



TRACTEBEL



Site Survey (Update) & Cooling Studies for SMRs in Estonia

8 February 2022
Tallinn



PUBLIC



INTERNAL



RESTRICTED



CONFIDENTIAL

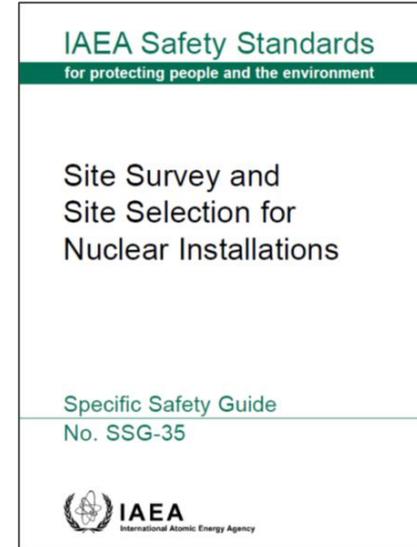


Site Survey Update

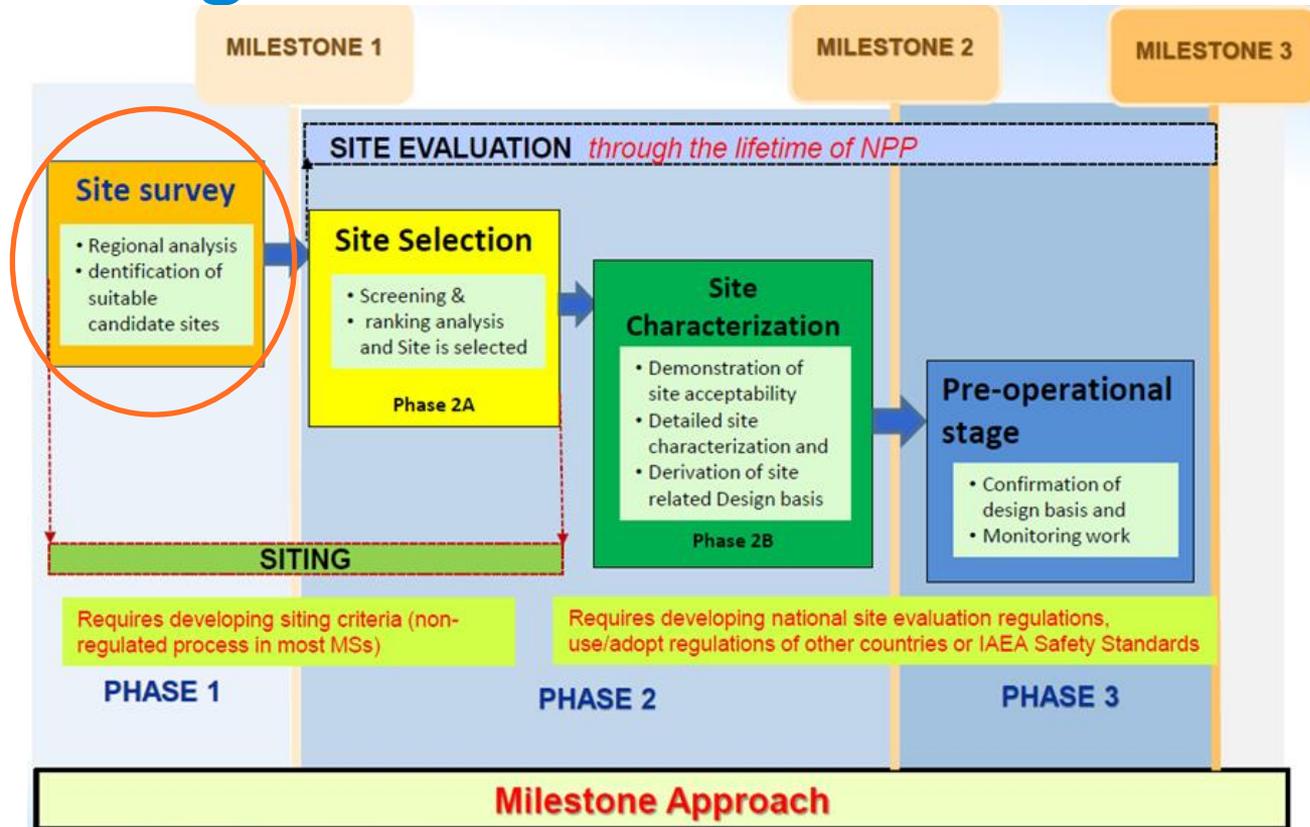


Site studies

- Country-wide survey process in full compliance with IAEA safety requirements
- Site(s) intended for multi-unit SMR plant of at least 600 MWe capacity
- Strong data management (ArcGIS database)
- Many technical disciplines involved:
 - Environment
 - Cultural heritage
 - Demography
 - Human-induced hazards
 - Land use
 - Infrastructure
 - Cooling water
 - Topography & Bathymetry
 - Geology & Seismology
 - Geotechnical
 - Flooding
 - Etc.

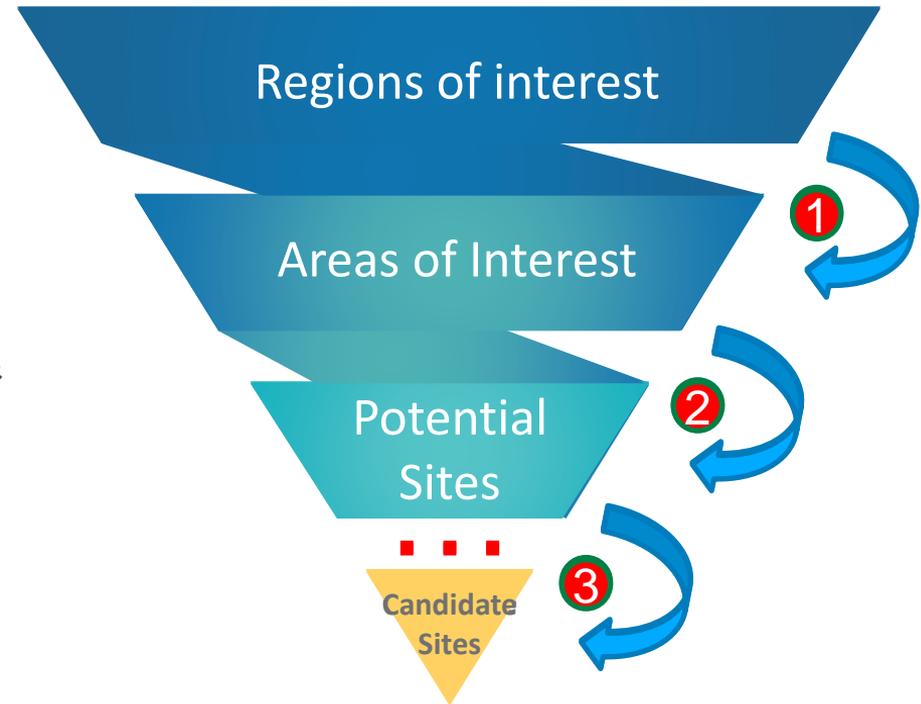


IAEA Siting Process

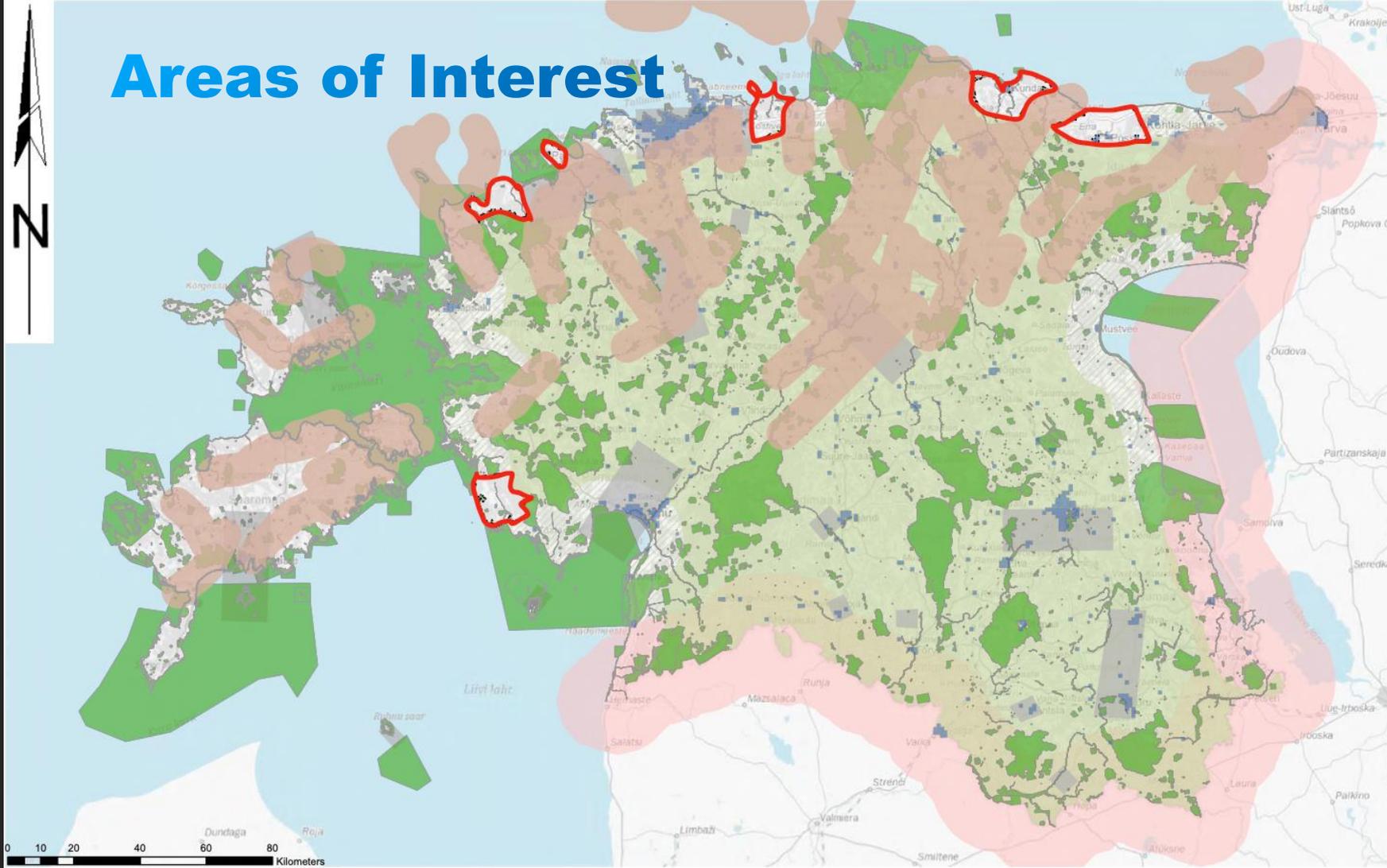


Screening Criteria and Process

- Exclusionary criteria:
 - Externally imposed restrictions (e.g. Natura2000)
- Discretionary criteria:
 - Other conditions that can cause significant risk to the project in terms of cost, licensing & permitting, public acceptance, construction risk, etc.
- **InSite™** evaluation tool
- Three-step approach **1** **2** **3**

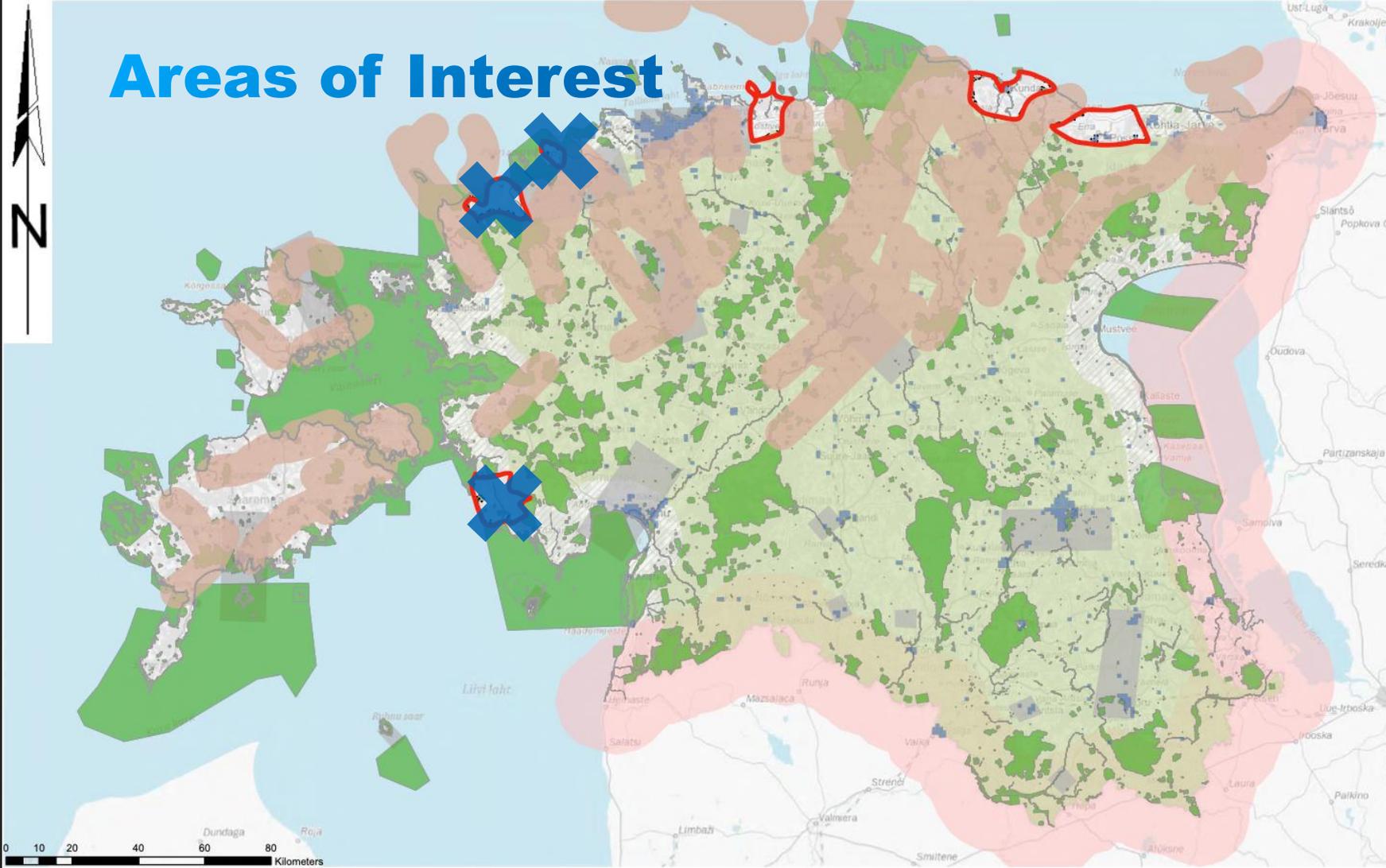


Areas of Interest



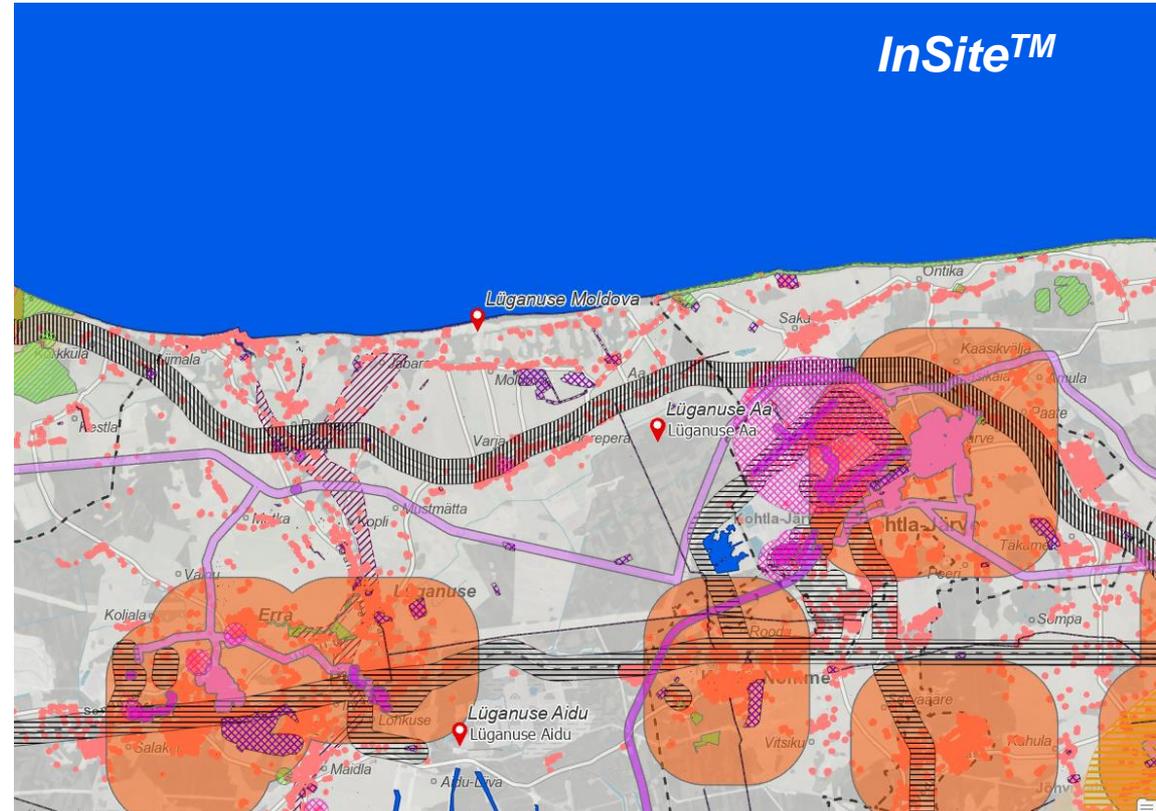
0 10 20 40 60 80 Kilometers

Areas of Interest



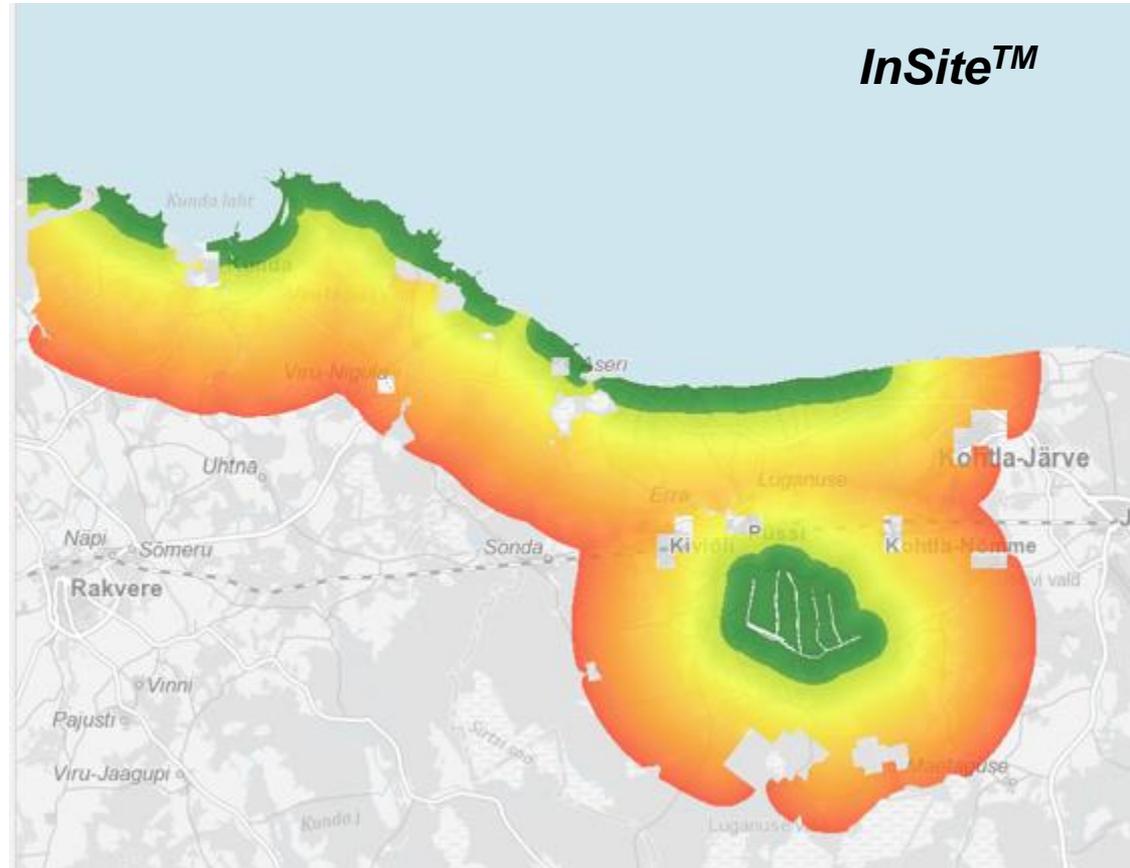
Exclusion criteria (local scale)

- Populated zones
- Built-up/residential areas
- Main roads and railways
- Cultural heritage
- Hazardous facilities and transport routes
- Flooding areas
- Environmental restrictions (e.g. local habitats)

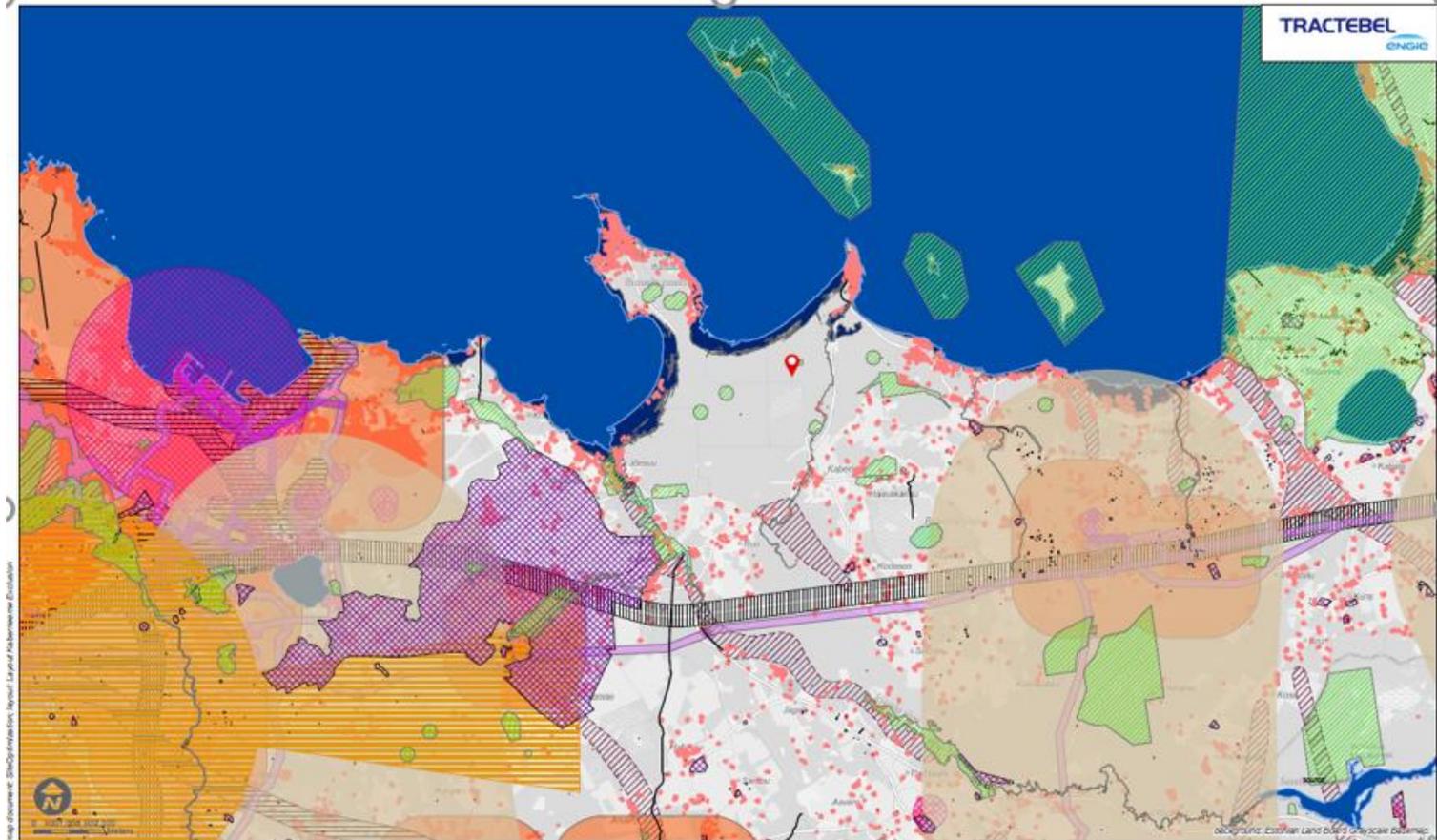


Evaluation criteria (local scale)

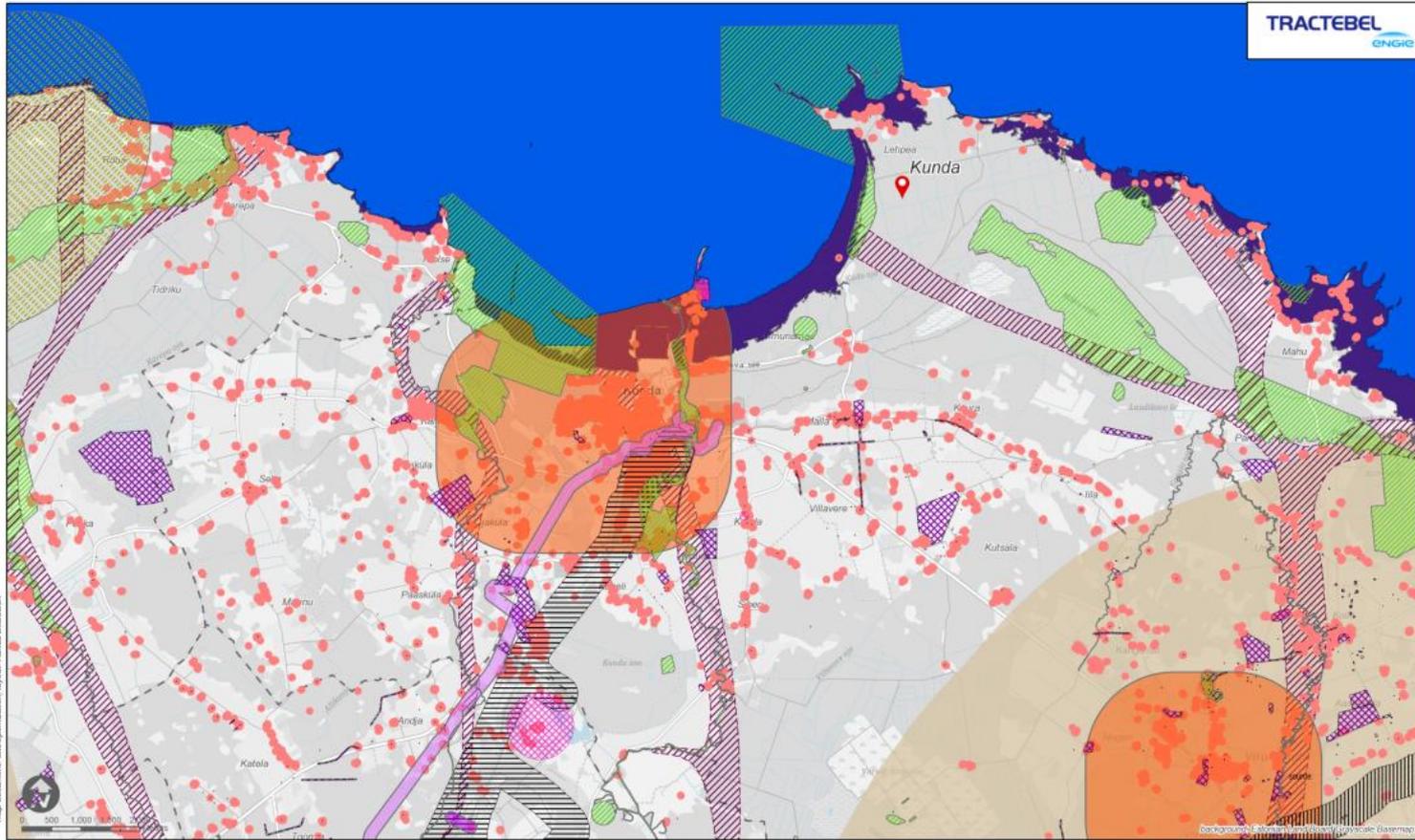
- Cooling water
- Land ownership
- Flooding risk
- Distance to cooling water
- Topography
 - Slopes
 - Elevation
- Population/residential areas
- Environmentally sensitive areas
- Etc.



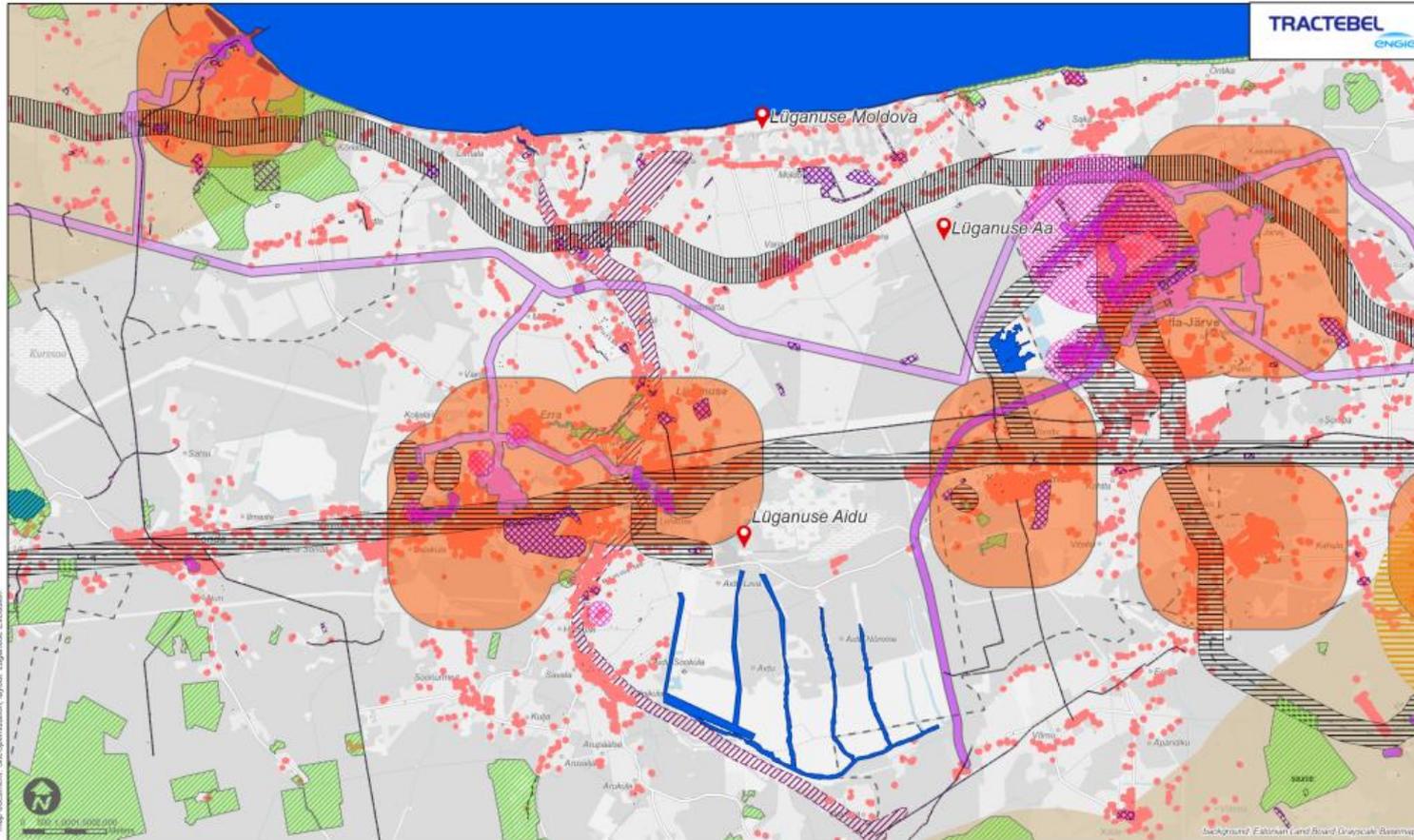
Exclusion map – Eastern Harjuma



Exclusion map – Western Virumaa

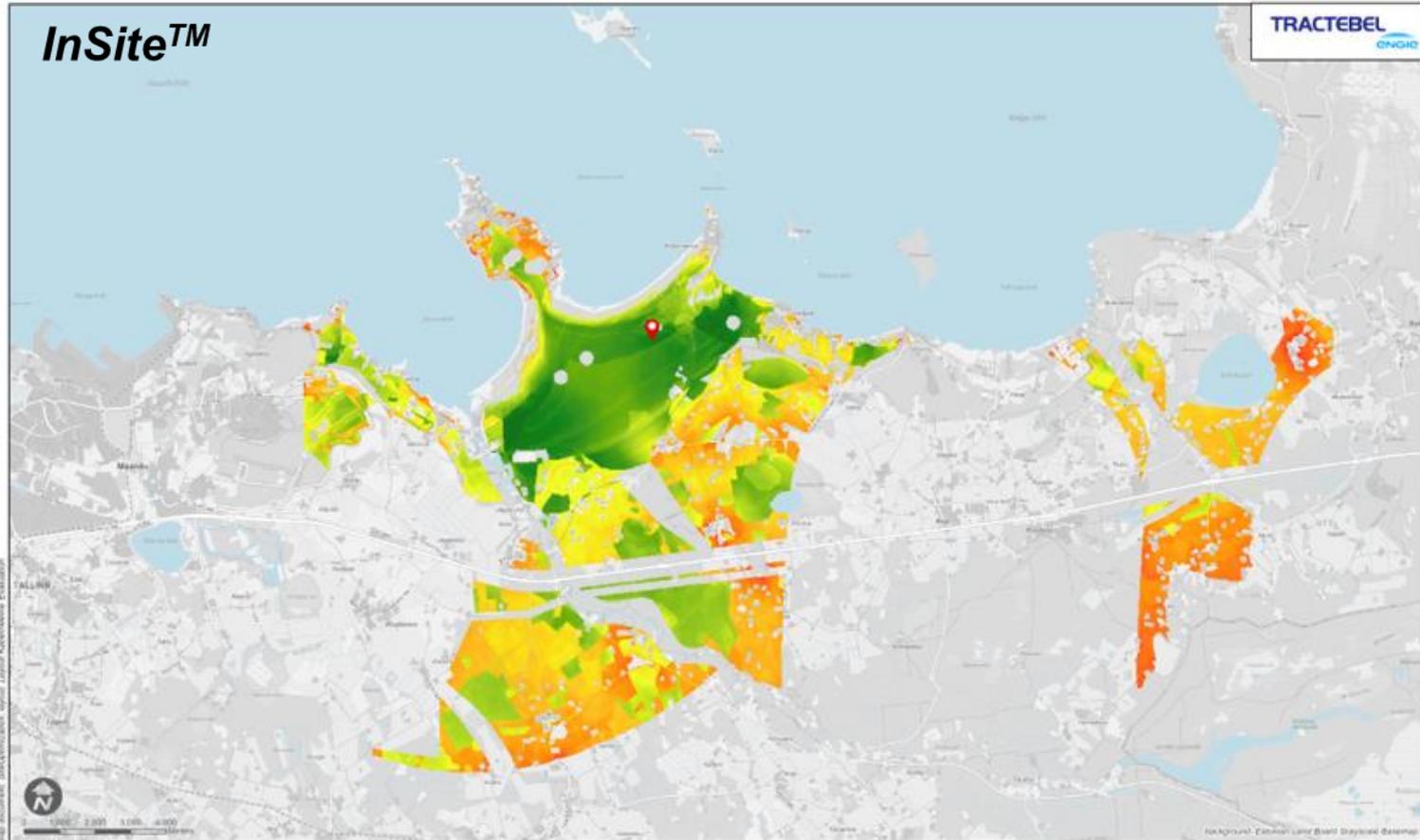


Exclusion map- Eastern Virumaa

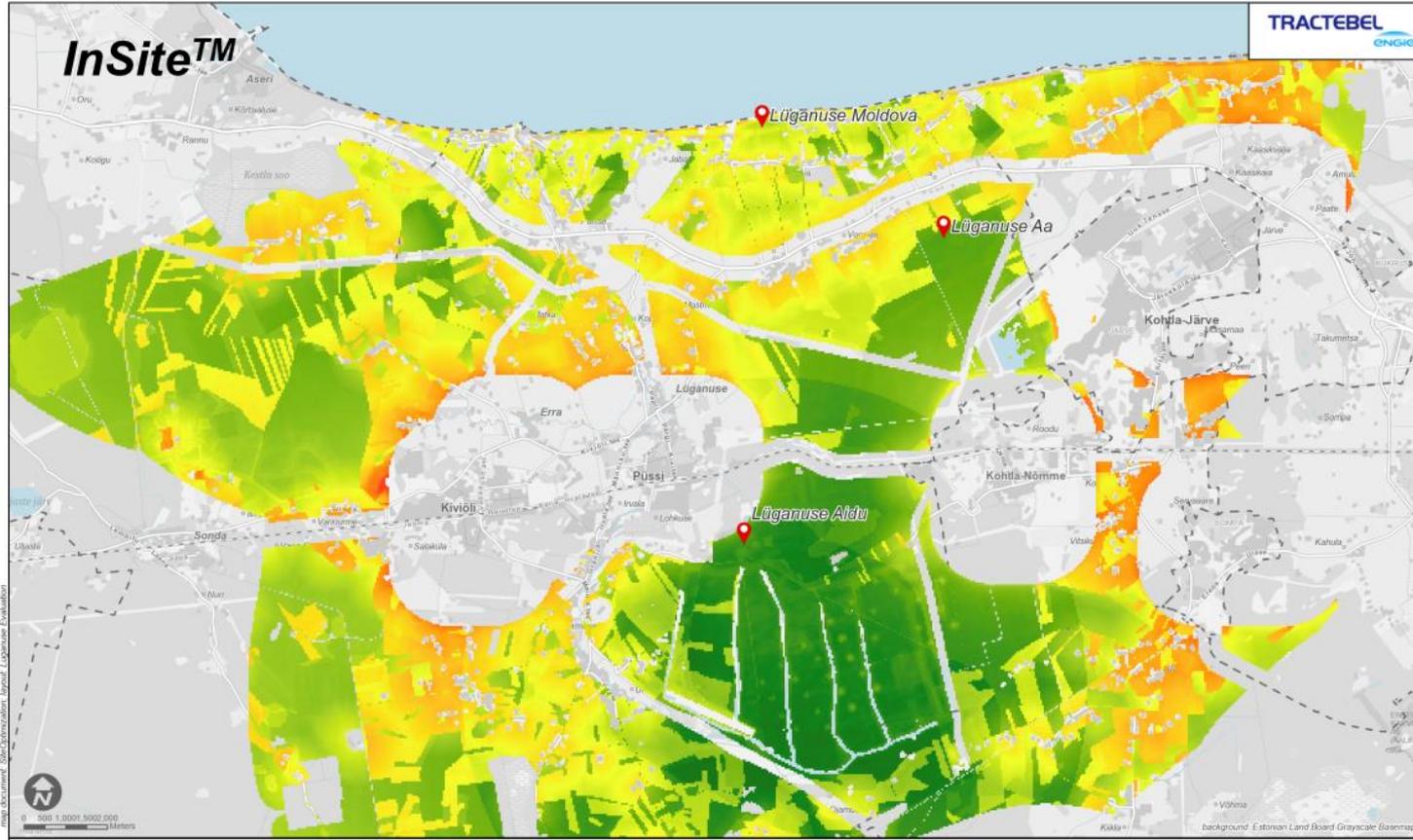


map document: zirekavastatus; by:of: Lügänuise LUGANUSE

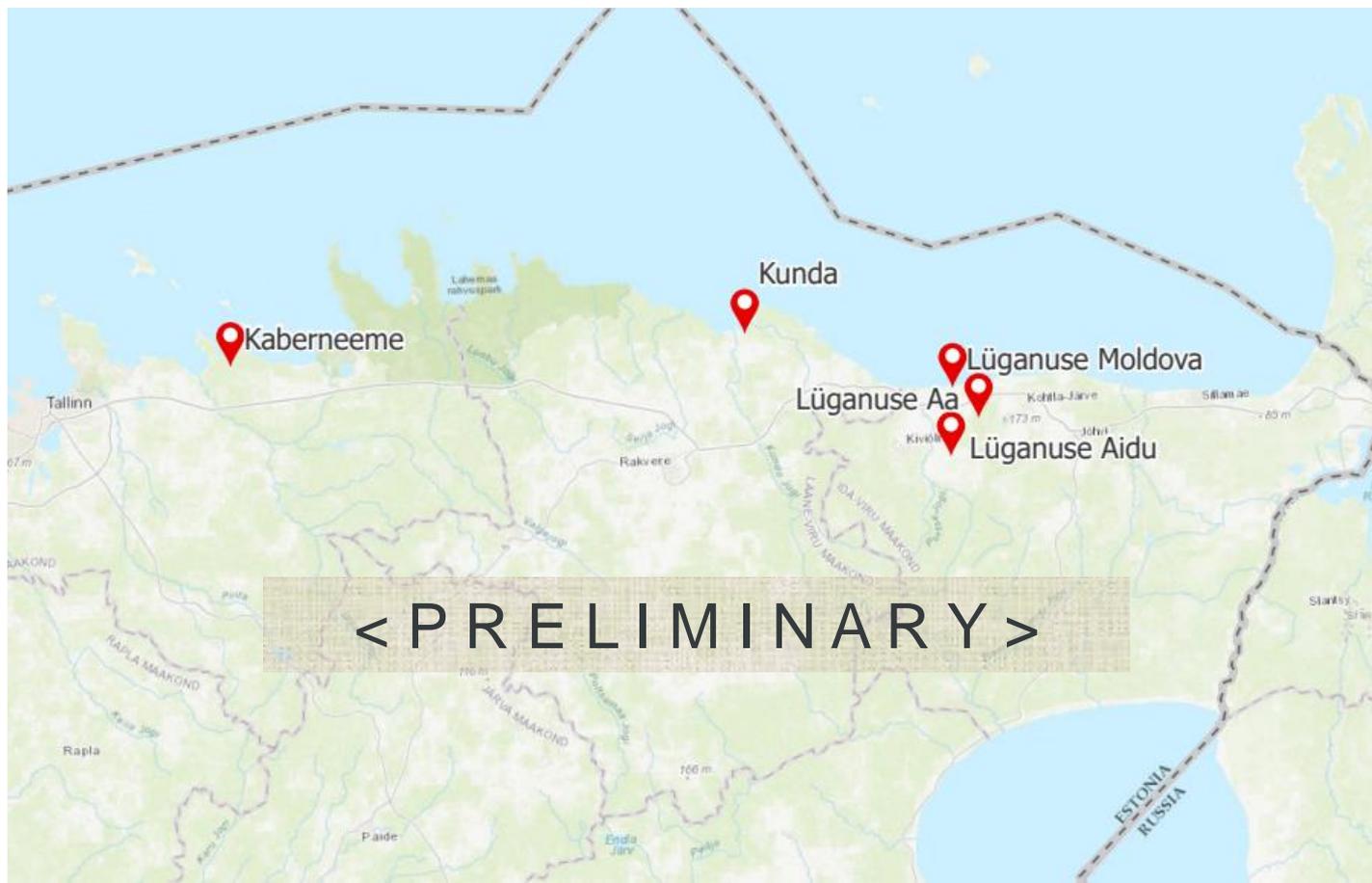
MCA Evaluation – Eastern Harjuma



MCA Evaluation – Eastern Virumaa

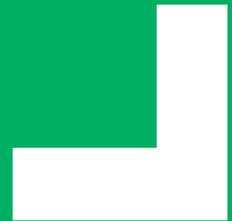


Results: candidate sites





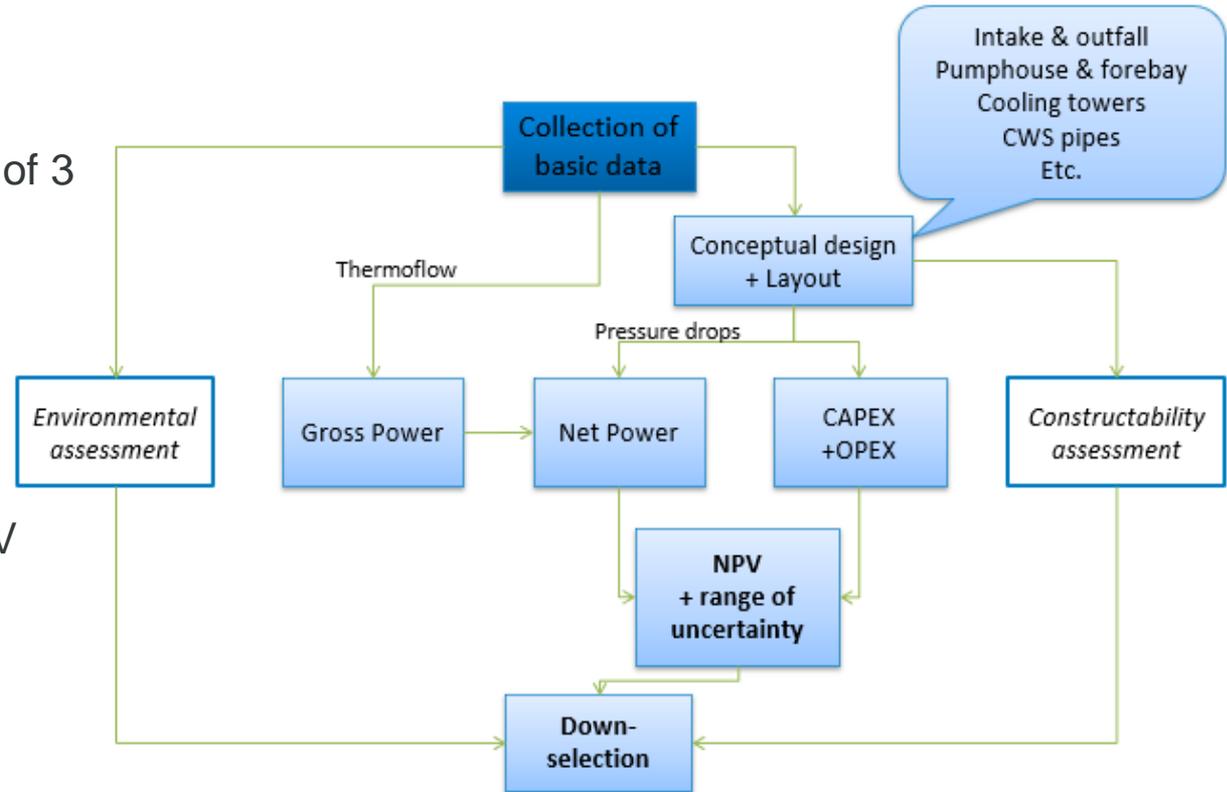
Cooling Studies



Scope and methodology

Comparative assessment of 3 sites:

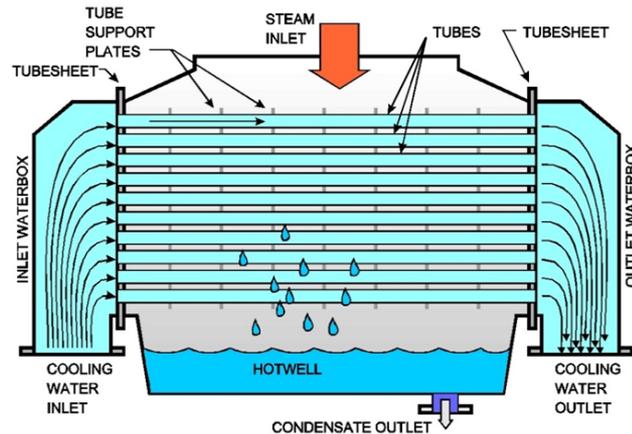
- Type of cooling system
- Impact on plant performances
- CAPEX, OPEX and NPV analysis



Cooling systems options

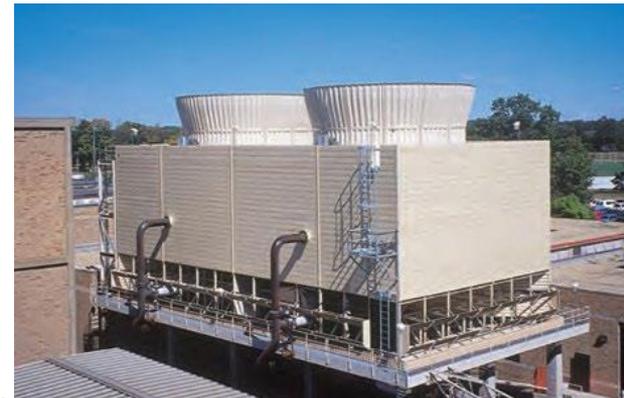
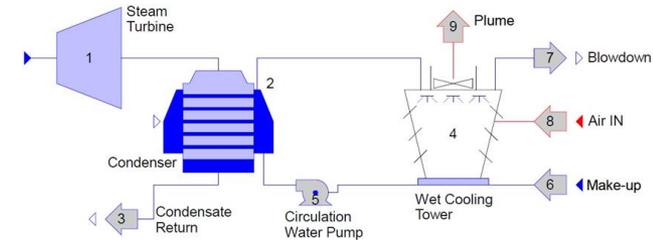
• Direct cooling

- Best suited when large amount of water is available
- Best efficiency

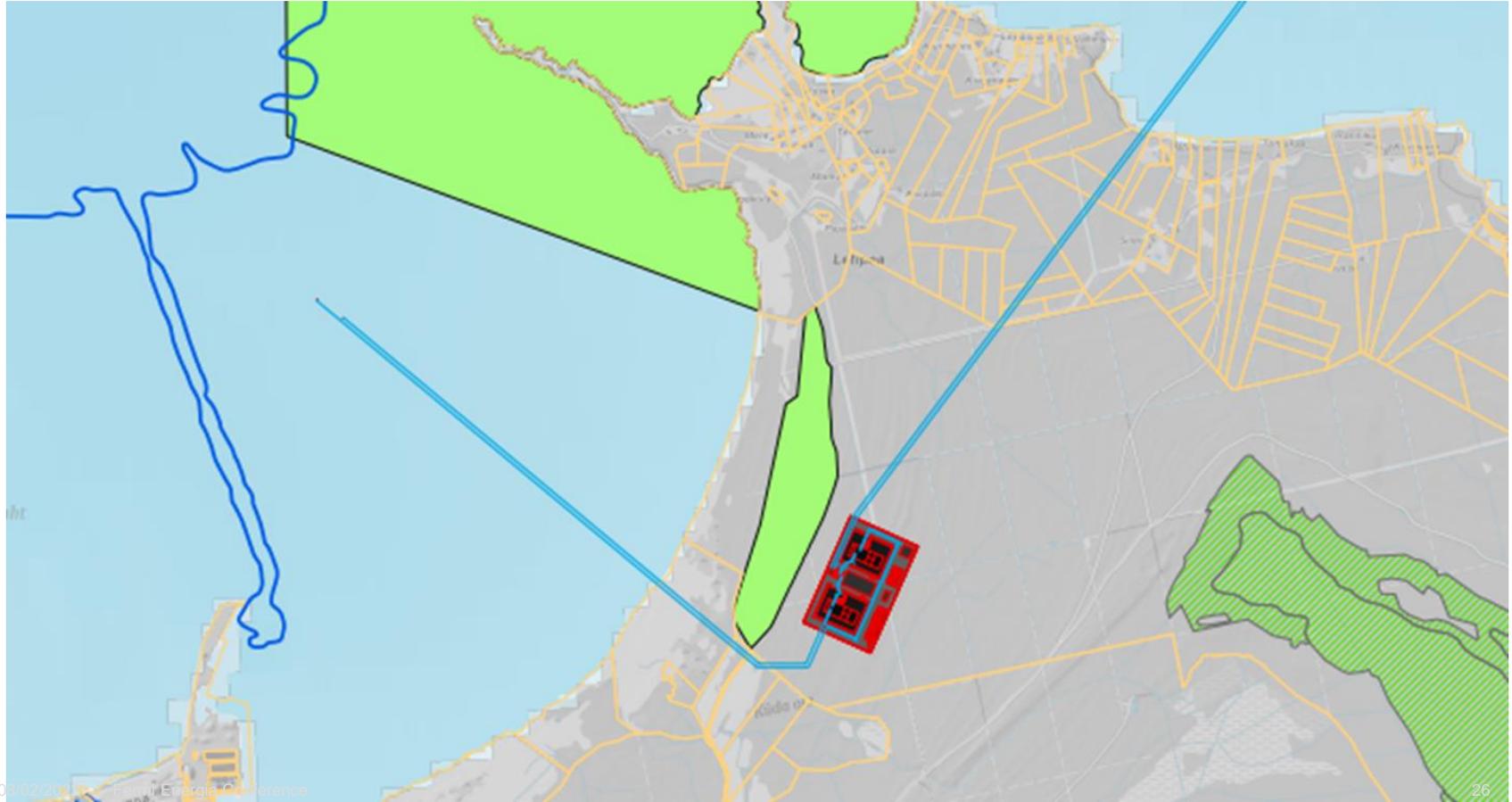


• Closed cooling with Mechanical Draft Wet Cooling Towers

- Best suited when limited quantity of water is available
- Lower cost



Kunda site (open or closed loop cooling)

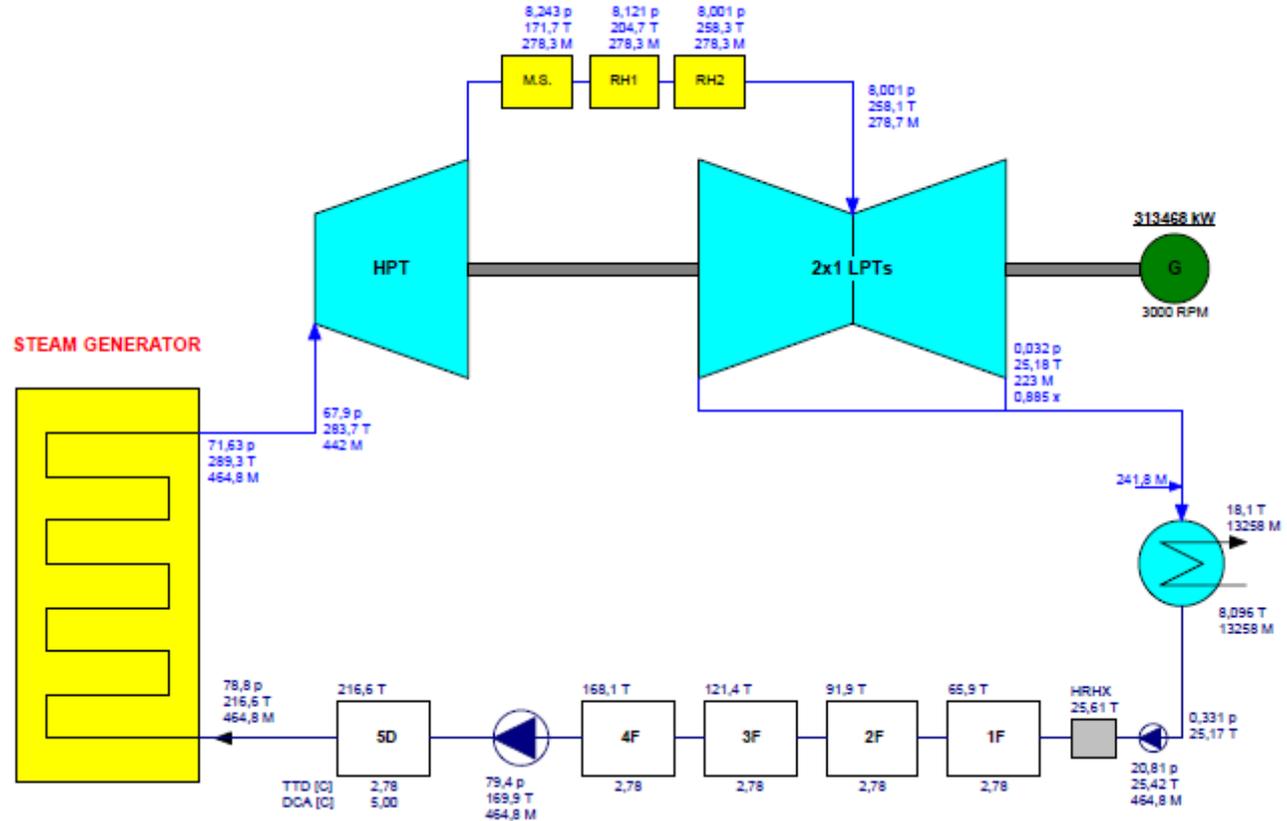


Aidu site (closed loop cooling)



Thermodynamic models

- Software :
Thermoflow suite
- Simulation of the secondary circuit
- Condenser with closed loop or open loop cooling system



Plant performances

	Kunda Direct cooling	Kunda Closed loop cooling
<i>Discharge flow temperature</i>	18.1°C	14.2°C
<i>Make-up flow per unit</i>	-	0.31 m ³ /s
<i>Blowdown flow per unit</i>	-	0.17 m ³ /s
<i>Gross power per unit</i>	313.4 MW	311.4 MW
<i>Net power per unit</i>	295.8 MW	289.7 MW
<i>Steam cycle efficiency</i>	36.4%	36.2%
<i>Net plant efficiency</i>	34.3%	33.6%

Not a huge difference in plant efficiency

Plant economics

	Kunda Direct cooling	Kunda Closed loop cooling	Aa Closed loop cooling	Aidu Closed loop cooling
CAPEX	82 900 000 €	23 500 000 €	25 800 000 €	19 900 000 €
OPEX	1% of CAPEX per year	4% of CAPEX per year	4% of CAPEX per year	4% of CAPEX per year
	Kunda direct cooling vs Aidu	Kunda direct cooling vs Aa	Aa vs Aidu	Kunda direct cooling vs Kunda closed loop
NPV difference – 4% WACC	21.1 M€	32.1 M€	-11 M€	26.5 M€
NPV difference – 8% WACC	-11 M€	-6.2 M€	-4.8 M€	-8.9 M€

***Better economic performance for direct cooling in case of low WACC, but...
Differential NPV very low compared to total investment
→ Economics is not a decisive factor for the cooling system selection***

QUESTIONS ?





Engineering a carbon-neutral future