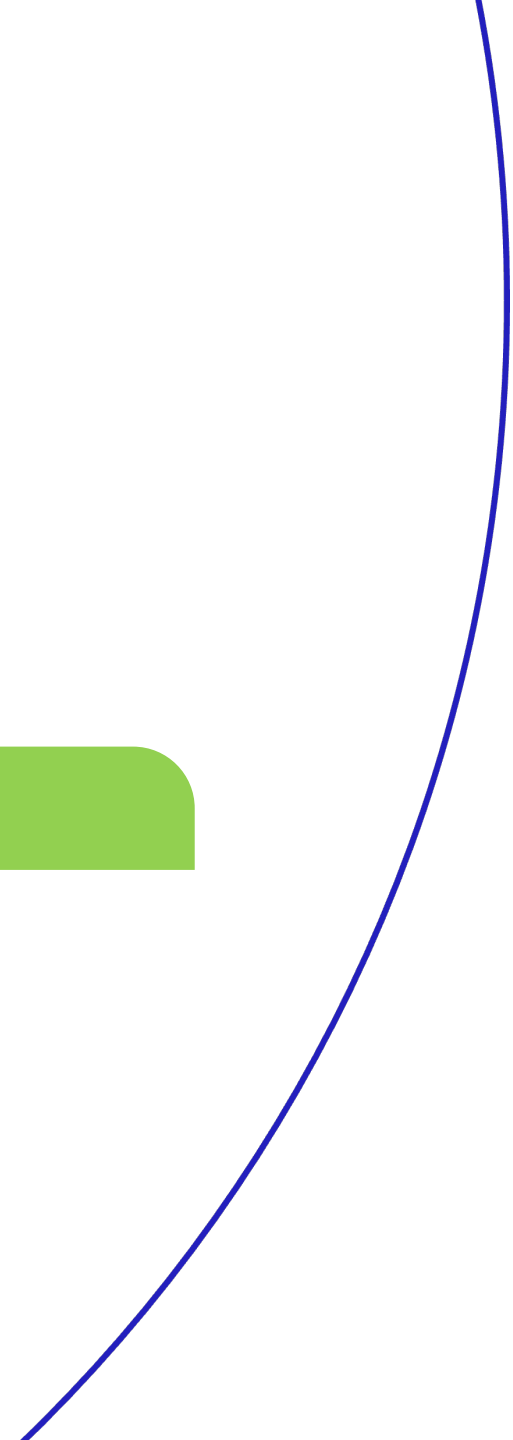
TARNEAHEL / SUPPLY CHAIN

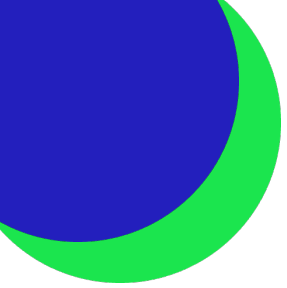


EHITUS / CONSTRUCTION



KÄIT / OPERATIONS





KONSTRUKTSIOON / ENGINEERING



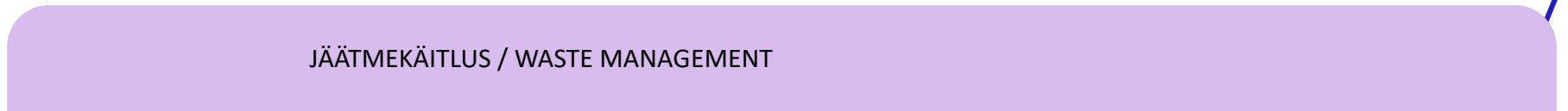
TARNEAHEL / SUPPLY CHAIN



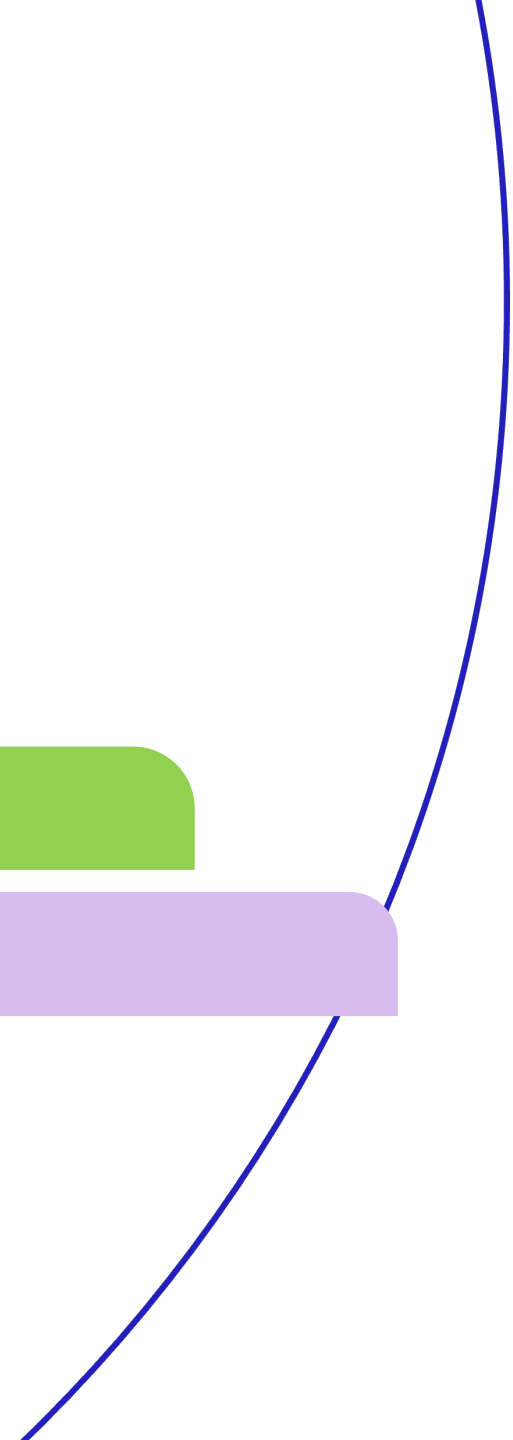
EHITUS / CONSTRUCTION

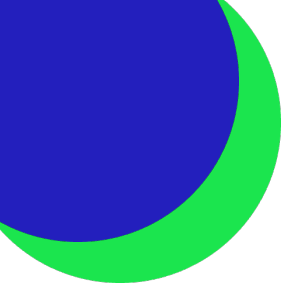


KÄIT / OPERATIONS



JÄÄTMEKÄITLUS / WASTE MANAGEMENT





KONSTRUKTSIOON / ENGINEERING



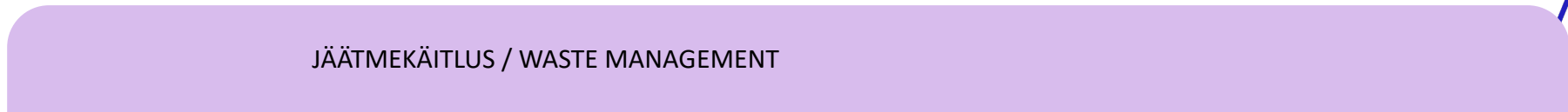
TARNEAHEL / SUPPLY CHAIN



EHITUS / CONSTRUCTION

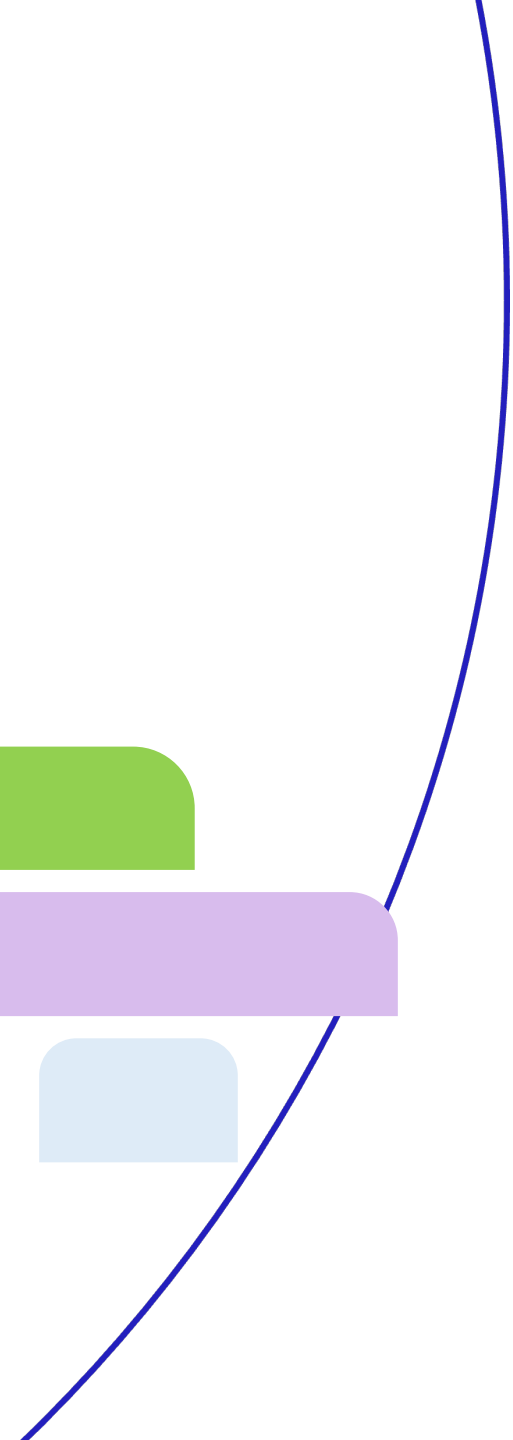
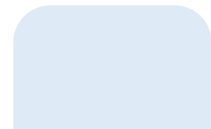


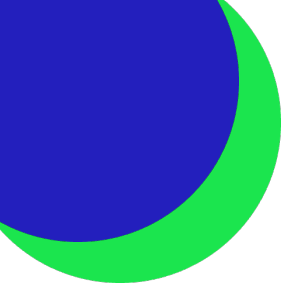
KÄIT / OPERATIONS



JÄÄTMEKÄITLUS / WASTE MANAGEMENT

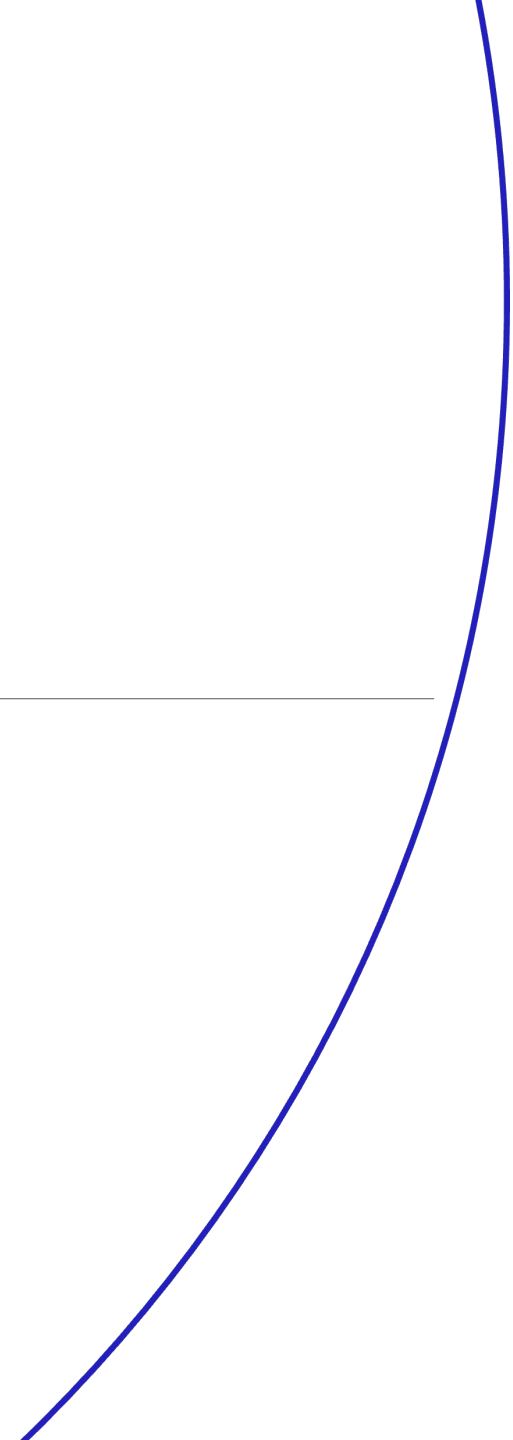
DEKOMISJONEERIMINE / DECOMMISSIONING

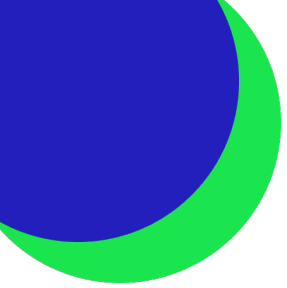




ELUTSÜKLI "KALLID" FAASID

THE "EXPENSIVE" PHASES OF THE LIFE CYCLE





KONSTRUKTSIOON
ENGINEERING

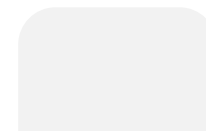
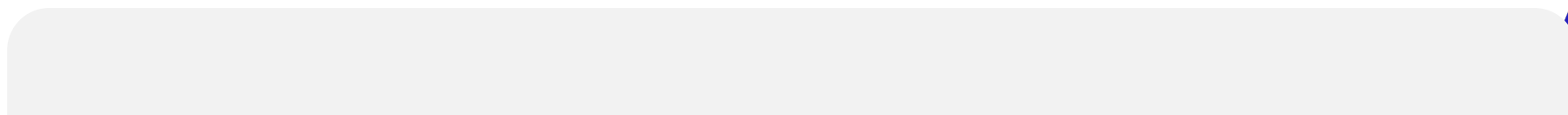
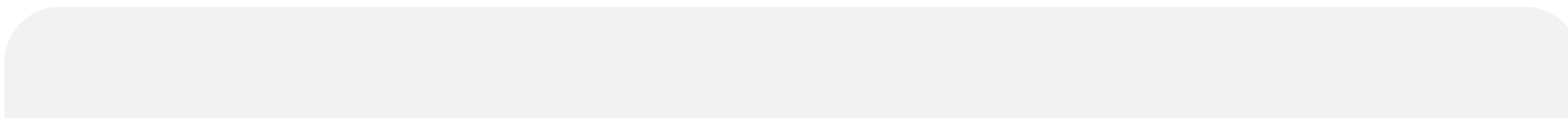
TARNEAHEL
SUPPLY CHAIN

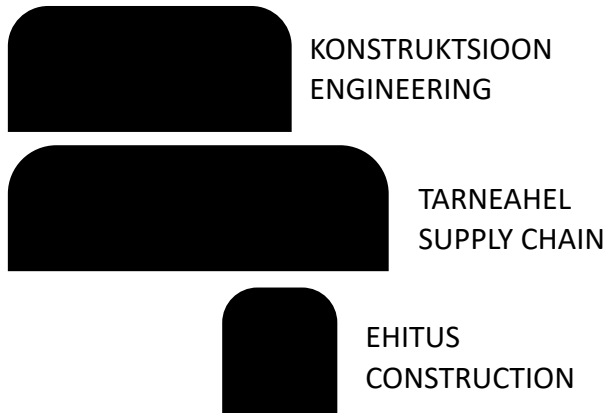
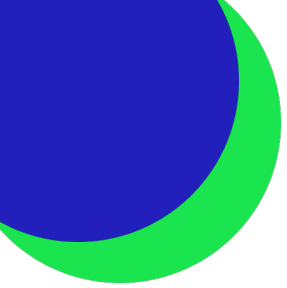
EHITUS
CONSTRUCTION

> 70%

JAAMA KOGUMAKSUMUSEST
SELLE ELUTSÜKLI JOOKSUL
ON SEOTUD EHITUSTEGEVUSEGA

TOTAL COST OF THE STATION IS ASSOCIATED
WITH ITS CONSTRUCTION





> 70%

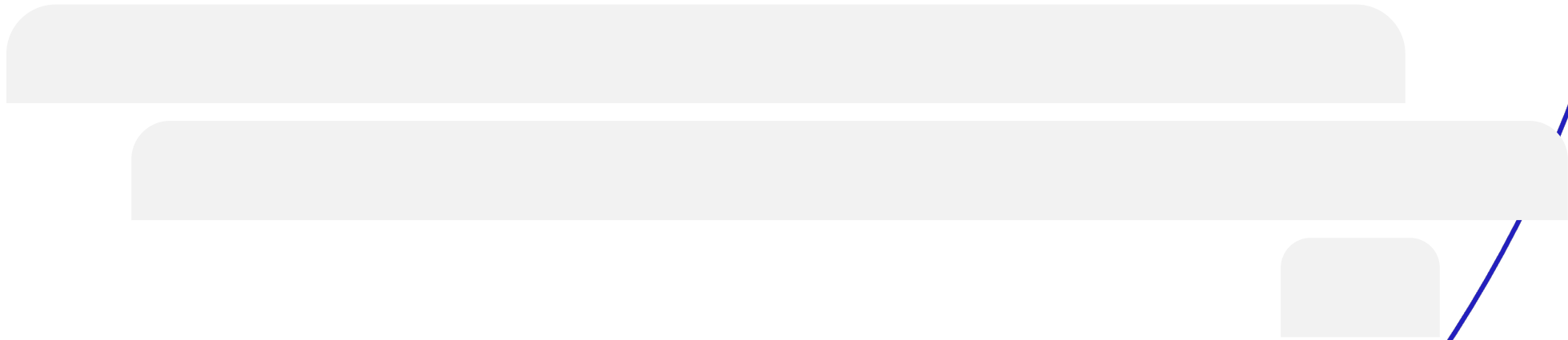
JAAMA KOGUMAKSUMUSEST
SELLE ELUTSÜKLI JOOKSUL
ON SEOTUD EHITUSTEGEVUSEGA

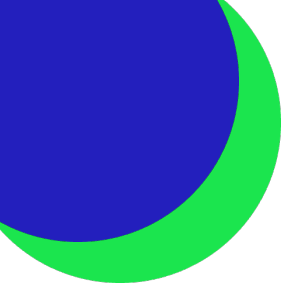
TOTAL COST OF THE STATION IS ASSOCIATED
WITH ITS CONSTRUCTION

20%

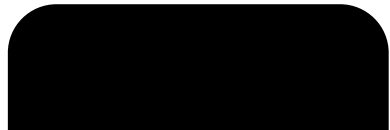
JAAMA KOGUMAKSUMUSEST
MOODUSTAB LAENUKULU,
EELDADES 7% INTRESSI JA
5-AASTAST EHITUSPERIOODI

FINANCING COST CONTRIBUTION TO THE TOTAL
COST OF THE STATION, ASSUMING 7% INTEREST
RATE AND A 5-YEAR CONSTRUCTION PERIOD





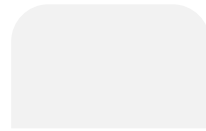
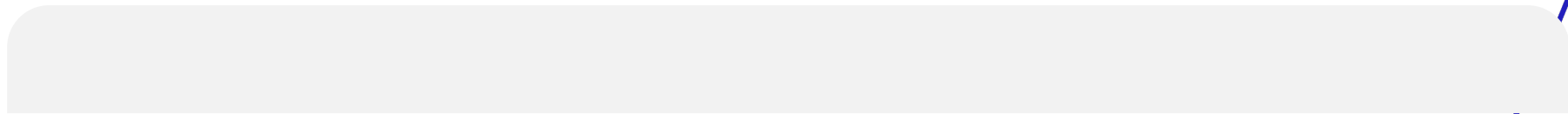
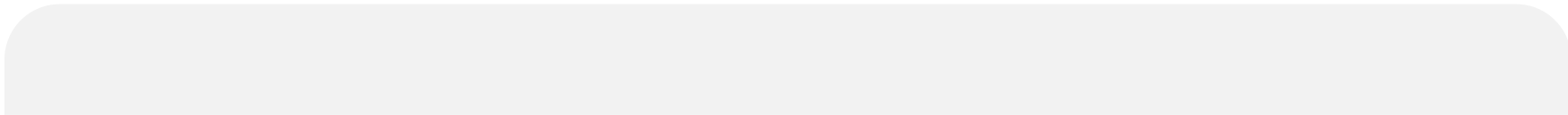
KONSTRUKTSIOON
ENGINEERING



TARNEAHEL
SUPPLY CHAIN



EHITUS
CONSTRUCTION



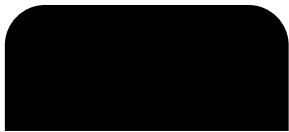
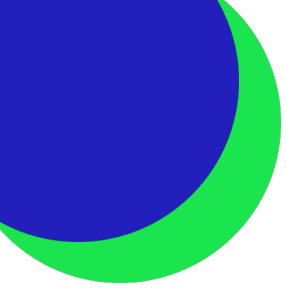
FOOKUS

EESTISSE RAJATAVA TUUMAJAAMA
KOGUMAKSUMUSE KONTROLLI ALL
HOIDMISEKS TULEB ÕPPIDA JAAMA
RAJAMISFAASIS TEHTUD VIGADEST NING
KOPEERIDA EDULUGUSID

FOCUS

IN ORDER TO CONTROL THE TOTAL COST OF
ESTONIA'S FUTURE NUCLEAR POWER PLAN,
WE NEED TO LEARN FROM THE MISTAKES
MADE AND COPY THE SUCCESS STORIES FROM
DESIGN AND CONSTRUCTION PHASES





KONSTRUKTSIOON
ENGINEERING



TARNEAHEL
SUPPLY CHAIN



EHITUS
CONSTRUCTION

FOOKUS

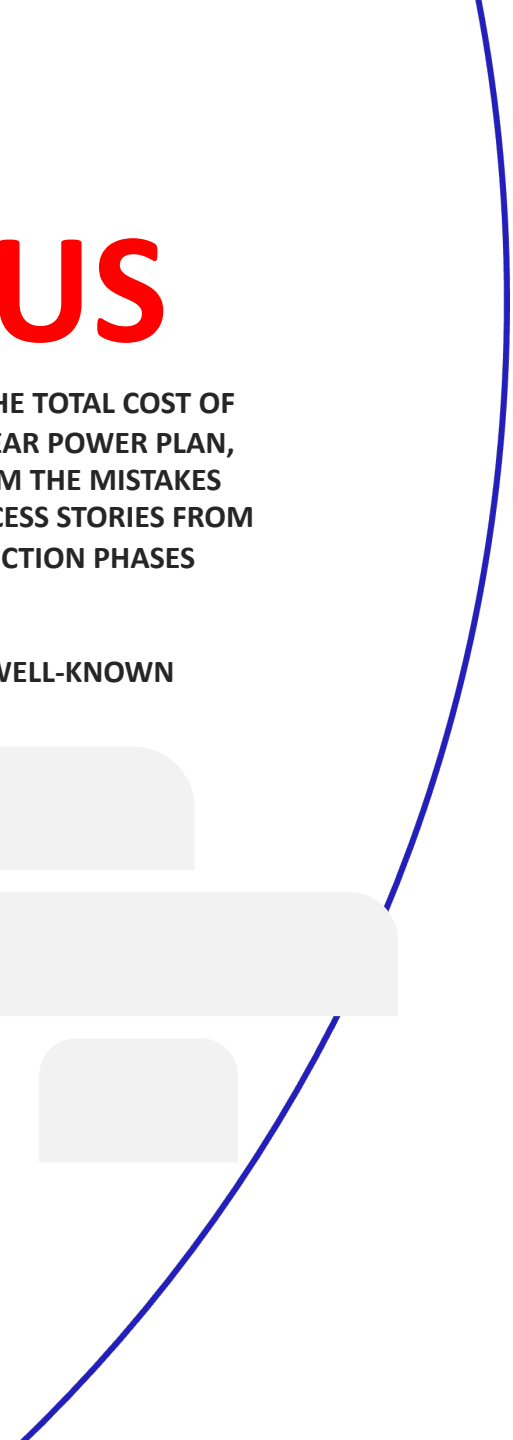
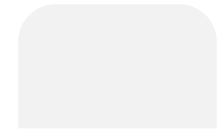
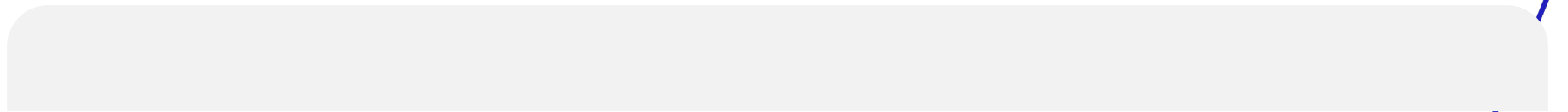
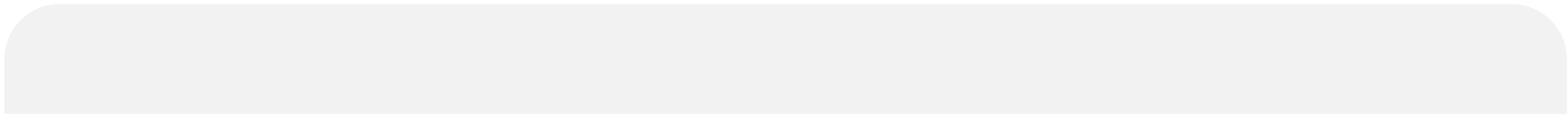
EESTISSE RAJATAVA TUUMAJAAMA
KOGUMAKSUMUSE KONTROLLI ALL
HOIDMISEKS TULEB ÕPPIDA JAAMA
RAJAMISFAASIS TEHTUD VIGADEST NING
KOPEERIDA EDULUGUSID

NEED ON ÕNNEKS TEADA

FOCUS

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ESTONIA'S FUTURE NUCLEAR POWER PLAN,
WE NEED TO LEARN FROM THE MISTAKES
MADE AND COPY THE SUCCESS STORIES FROM
DESIGN AND CONSTRUCTION PHASES

LUCKILY, THESE ARE WELL-KNOWN

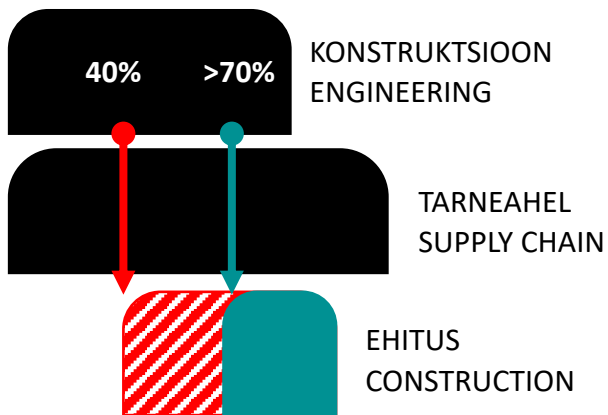




ÕPPETUND NR 1: ENNE PABER, SIIS BETOON

LESSON NO. 1: FIRST PAPER, THEN CONCRETE





KALLID JAAMAD

Arendajad valasid "esmase betooni" kui 40% jaama konstruktsioonist oli lõpetatud, pikendades sellega ehitusperioodi. Muudatused konstruktsioonis loovad suurusjärgudes kallimaid tööülesandeid ehitusplatsil.

TASKUKOHASED JAAMAD

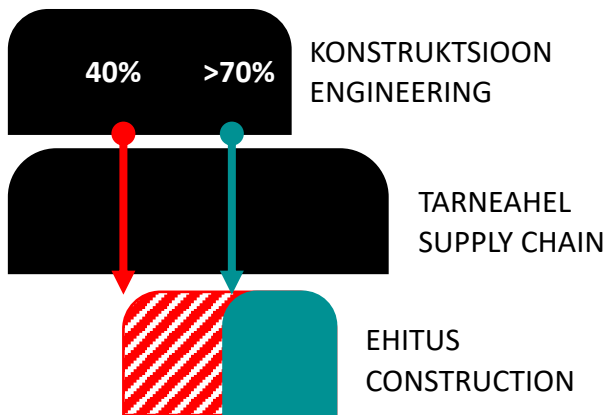
Arendajad valasid "esmase betooni" kui vähemalt 70% jaama detailkonstruktsioonist oli lõpetatud, piiratud tagajärgedega ehitusperioodi pikkusele.

EXPENSIVE STATIONS

Developers poured "first concrete betooniga" once 40% of the design had been completed, resulting in a longer construction. Changes in design create order of magnitude more expensive work on the construction site.

AFFORDABLE STATIONS

Developers poured "first concrete" once at least 70% of the station's detailed construction had been completed, with limited consequences for the construction length



KALLID JAAMAD

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AFFORDABLE STATIONS

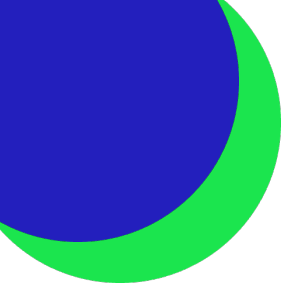
Developers poured "first concrete" once at least 70% of the station's detailed construction had been completed, with limited consequences for the construction length

EESTI JAAM

Kuna Eestisse ei ehitata FOAK, on valdav osa konstruktsiooni arendustööst eelnevalt lõpetatud. Kohandused vajalikud, kuid ehituse alguse ajastamine lihtsam.

ESTONIAN STATION

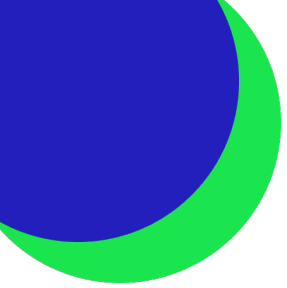
Given that Estonia will not build a FOAK plan, it is safe to assume that a large portion of engineering work has been completed. Adjustments necessary, but timing the beginning of construction is simpler.



ÕPPETUND NR 2: TAGA KVALITEETNE TARNEAHEL

LESSON NO. 2: SECURE HIGH-QUALITY SUPPLY CHAIN





KONSTRUKTSIOON
ENGINEERING



TARNEAHEL
SUPPLY CHAIN



EHITUS
CONSTRUCTION

KALLID JAAMAD

Otsesed ja kaudsed kulud tõusevad stagneerunud tarneahelate tõttu, st kadunud on tuumaspetsiifiline tootmisvõimsus, pädevus, kvaliteet ja konkurents on kehv. Ettevalmistuste vajalikku mahtu ja ajakulu alahinnatakse. Lepingud ei soosi koostööd vaid riskide hinnastamist ja kohtuvaidlusi. Ehitamise lõptamine venib.

TASKUKOHASED JAAMAD

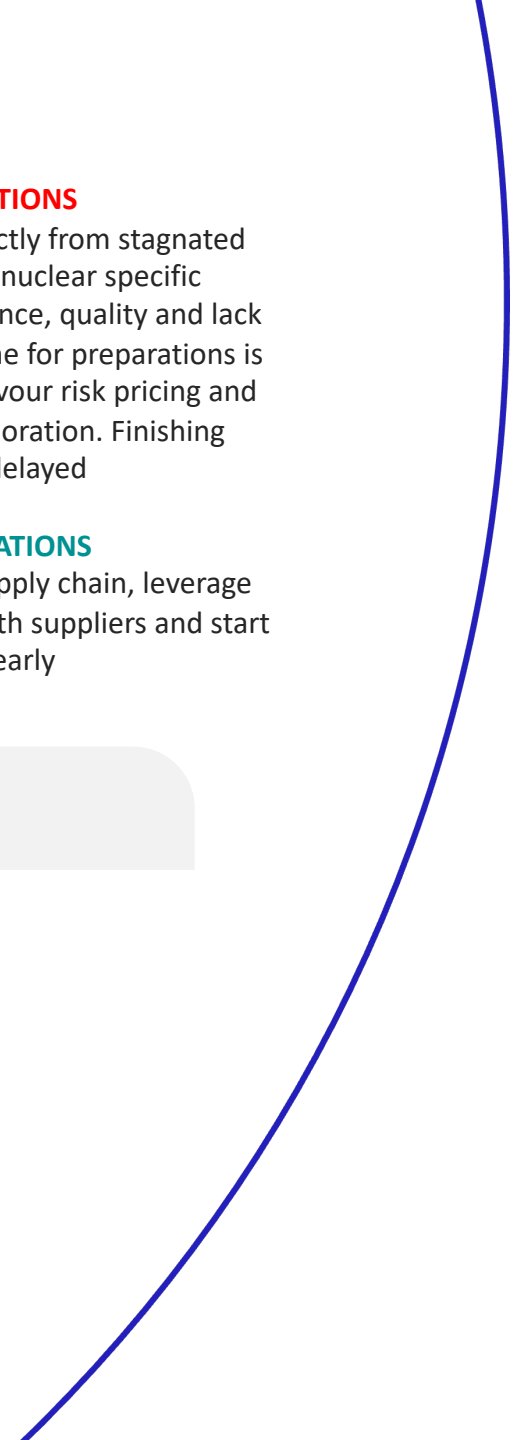
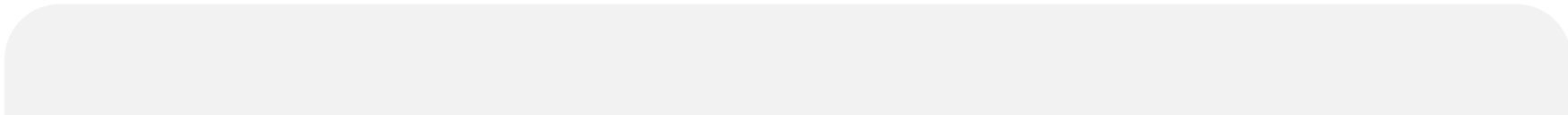
Lõikavad kasu sissetöötatud tarneahelast, rõhuvad ühistele ärihuvidele tarnijatega ja alustavad ettevalmistustega varakult

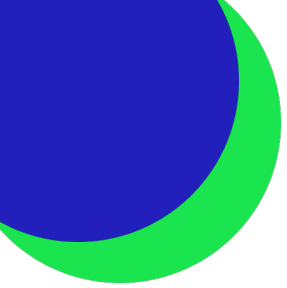
EXPENSIVE STATIONS

Costs rise directly and indirectly from stagnated supply chains, i.e. loss of nuclear specific production capacity, competence, quality and lack of competition. Scope and time for preparations is underestimated. Contracts favour risk pricing and litigation rather than collaboration. Finishing construction is delayed

AFFORDABLE STATIONS

Profit from an established supply chain, leverage common business interests with suppliers and start preparations early





KONSTRUKTSIOON
ENGINEERING



TARNEAHEL
SUPPLY CHAIN



EHITUS
CONSTRUCTION

KALLID JAAMAD

Otsesed ja kaudsed kulud tõusevad stagneerunud tarneahelate tõttu, st kadunud on tuumaspetsiifiline tootmisvõimsus, pädevus, kvaliteet ja konkurents on kehv. Ettevalmistuste vajalikku mahtu ja ajakulu alahinnatakse. Lepingud ei soosi koostööd vaid riskide hinnastamist ja kohtuvaidlusi. Ehitamise lõptamine venib.

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EESTI JAAM

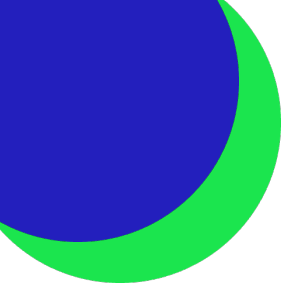
Saab lõigata kasu Põhja-Ameerika, Euroopa ja Aasia tarneahelate juba realiseerinud arengust. Lisaks võib oodata kiiret tarneahelate arengut samade ja sarnaste väikereaktorite rajamisel Euroopas.

Tarnijate seire ja hindamine juba töös.

ESTONIAN STATION

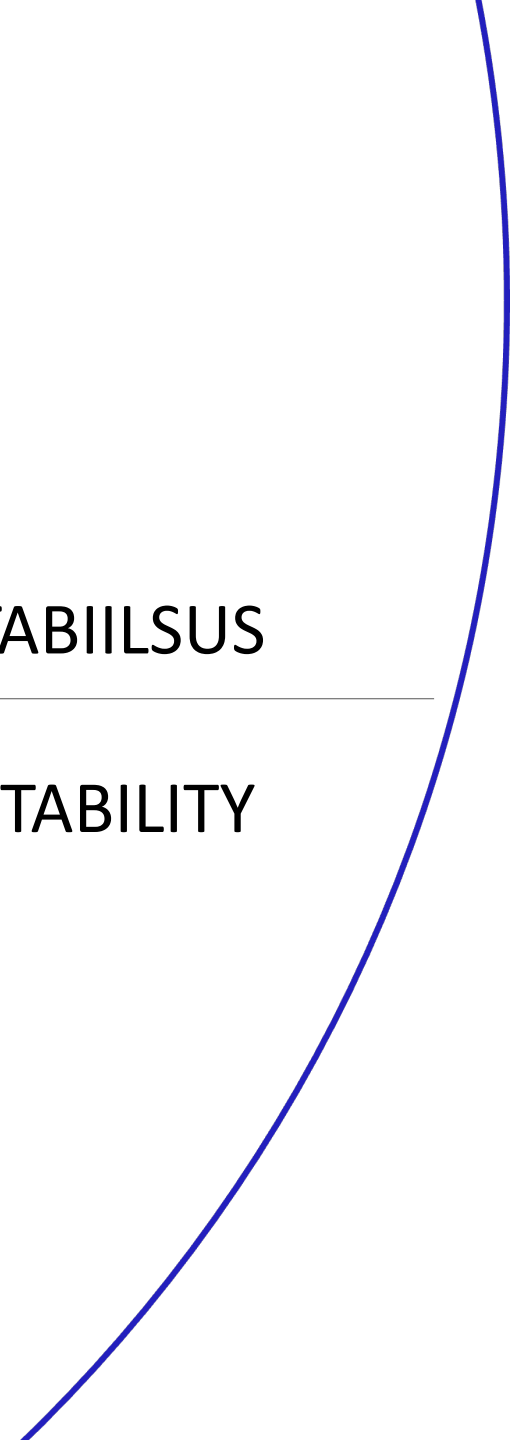
Can benefit from recent supply chain developments in North-America, Europe and Asia. Additionally, rapid developments expected in Europe due to constructing the same and similar reactors in Europe.

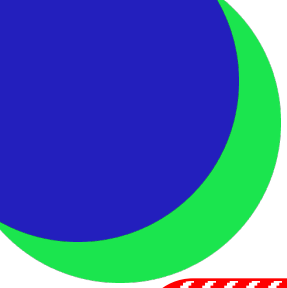
Monitoring and evaluation of Suppliers already ongoing.



ÕPPETUND NR 3: TÖÖTA KOOS REGULAATORIGA, TAGA STABIILSUS

LESSON NO. 3: WORK WITH YOUR REGULATOR, ENSURE STABILITY





KONSTRUKTSIOON
ENGINEERING



TARNEAHEL
SUPPLY CHAIN



EHITUS
CONSTRUCTION

KALLID JAAMAD

Arendaja on regulaatorist distantseerunud, suhtlusvorm on reaktiivne ja (liig)formaalne. Arendajale on nõuded ebaselged ja muutused tulevad ootamatult. Arendustöö vajalik alahinnatud. Konstruktsiooni ja ehitustööde lõpetamine ning käidu algus venivad.

TASKUKOHASED JAAMAD

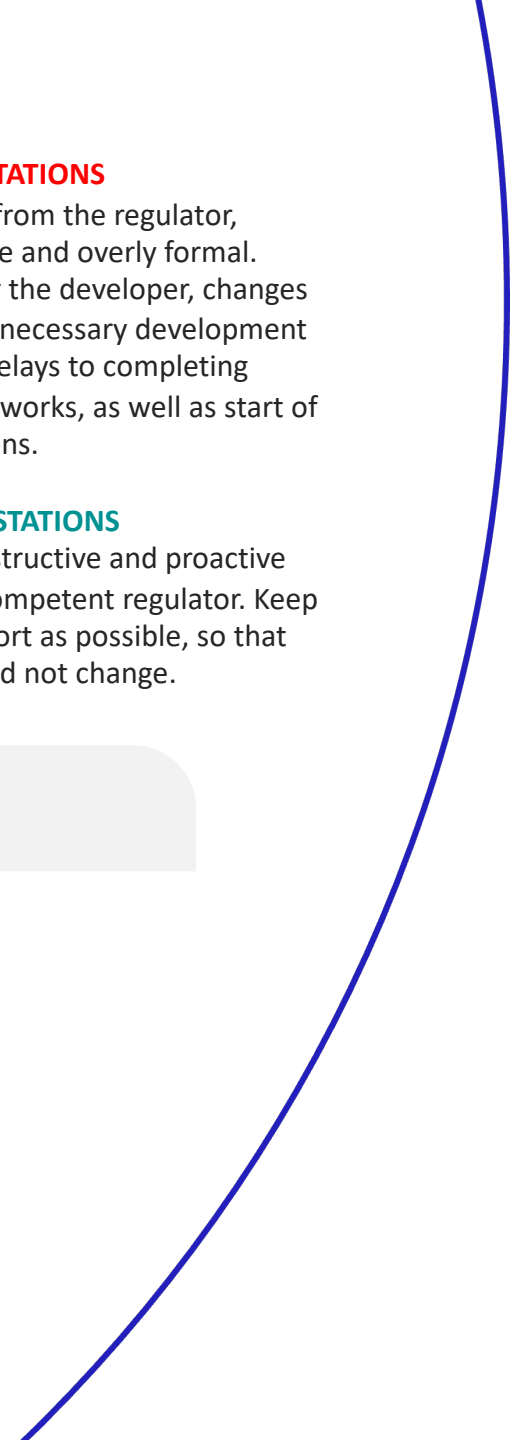
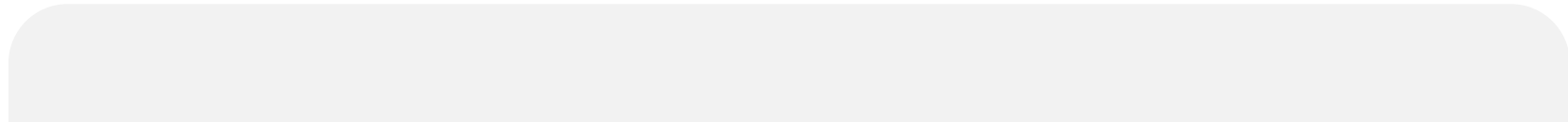
Arendaja hoiab pädeva regulaatoriga konstruktiivset ja proaktiivset töösuhet. Arendaja hoiab tööaknad võimalikult väikese, et nõuded ei jõuaks keset protsessi muutuda.

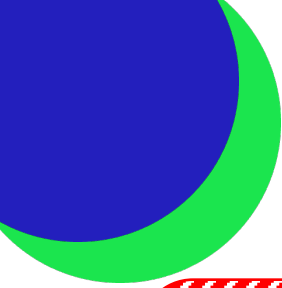
EXPENSIVE STATIONS

Developer is distanced from the regulator, communication is reactive and overly formal. Requirements are unclear for the developer, changes come as a surprise. Scope of necessary development work underestimated. Delays to completing engineering and construction works, as well as start of operations.

AFFORDABLE STATIONS

Developer maintains a constructive and proactive working relationship with a competent regulator. Keep their working periods as short as possible, so that requirements would not change.





KONSTRUKTSIOON
ENGINEERING



TARNEAHEL
SUPPLY CHAIN



EHITUS
CONSTRUCTION

KALLID JAAMAD

Arendaja on regulaatorist distantseerunud, suhtlusvorm on reaktiivne ja (liig)formaalne. Arendajale on nõuded ebaselged ja muutused tulevad ootamatult. Arendustöö vajalik alahinnatud. Konstruktsiooni ja ehitustööde lõpetamine ning käidu algus venivad.

TASKUKOHASED JAAMAD

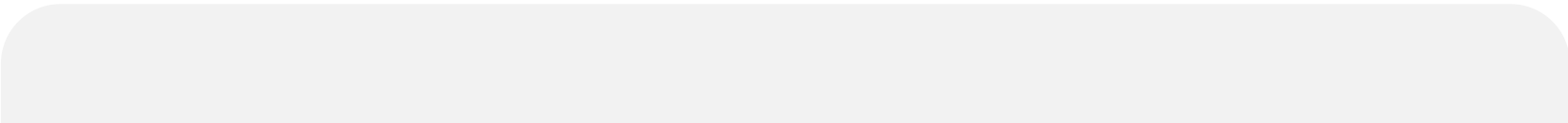
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EESTI JAAM

Tuumaenergeetika liigub harmoniseerumise ja standardiseerumise suunas, Eestil puuduvad ajaloolised takistused moodsa regulaatori arendamisel. Võimalik arendada regulaatorit põhimõttel "turvalisus ja edasminek". Arendajal puudub (õigustatult) kontroll regulaatori üle, aga kontrollib omapoolset avatust ja koostöövalmidust.

ESTONIAN STATION

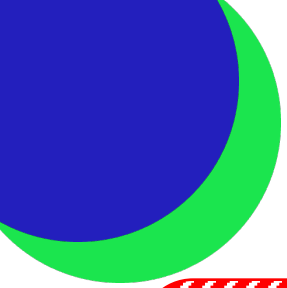
Nuclear energy is moving towards harmonization and standardization, Estonia has no legacy hindering the development of a modern regulator. Possible to develop the regulator on the principle of "safety and progress". The developer has (justifiably) no control over the regulator, but does control own transparency and willingness to collaborate.



ÕPPETUND NR 4: KASUTA KOGENUD PROJEKTIMEESKONDA

LESSON NO. 4: USE AN EXPERIENCED PROJECT TEAM





KONSTRUKTSIOON
ENGINEERING



TARNEAHEL
SUPPLY CHAIN



KÄIT
OPERATIONS



AEG ON RAHA
TIME IS MONEY

KALLID JAAMAD

Arendaja kasutab kogeenematut meeskonda projekti juhtimiseks. Puudub ka tugev juhtimiskultuur, rollid ja vastutusosalad on ebaselged, projekti meeskond ei ole kohal, puudub arusaam projekti keerukusest ja võime võtta vastu operatiivseid otsuseid. Projekti planeerimine on optimistlik nii aja kui eelarve osas, esmane hinnang jääb ankruks ning vigu ei julgeta tunnistada.

TASKUKOHASED JAAMAD

Taaskasutavad eelnevalt edukat projekti meeskonda, kes on suuteline E ja P nii ellu viima, et C jääks projekti tähtaegade piiridesse. Aeg on raha.

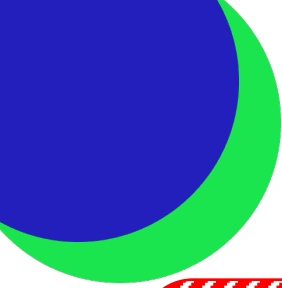
EXPENSIVE STATIONS

Developer uses an inexperienced team to run the project. Leadership culture is lacking, roles and responsibilities are unclear, project team is not on site, lack of understanding of the complexity of the project and inability to take operative decisions.

Planning is time and budget optimistic, first estimations become anchors, mistakes are not admitted.

AFFORDABLE STATIONS

Reuse previously successful project teams that are able to execute E and P and so that C can be delivered within project deadlines. Time is money.



KONSTRUKTSIOON
ENGINEERING



TARNEAHEL
SUPPLY CHAIN



AEG ON RAHA
TIME IS MONEY

KÄIT
OPERATIONS

KALLID JAAMAD

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EESTI JAAM

Peab kombineerima FOAK jaama ehitanud projekti meeskonna, õnnestunud suuri jaamu ehitanud individide ja ettevõtete ning Eestis edukalt suurprojekte ellu viinute kogemusi ja pädevusi.

Pädevuse kasvatamine tööpostil õppimise kaudu ei ole õige lähenemine.

EXPENSIVE STATIONS

Developer uses an inexperienced team to run the project. Leadership culture is lacking, roles and responsibilities are unclear, project team is not on site, lack of understanding of the complexity of the project and inability to take operative decisions.

Planning is time and budget optimistic, first estimations become anchors, mistakes are not admitted.

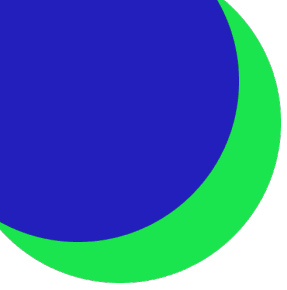
AFFORDABLE STATIONS

Reuse previously successful project teams that are able to execute E and P and so that C can be delivered within project deadlines. Time is money.

ESTONIAN STATION

Must combine the experiences and competences of those who will have built the FOAK station, those who have successfully built large stations, and those who have successfully executed large projects in Estonia.

Do not learn on the job.



TUUMAJAMAAD EI PEA OLEMA KALLID...

NUCLEAR POWER PLANTS DON'T HAVE TO BE EXPENSIVE...

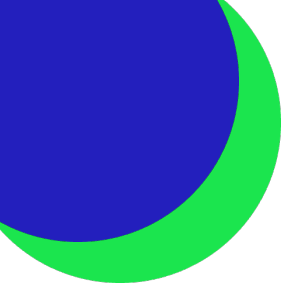




...KALLIS ON VIGADEST MITTE ÕPPIDA

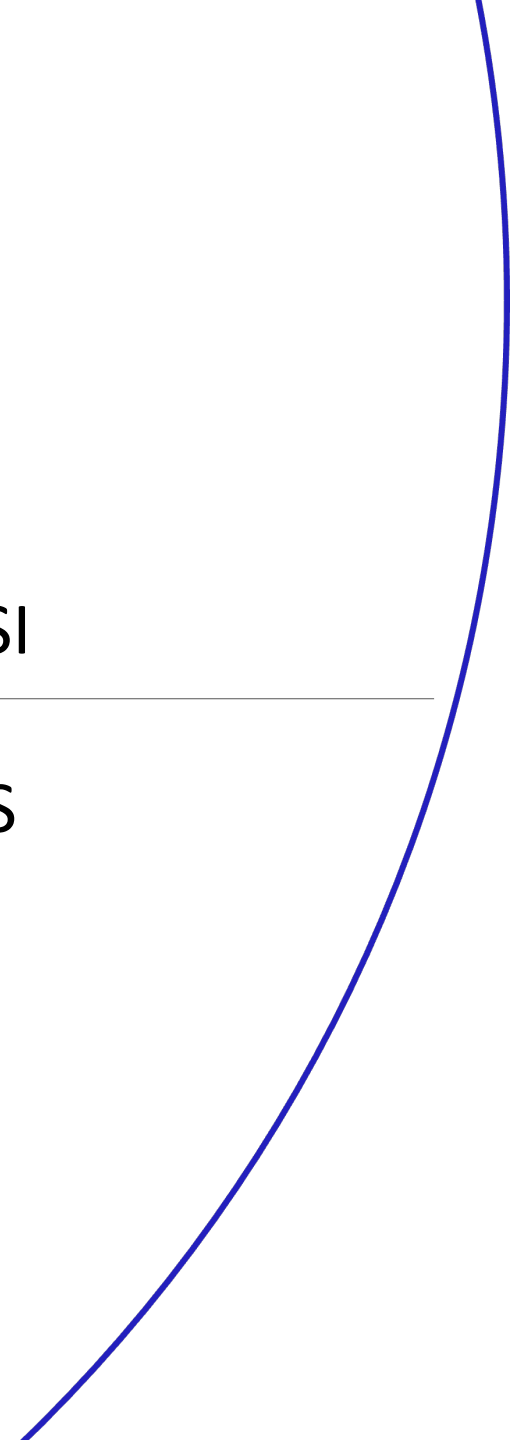
...NOT LEARNING FROM MISTAKES IS EXPENSIVE

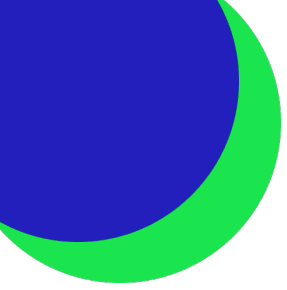




LAS EESTI RAKENDAB TEISTELT SAADUD KOGEMUSI

LET ESTONIA APPLY LESSONS LEARNED BY OTHERS





EHITAME TASKUKOHASE JAAMA!

LET'S BUILD AN AFFORDABLE PLANT!

