Jarðstrengslagnir í flutningskerfinu

Kynning fyrir Hagsmunaráð Landsnets

31.10.2018 / Magni Þór Pálsson

Yfirlit

- Tæknilegir þættir
- Kerfislægir þættir
- Lagning og fylliefni
- Ísland og útlönd
- Þróun og framtíðarhorfur

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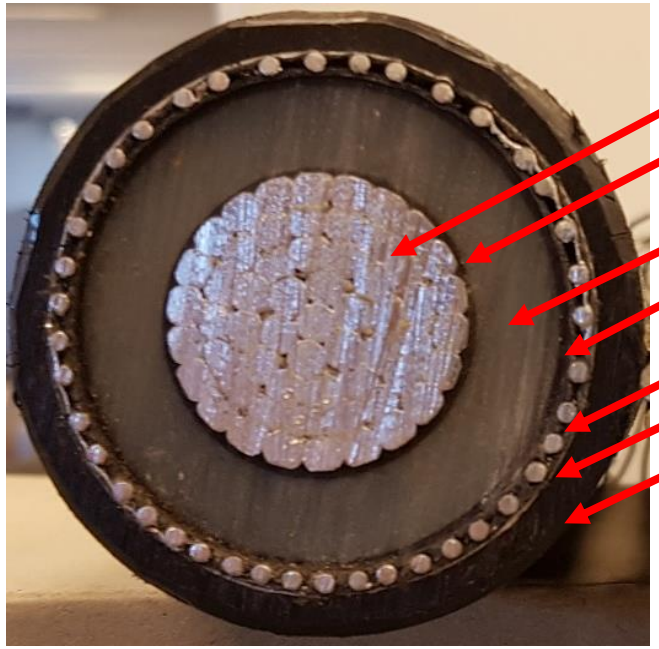
Tæknilegir þættir

Jarðstrengur og loftlínuleiðari - uppbygging



1. Leiðari
2. Leiðaraskermur (innra hálfleiðandi lag)
3. Einangrun
4. Einangrunarskermur (ytra hálfleiðandi lag)
5. Skermleiðari
6. Málmvafningur
7. Kápa

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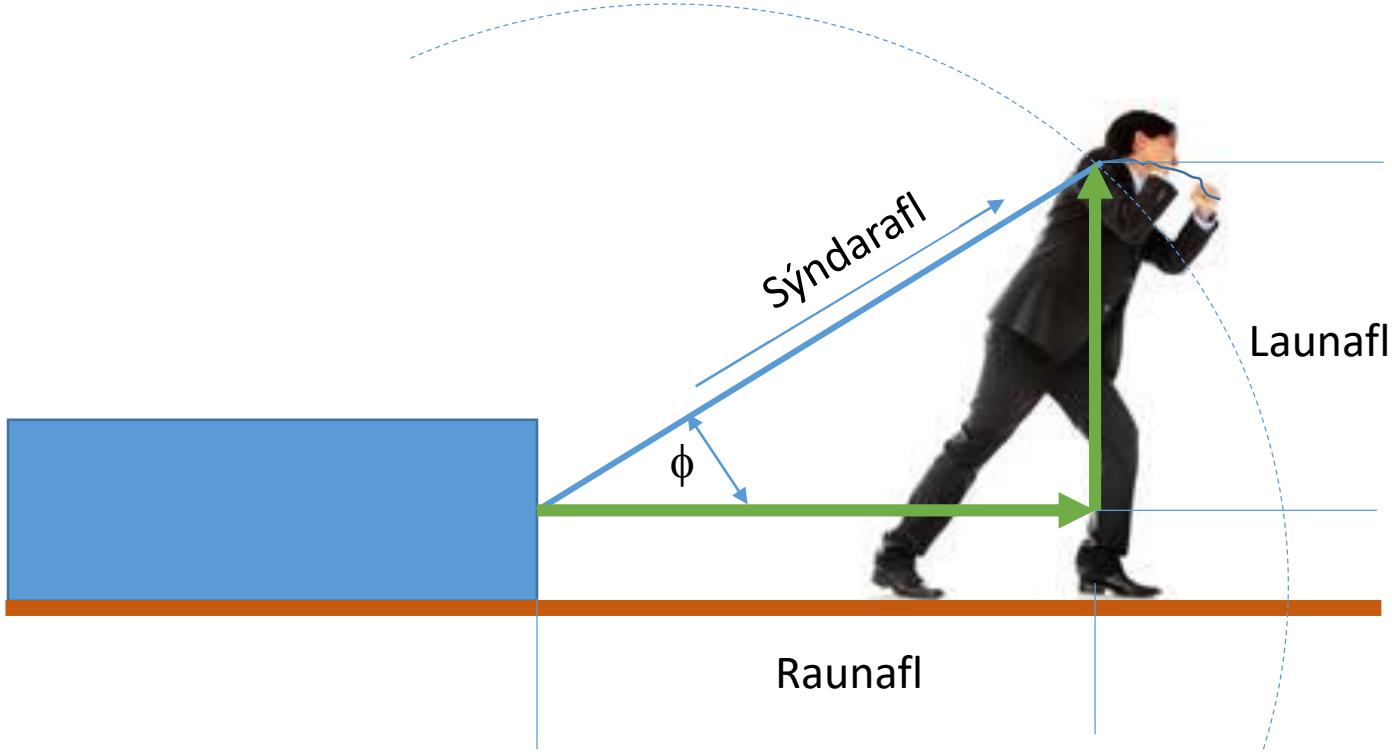
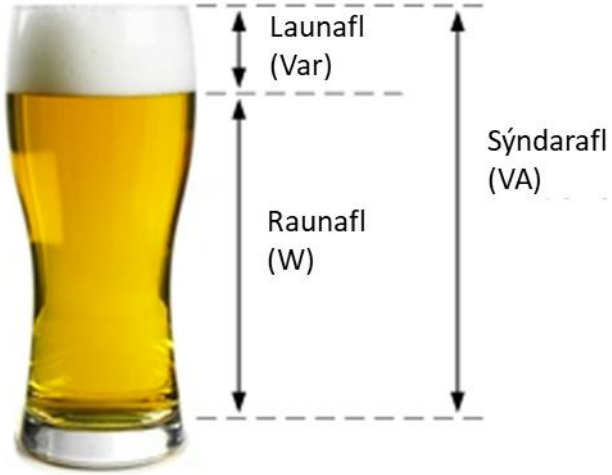
Raunafl, launafl, sýndarafl, aflstuðull





Aflstuðullinn, cosϕ, er mælikvarði á hve raunaflið er stór hluti sýndaraflsins

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Launafl – spenna – strenglengd

- Launafl er gagnlegt upp að vissu marki
- Launafl hefur áhrif á spennu í kerfinu
- Launafl er í hlutfalli við spennuna í öðru veldi
- Einn kílómetri af 220 kV jarðstreng framleiðir jafnmikið launafl og...
  - ...rúmir 2 km af 132 kV streng
  - ...8 km af 66 kV streng
  - ...40 km af 33 kV streng
  - ...tæplega 100 km af 19 kV streng
  - ...180 km af 11 kV streng

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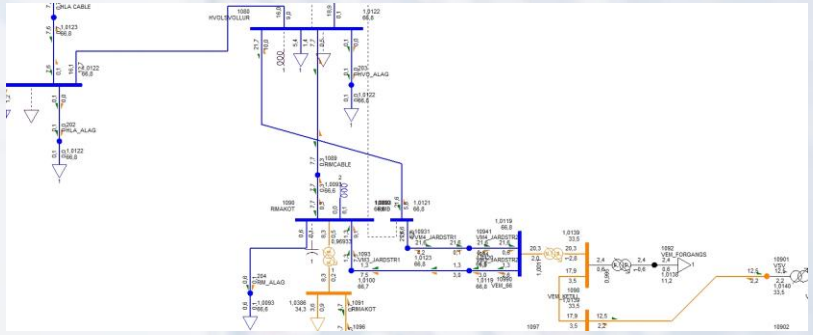
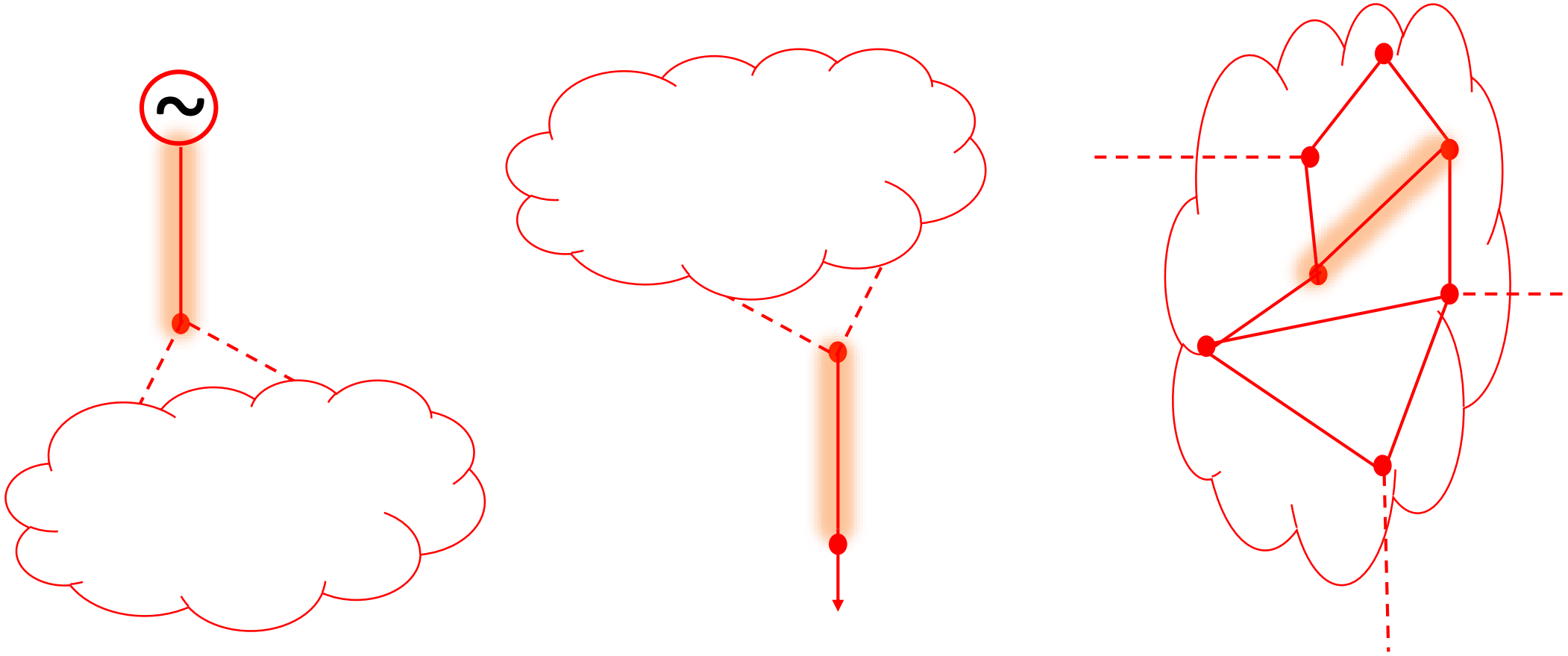
Kerfislægir þættir



Staðsetning og hlutverk strengs



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Launafl og styrkur kerfis

- Samspil launafls og kerfisstyrks í tengipunkti ráðandi þáttur varðandi mögulega jarðstrengslengd
  - *Spennuþrep*
  - *Yfirtónamögnun*

  } Áhrif á spennugæði
- Kerfisstyrkur misjafn eftir landsvæðum
- Í samtengdu kerfi hefur jarðstrengur í einni línu áhrif á mögulegar jarðstrengslagnir í annarri (öðrum) línu(m) innan sama svæðis
- Þetta á líka við á milli spennustiga!

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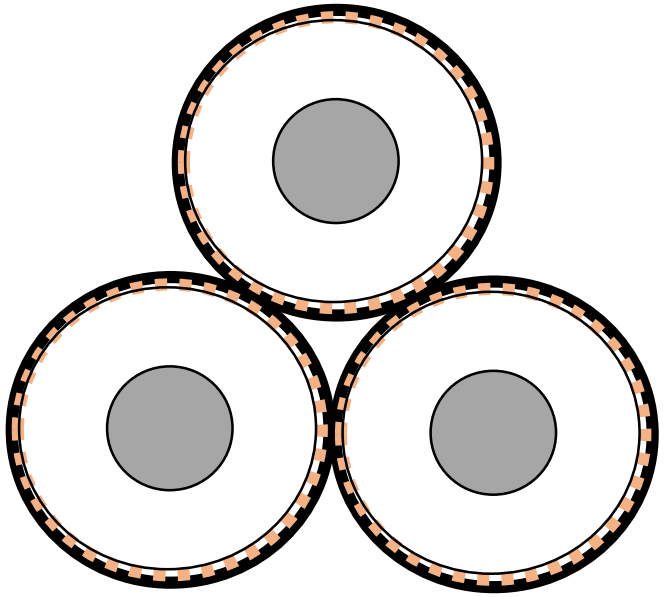
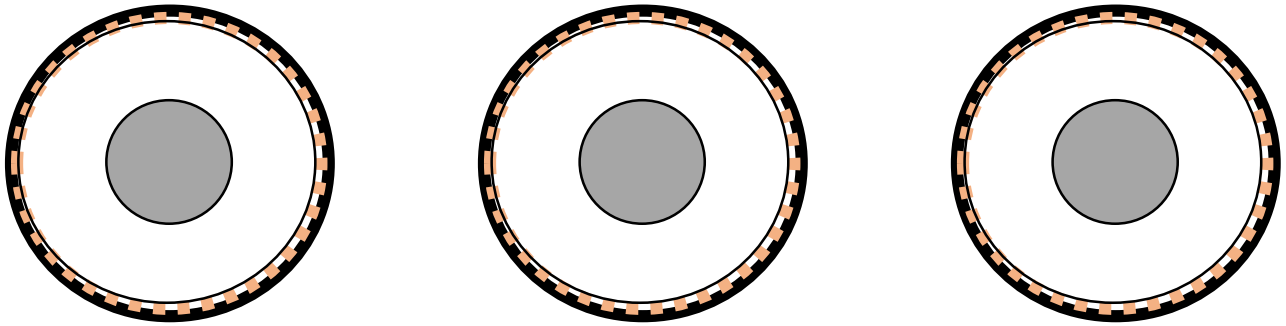
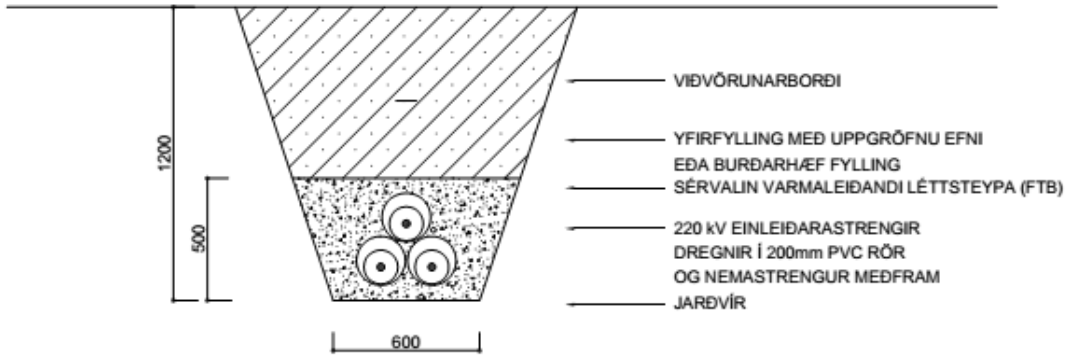
Lagning og fylliefni

Lagning

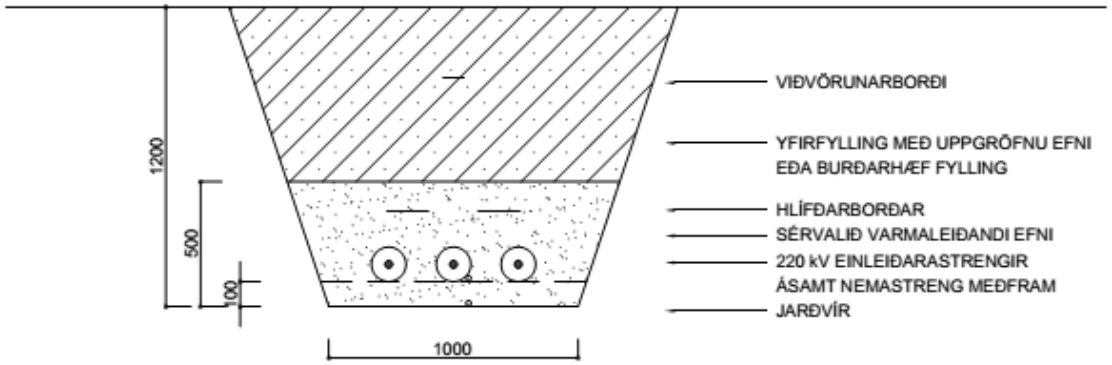




Þríhyrningsuppröðun

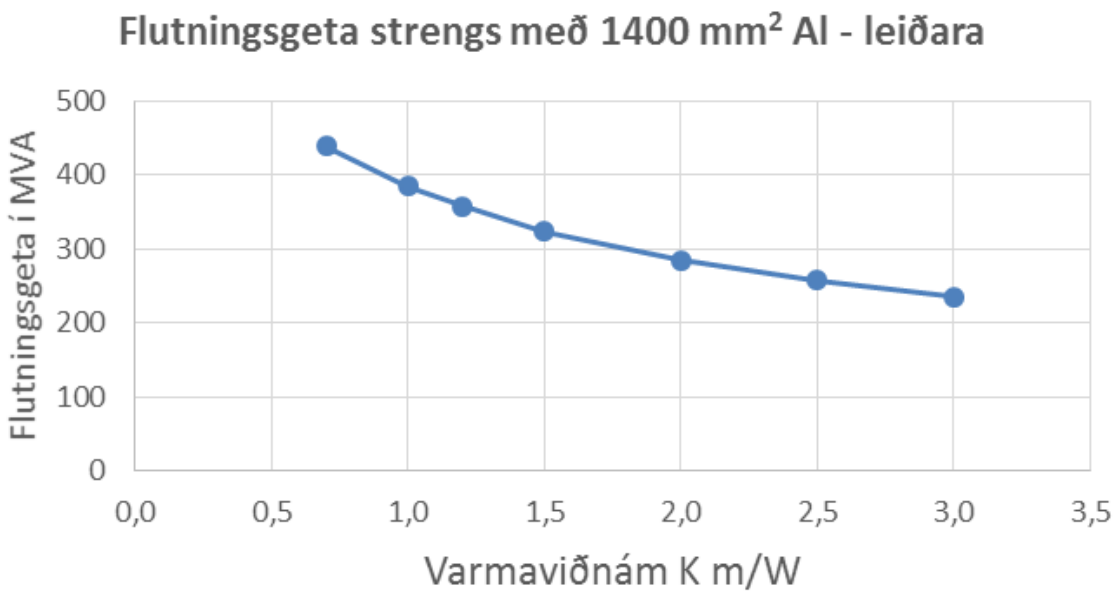


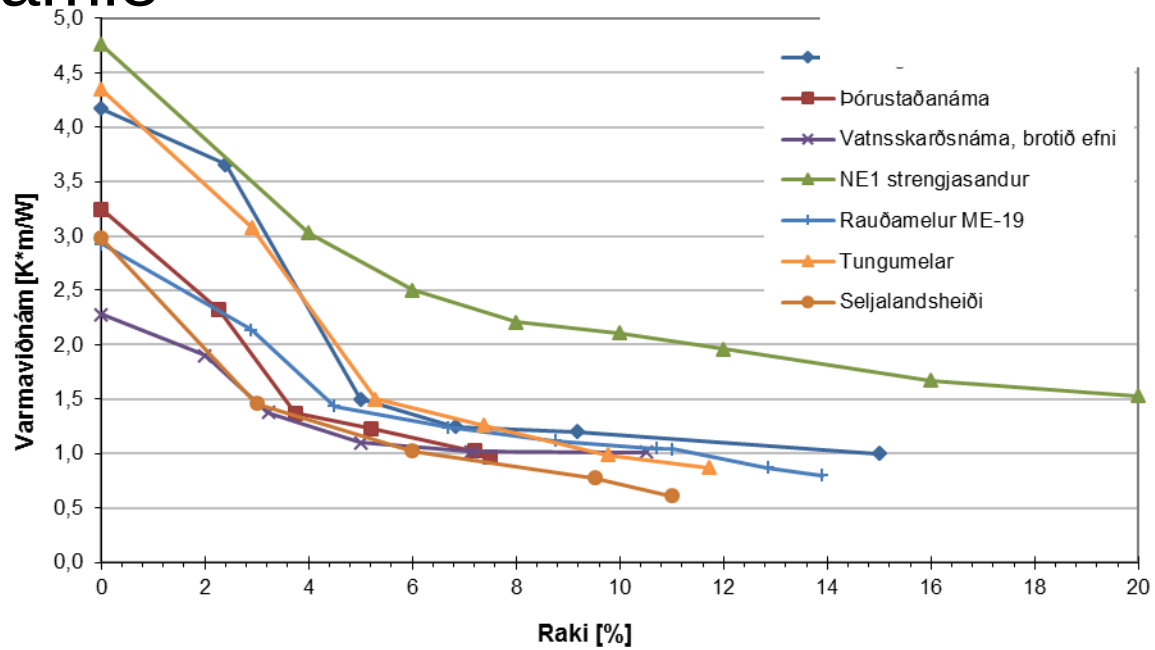
Flöt uppröðun



Strengjasandur - fylliefni

- Leiðir hita frá strengnum
- Varmaviðnám efnisins ráðandi þáttur varðandi flutningsgetu
- Rakastig efnisins hefur mikil áhrif á varmaviðnámið





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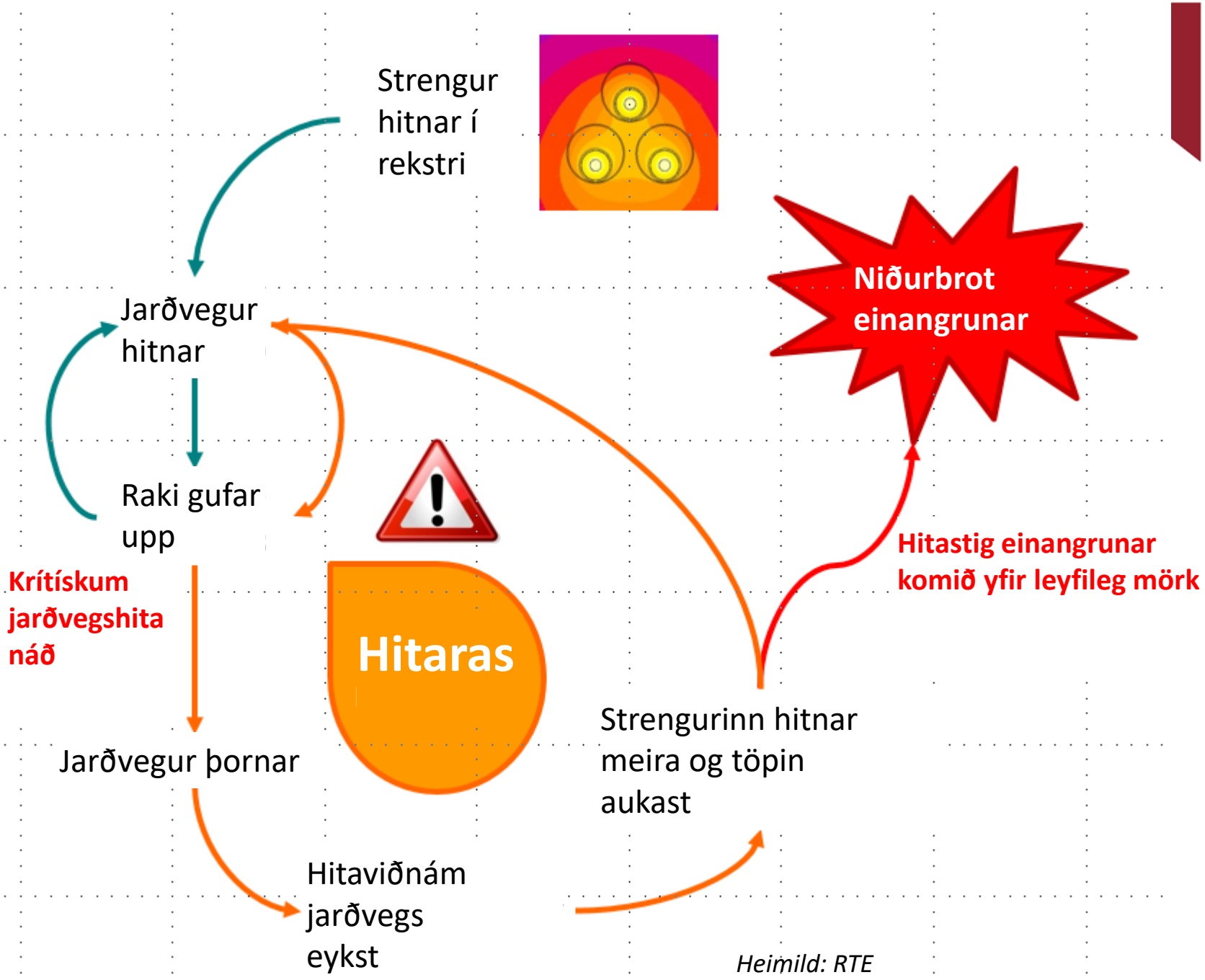
Varmabúskapur



Heimild: RTE

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Ísland og útlönd

Danmörk

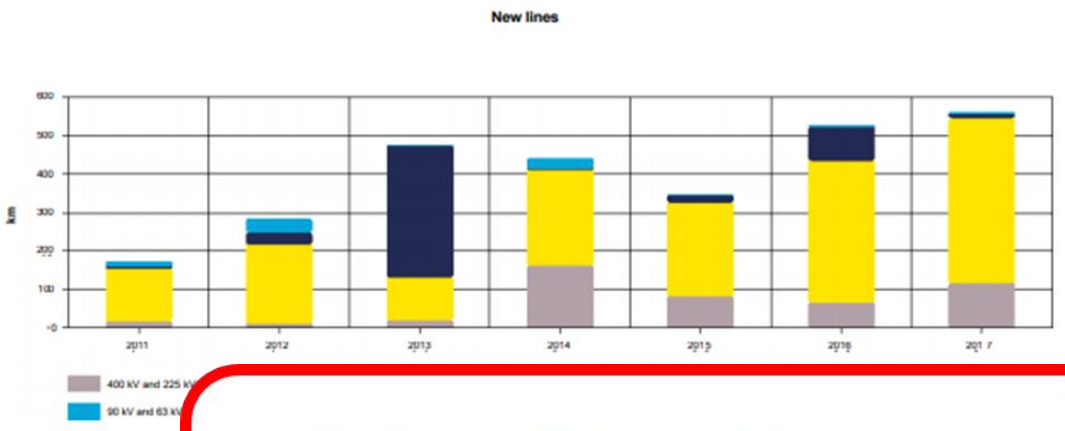
Spennustig	Loftlína (km)	Jarðstrengur (km)	Samtals (km)	Hlutfall (%)
132 kV	753	476	1.228	39
150 kV	1.216	605	1.822	33
220 kV	40	84	124	68
400 kV	946	114	1.061	11
Samtals	2.956	1.279	4.235	30

Ísland

Spennustig	Loftlína (km)	Jarðstrengur (km)	Samtals (km)	Hlutfall (%)
33 kV	27	31	58	53,4
66 kV	906,3	127,5	1.033,8	12,3
132 kV	1.246,8	86,4	1.333,2	6,5
220 kV	917,8	0,07	917,9	0,008
Samtals	3.098	245	3.343	7,3

14,5%

Frakkland



- 7.7% of all 63/90 kV lines,
- 5.1% of all 225 kV lines,
- a negligible share of 400 kV lines.

Overhead

A variety of s
economic, env

RTE has comm
place at least 30%

The difference in investment cos etween overhead and underground lines depends on voltage levels: costs are the same fo nd 90 kV, but underground lines cost about twice as much as overhead lines for 225 k eight times as much for 400 kV(*).

Underground lines c tly represent:

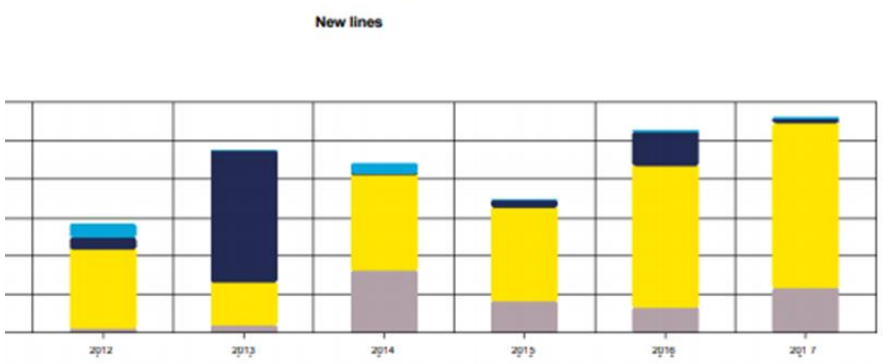
- 7.7% of all 63/90 kV lines,
- 5.1% of all 225 kV lines,
- a negligible share of 400 kV lines.

(*) Underground cables for 400 kV AC are quite expensive and substations must be installed every 20 km to offset the capacitive effect of the cables. At this voltage level, buried DC lines can be an option. The cost is the same as an overhead AC line, but transmission capacity is three to five times lower.

Danmörk

- Det eksisterende transmissionsnet på 132 kV og 150 kV bevares som udgangspunkt som luftledninger. Der kabellægges på udvalgte strækninger gennem naturområder og bymæssig bebyggelse.
- De seks konkrete projekter beskrevet i rapporten "Forskønnelse af 400 kV-nettet" fastholdes. Heraf er tre projekter allerede gennemført.
- Nye 400 kV-forbindelser etableres som luftledninger med mulighed for kabellægning på udvalgte strækninger og med mulighed for kompenserende kabellægning af 132-150 kV-net i nærheden af 400 kV-luftledninger.
- Nye 132-150 kV-forbindelser etableres med kabler.

d



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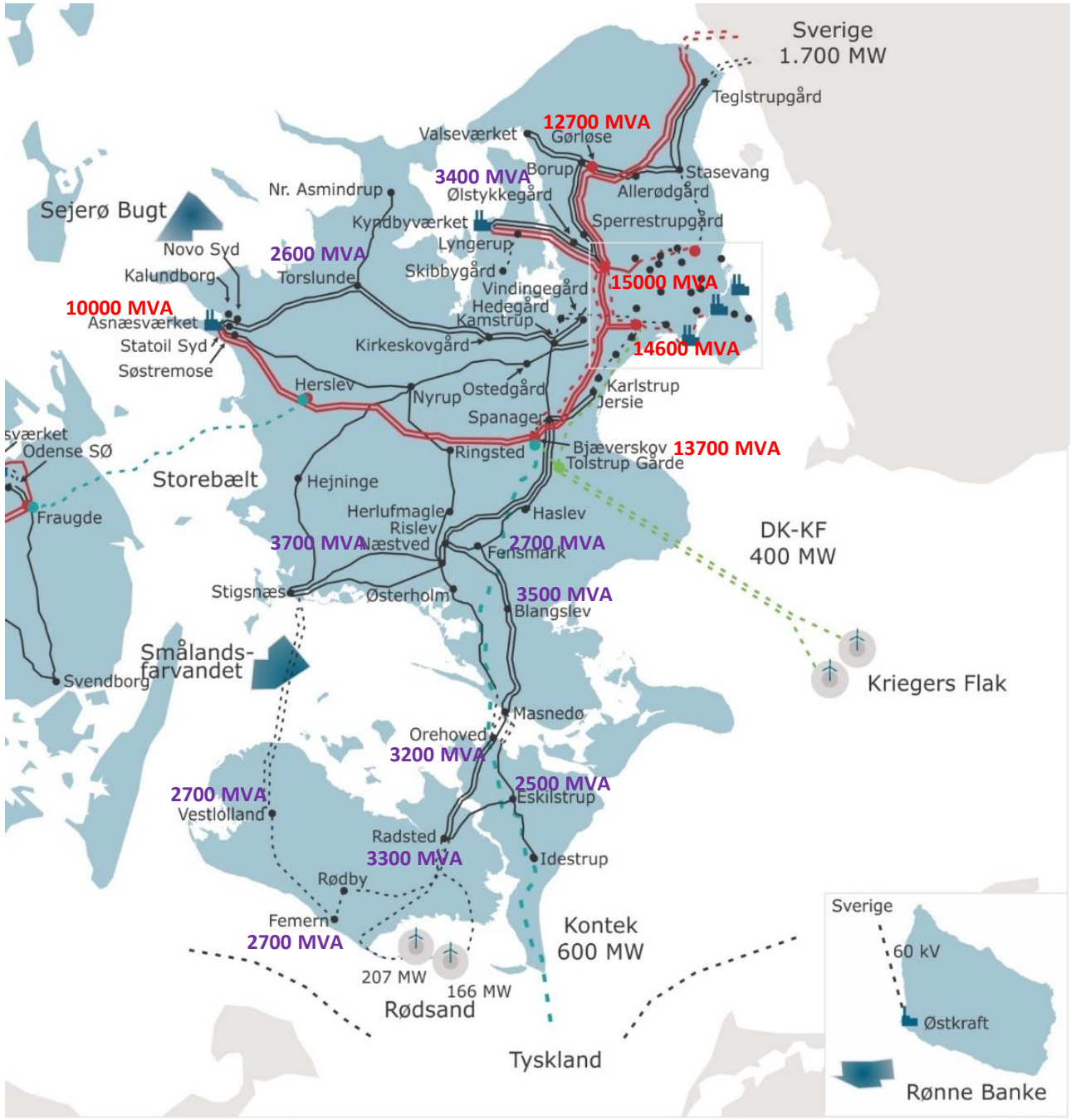

Skammhlaupsafl á 400 kV

Skammhlaupsafl á 132/150 kV

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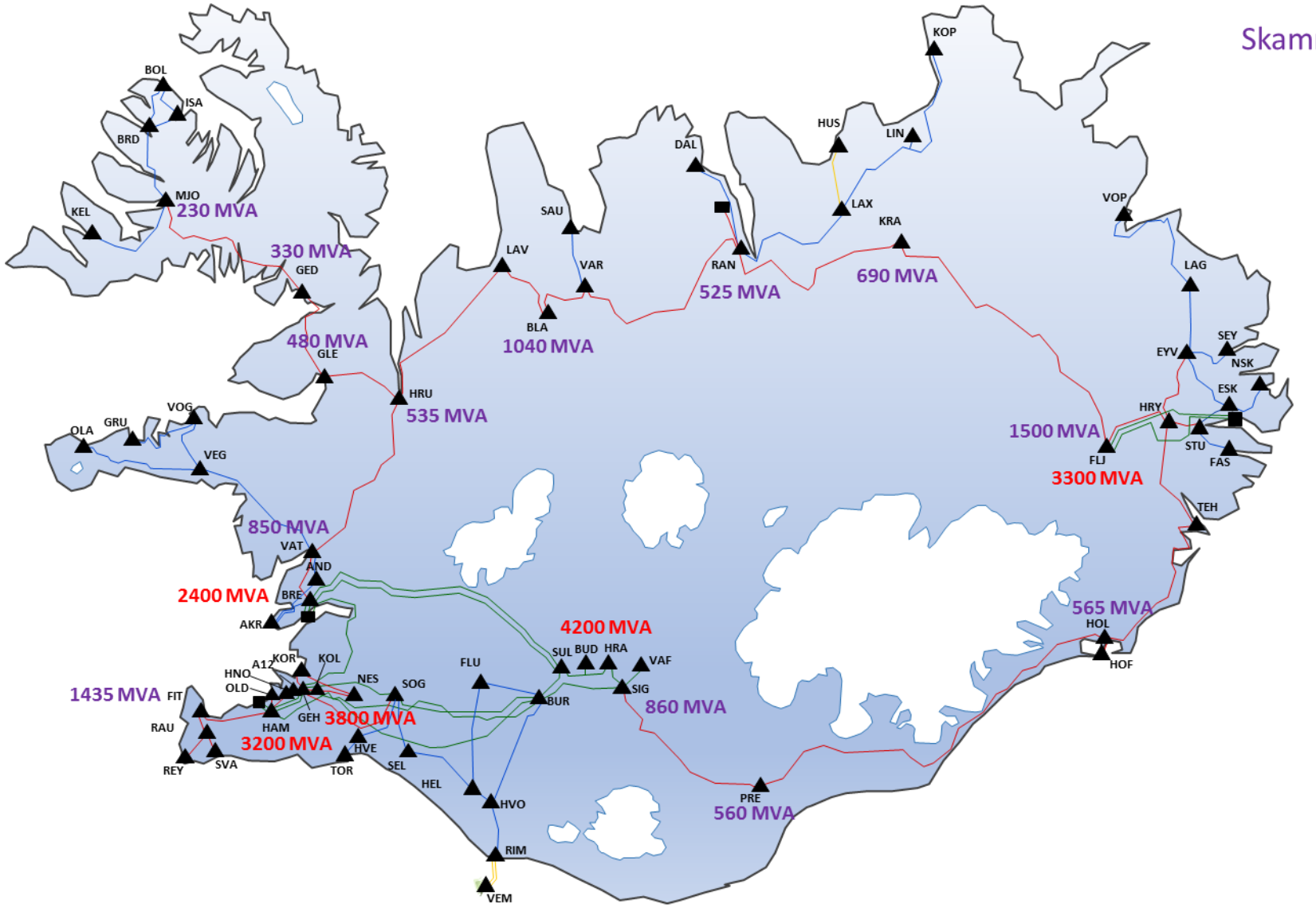
Skammhlaupsafl á 220 kV

Skammhlaupsafl á 132 kV



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Jarðstrengslengdir í meginflutningskerfinu

Mat á mögulegum jarðstrengslengdum í nýju 220 kV flutningskerfi á Norðurlandi

Kerfisgreining

LANDSNET 17003

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TEKNISK REDEGØRELSE: OP TIL 15 PROCENT AF 400 KV ELFORBINDELSE KAN GRAVES I JORDEN

PUBLICERET D. 1.10.2018 14.00

Det vil medføre betydelige risici og kan påvirke både Danmarks forsyning og forbrugernes elapparater, hvis lange stræk eller hele de planlagte 400 kV-forbindelser i Vest- og Sønderjylland lægges som kabler i jorden. Teknisk redegørelse til ministeren viser, at op til ca. 15 procent kabellægning er muligt.

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NOTAT

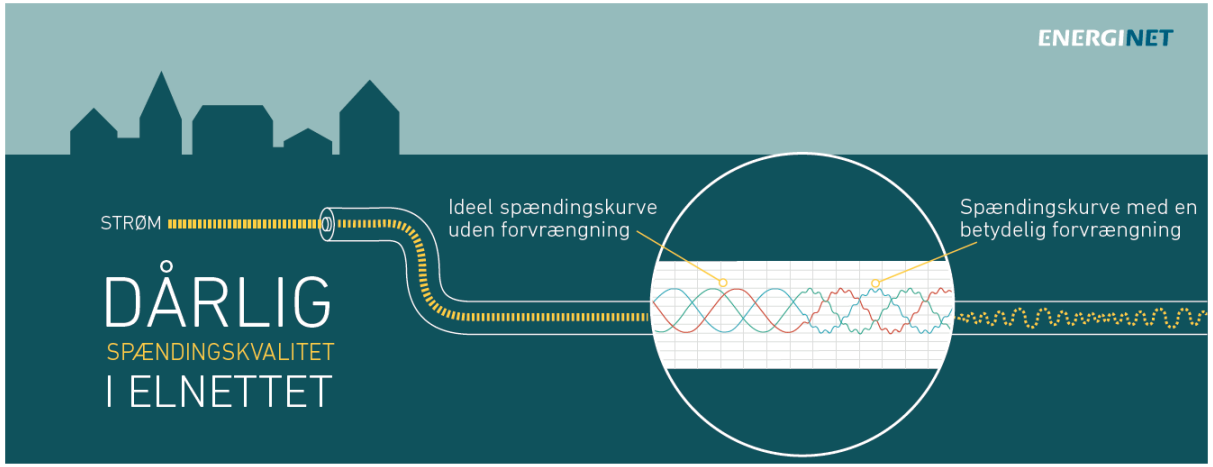
Dato:
28. september 2018

DANSK RESUMÉ – TEKNISK REDEGØRELSE OM ANVENDELSE AF KABELANLÆG VED UDBYGNING AF 400 KV-NETTET I SYD- OG VESTJYLLAND

3. Fremtidsperspektiv:

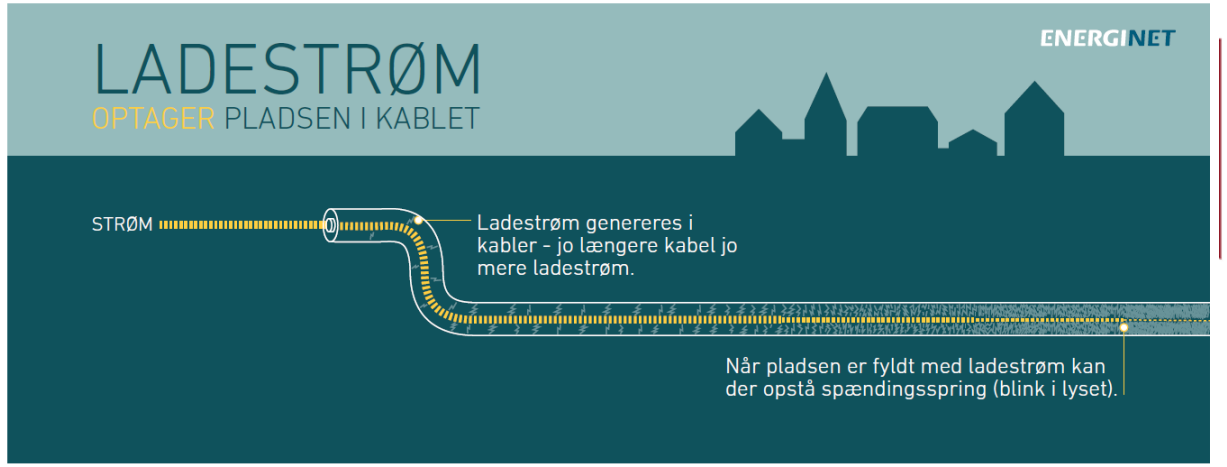
3.1 Elnettet forandrer sig – kabler skal bruges med varsomhed

Transmissionsnettet er et stort sammenhængende net, og mange kabler ét sted begrænser mulighe-den for anvendelsen af kabler andre steder. I fremtidens udbygning af transmissionsnettet vil der sandsynligvis også blive brug for at kabellægge nær særlige naturområder eller nær byer. Samtidig vil der blive introduceret endnu flere kabler i transmissionsnettet i forbindelse med nettilslutning af kommende havmølleparker.



TEKNISK UDFORDRING

ELEKTRISK STØJ KAN OVERSKRIDE GRÆNSEVÆRDIER



TEKNISK UDFORDRING

LADESTRØM FYLDER KABLERNE OG OPTAGER PLADS

TEKNISK UDFORDRING

JÆVNSTRØM VIL GØRE ELSYSTEMET UHYRE KOMPLEKST

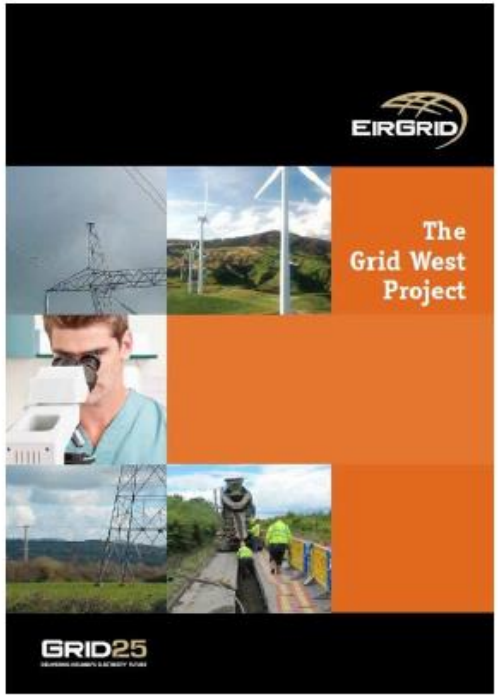
TEKNISK UDFORDRING

150 kV NETTET OVERBELASTES VED STORE MÆNGDER STRØM

EirGrid

10344 – PSP019 - AC CABLE STUDIES FOR GRID WEST

Full and Partial AC Underground Solution



Main Report

30/01/2015

Partial Underground Option	
Meets the Need	✔
Present Value	€207.4M – €249M
Construction	3.5 years
Longevity and Flexibility	Moderate
Amount of Undergrounding	Maximum of 30km for the region

220kV UGC is a standard technology in use on the Irish transmission system. However, given its characteristics, there are limits to how much can be used in any area and use on one project reduces the amount of underground cable that can be used on future development. A partially undergrounded 220kV solution is typically employed in limited circumstances, such as major water crossings, when traversing densely populated or congested areas.

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Þróun og framtíðarhorfur

Saga og þróun

- PEX-strengurinn
- Verðsamráð evrópskra framleiðenda
- „Blönduð leið“
- Notkun jafnstraums sem „aðalvalkosts“ í flutningskerfum óraunhæf næstu áratugi
- Þróun aflrafeindabúnaðar
- Minnkandi kerfisstyrkur vegna vind- og sólarorkuvera

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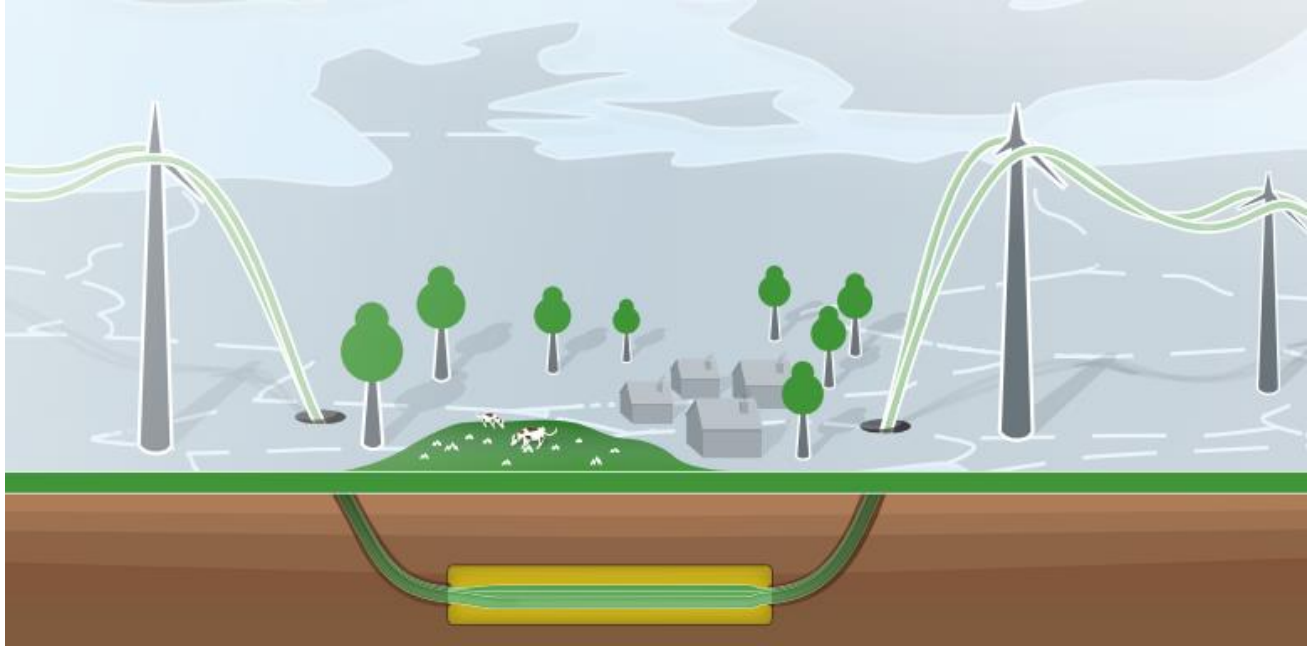
„Blönduð leið“



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PARTIAL UNDERGROUNDING

The Europacable Concept of Partial Undergrounding

FACILITATING PUBLIC ACCEPTANCE THROUGH UNDERGROUNDING

The Europacable Concept of Partial Undergrounding foresees the undergrounding of power lines in sensitive areas complementing overhead lines where their deployment is restricted by public concerns or environmental limitations.

Þingsályktun

um stefnu stjórnvalda um lagningu raflína.

1.4. Markmið um hlutfall jarðstrengja árin 2020, 2025 og 2035.

Við uppbyggingu og þróun flutningskerfis raforku skal stefnt að því að árið 2020 verði samanlagt heildarhlutfall jarðstrengja í landshluta- og meginflutningskerfi raforku á 11 kV spennustigi eða hærra orðið a.m.k. 50% af lengd raflína, 65% árið 2025 og 80% árið 2035. Náist þessi markmið ekki skal endurskoða þingsályktun þessa.

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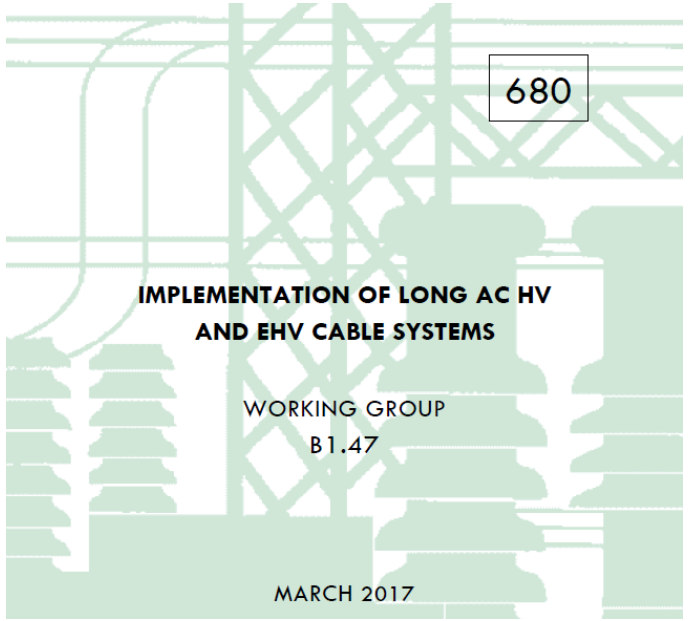
Lokaorð



- Ítarleg kerfisgreining nauðsynleg í hverju tilfelli
- Áhrif strengs á kerfi og nauðsynlegar aðgerðir háðar nokkrum þáttum
  - Spennustigi
  - Kerfisuppbyggingu
  - Skammhlaupsafli
  - Hlutverki strengs í kerfi

Hence for the reliable application of long AC cable connections detailed system modelling studies are necessary. If the study results show that resonance or unacceptable amplification of higher harmonics can occur, then suitable measures must be taken. Naturally this depends on the nature of the identified problem and the severity so that the best countermeasures can be taken.

The extent to which an AC grid is influenced by the application of underground cable and the amount of measures that must be taken varies significantly depending on the voltage level, the grid configuration, the short circuit level and the reason for the cable in the power system.

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