



IEA Task 19: Cold climate wind power market study 2015-2020

Timo Karlsson,

Research Scientist

VTT Technical Research Center of Finland

Winterwind 2017

Skellefteå, 7.2.-8.2. 2017

Contents

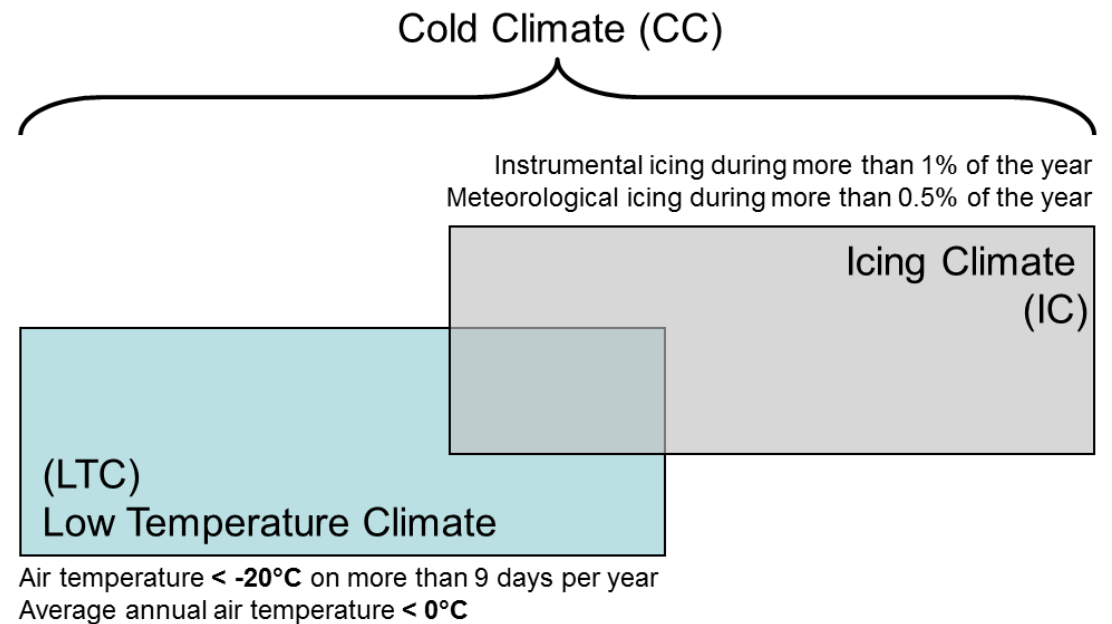
- § Introduction
- § Data sources
- § Method
- § Results
- § Conclusions



Introduction

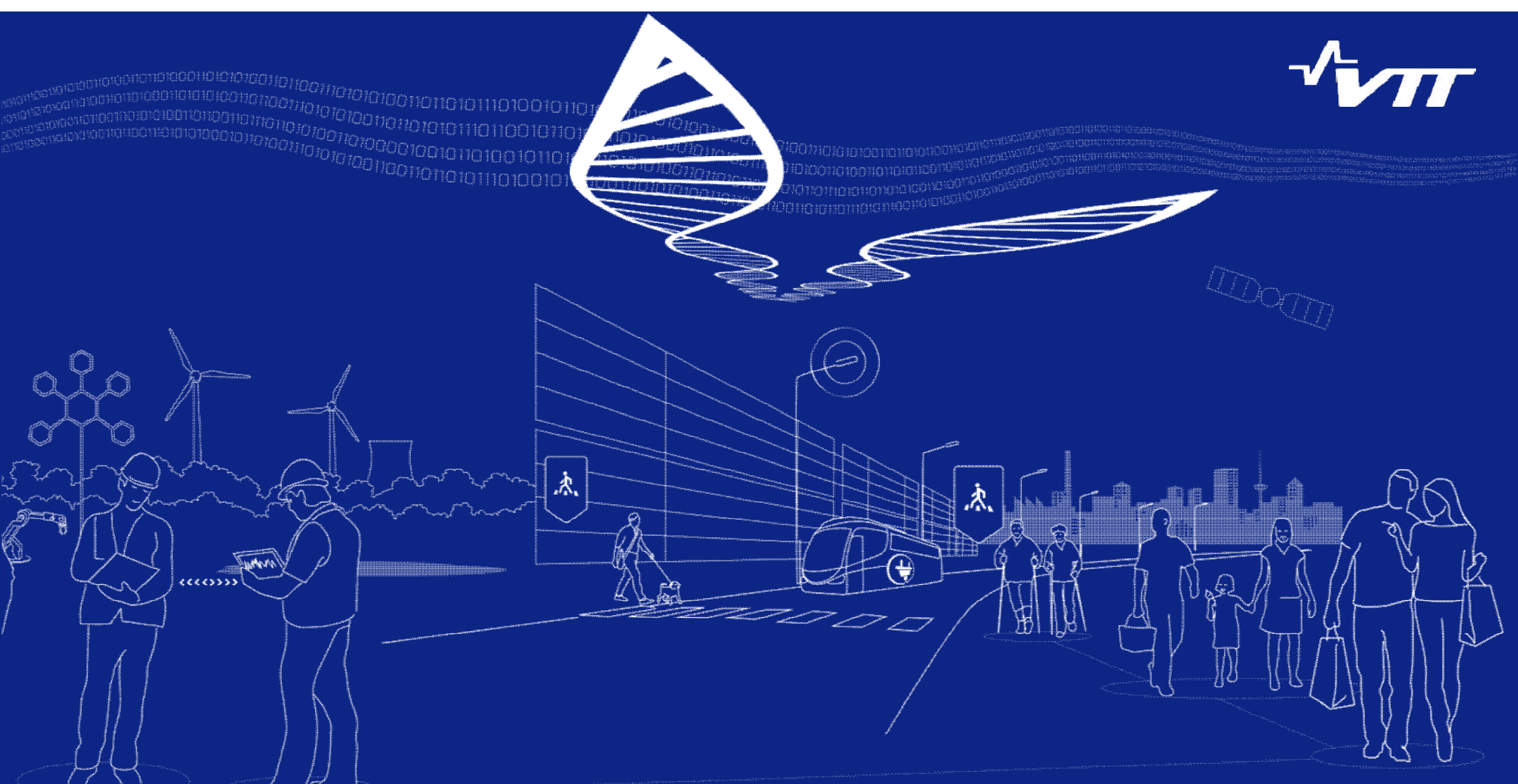
§ **Goal:** Estimate size of wind power markets in low temperature and icing climate conditions

§ Combine several sources of data to create a global estimate



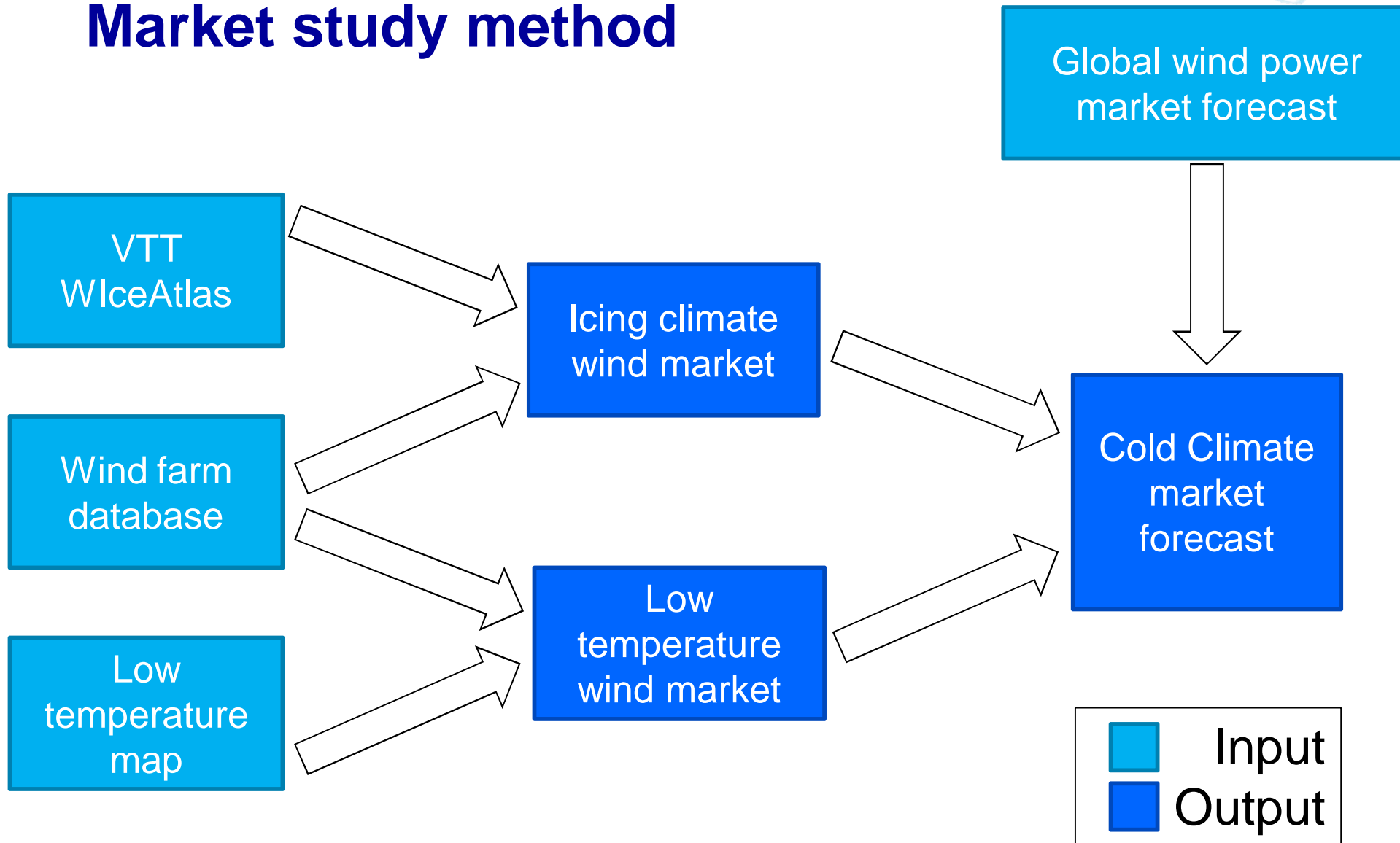
Source:

IEA wind Task 19: Available Technologies for Wind Energy in Cold Climates, 2016



Methods

Market study method





Wind Farm database

§ Commercial, global windfarm database

§ Coordinates, power, etc.

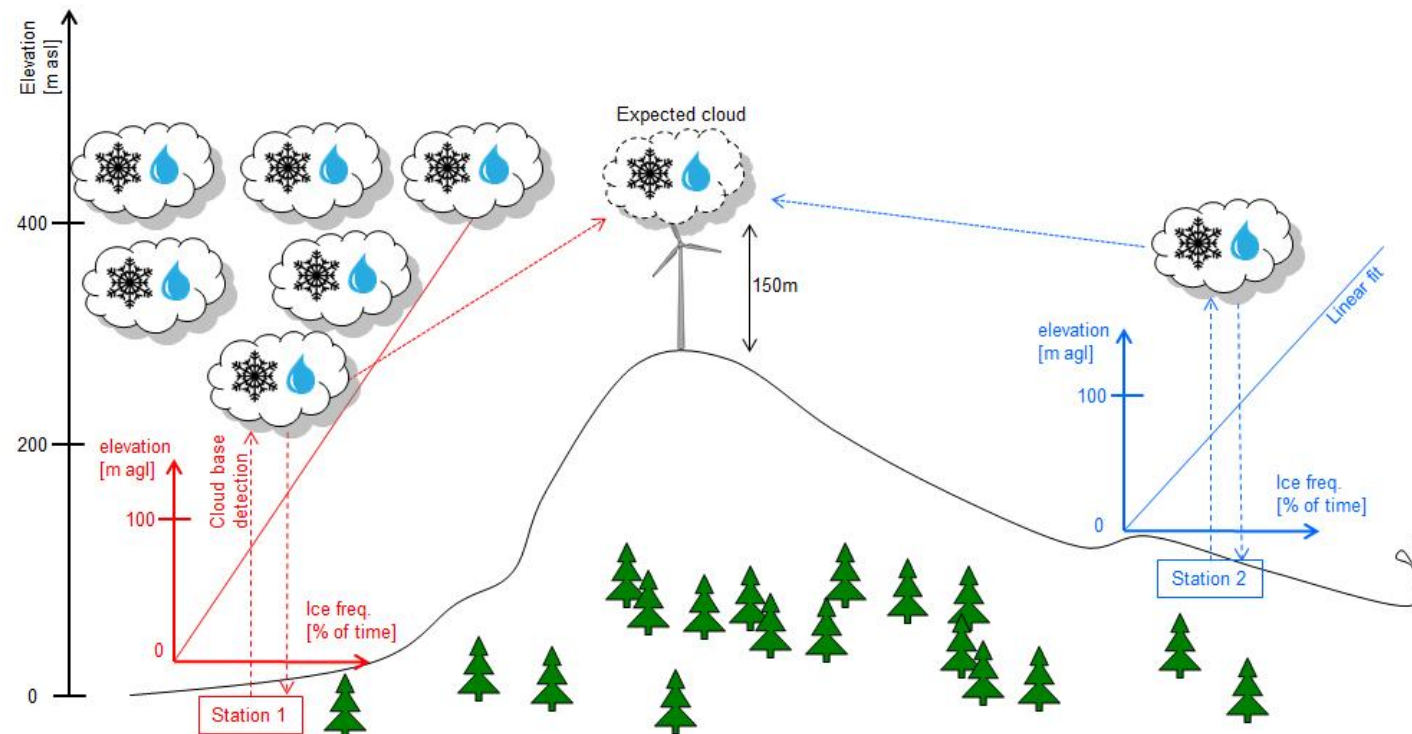
§ > 22000 sites, all continents

§ Coverage ~79 % of GWEC world capacity estimate



Icing

- § Icing was calculated from VTT WIceAtlas for all sites in the wind farm database
- § Meteorological icing at 150 m agl
- § Based on cloud base height & temp. measurements



Icing

§ Icing was divided into three categories

§ No icing

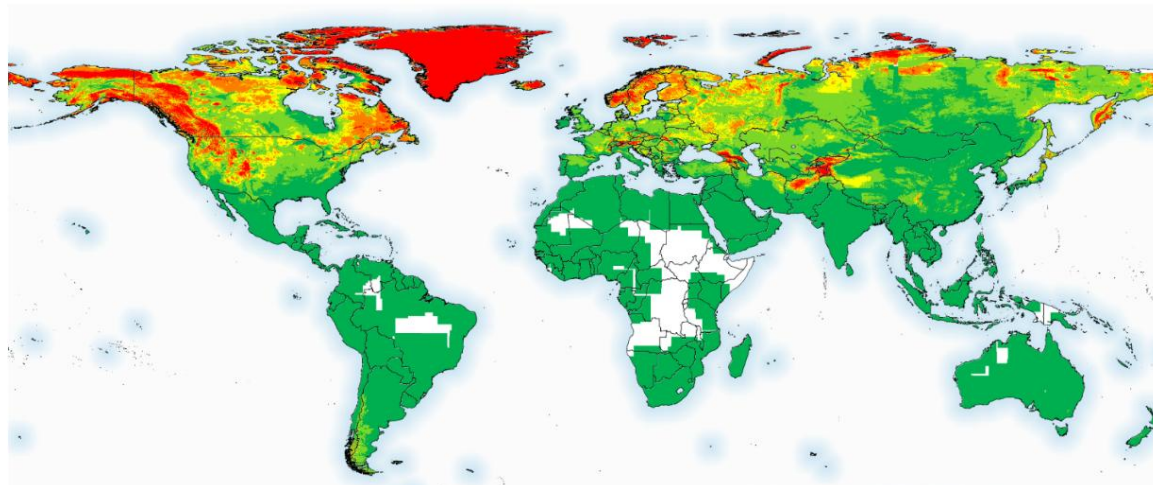
§ Light icing

(IEA ice class 2)

§ Moderate/heavy icing

(IEA ice class > 2)

IEA Ice Class	Duration of Meteorological Icing [% of Year]	Duration of Instrumental Icing [% of Year]	Production Loss [% of AEP]
5	>10	>20	>20
4	5-10	10-30	10-25
3	3-5	6-15	3-12
2	0.5-3	1-9	0.5-5
1	0-0.5	<1.5	0-0.5

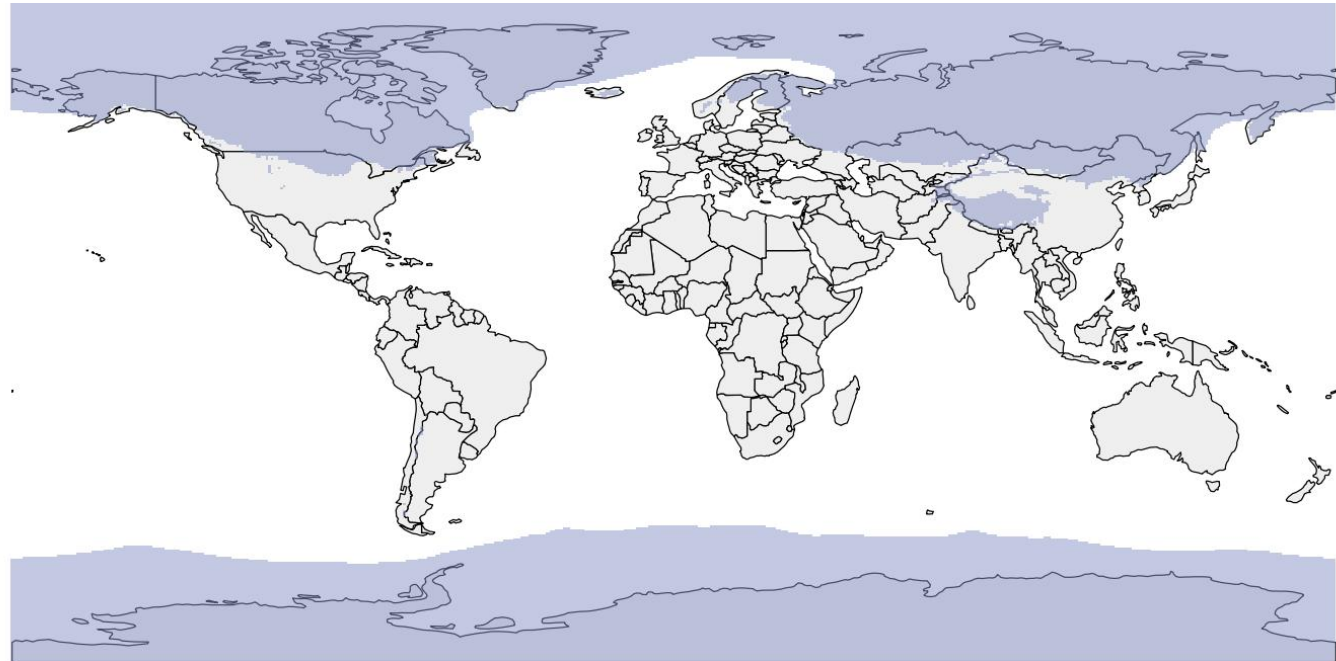


Low temperature map

§ Low temperature site definition (DNV GL):

§ Minimum temperature below -20°C for at least an hour per day on 9 or more days a year on average in long term data (>10 years)

§ Map built based on MERRA data

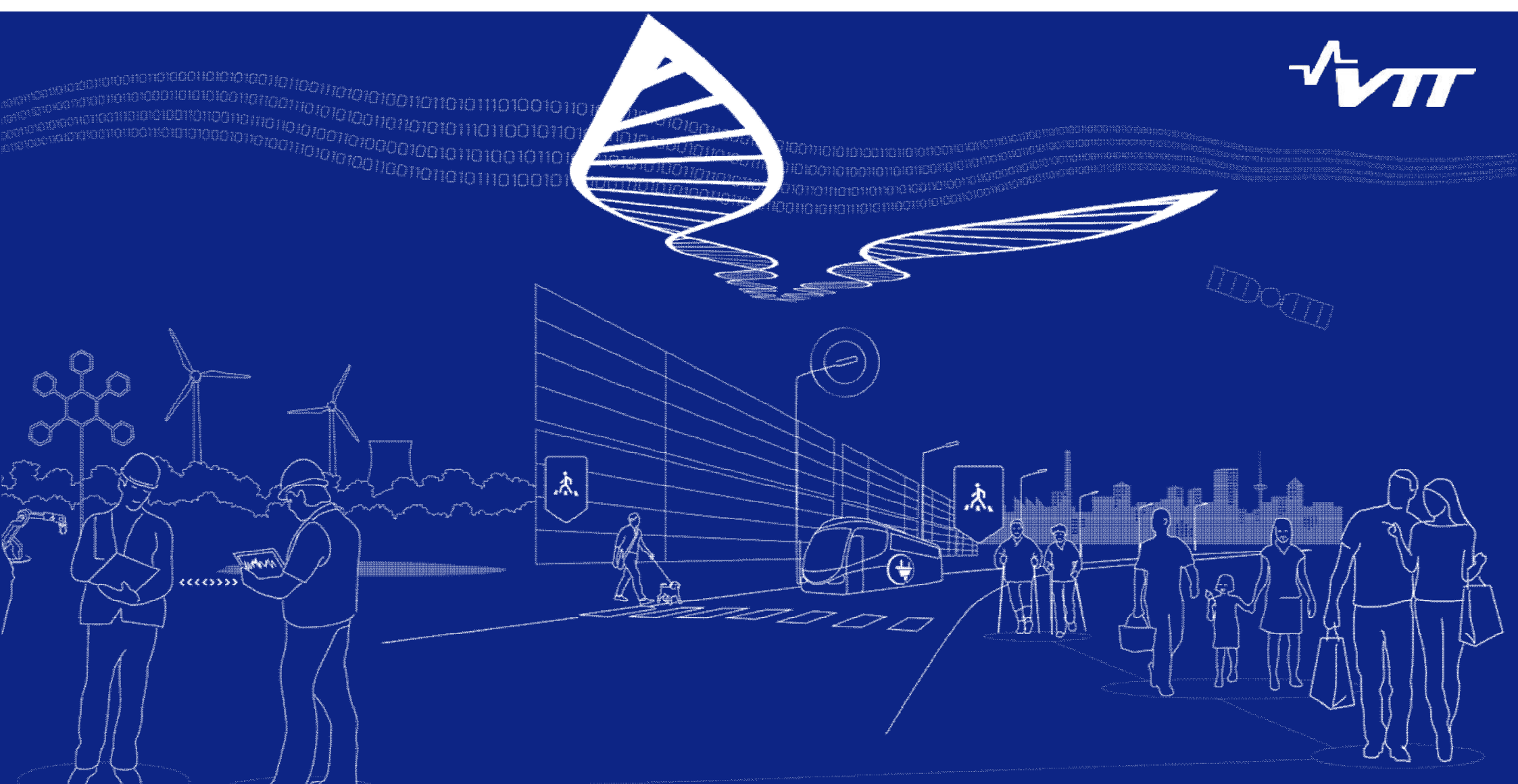




Forecast

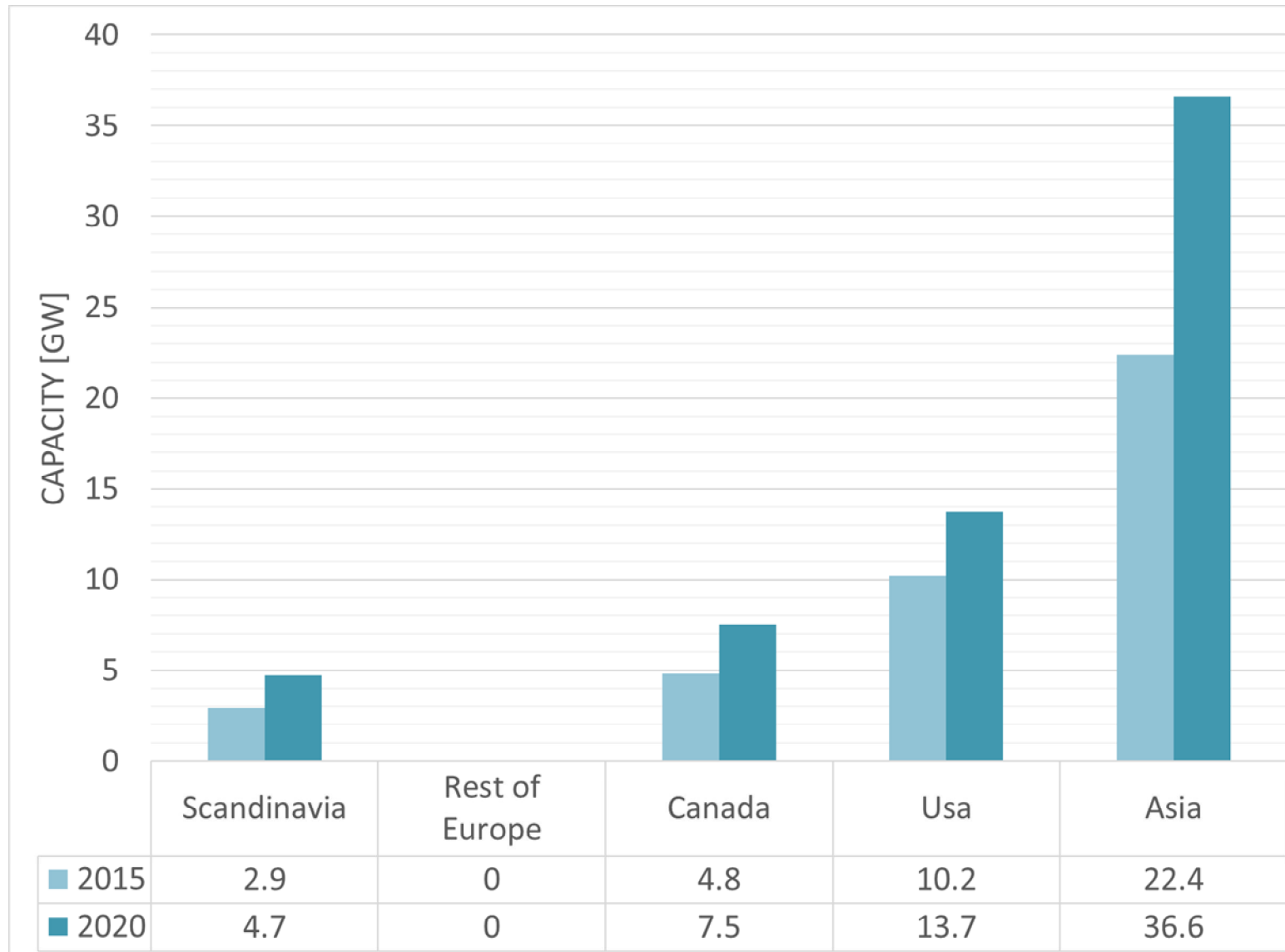
- § Calculate the share of wind power in cold climate and icing conditions in each geographical area
- § Assume the share remains constant
- § Market forecast from BTM world market update
- § Checked against GWEC forecast



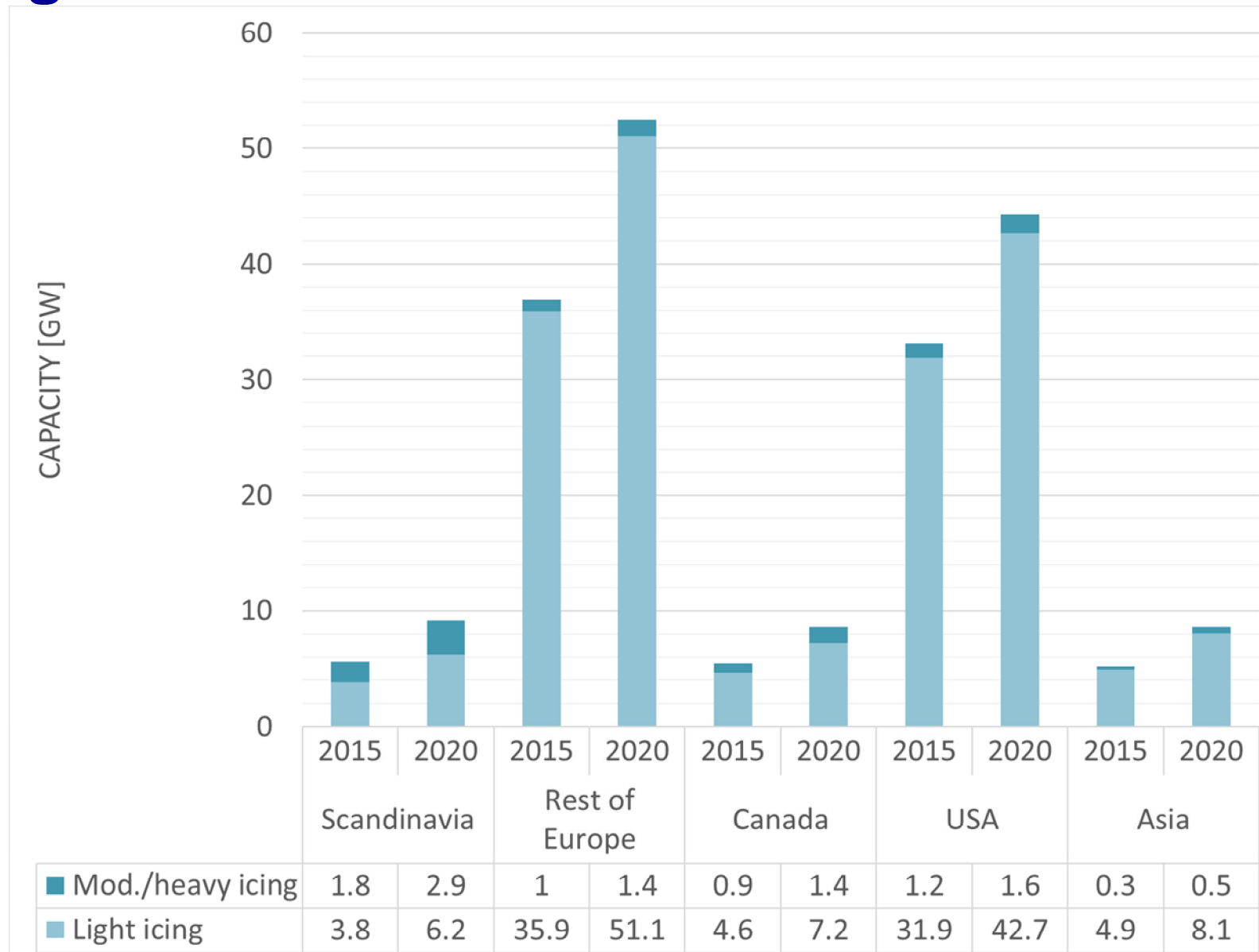


Results

Low temperature market size



Icing market size





Conclusions



Previous forecast BTM 2012

presented in winterwind 2014

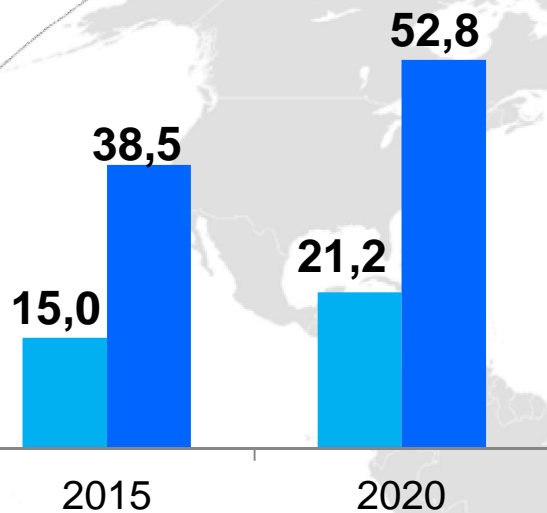
§ Forecast was published in BTM world market update 2012

	BTM 2012 forecast for 2017	Current
Low temperature	38	40
Light icing	60	81
Moderate/heavy icing	20	5

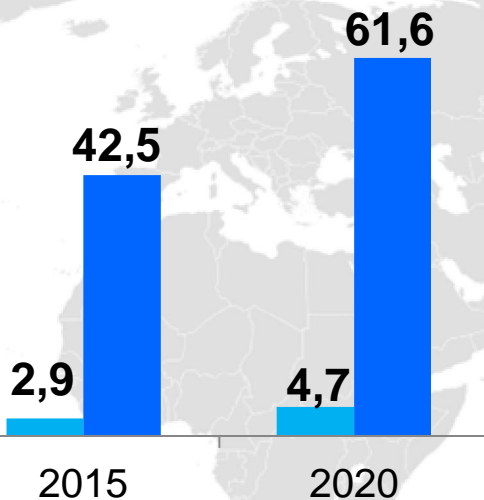
§ Total sum pretty close, old forecast overestimated icing severity

Key takeaways

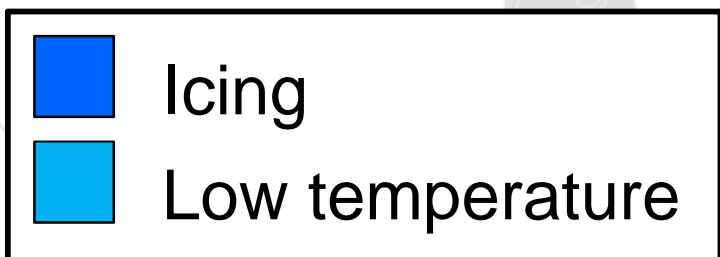
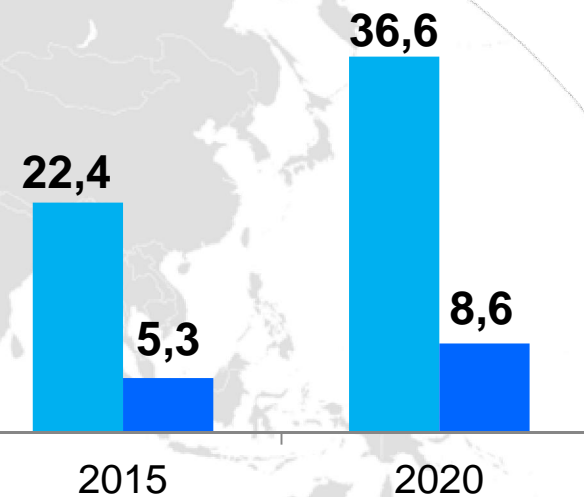
North America



Europe



Asia





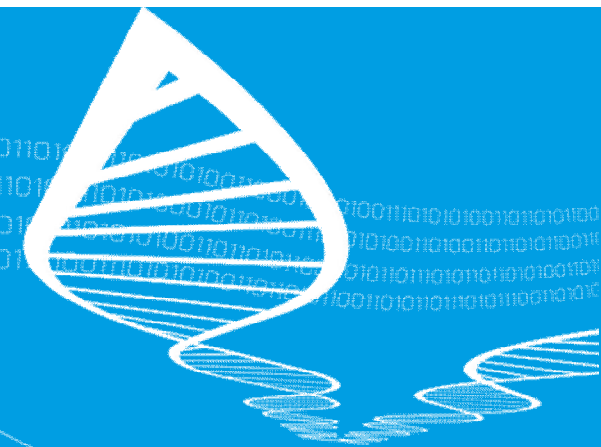
Cold climate markets 2015-2020

Cumulative installed capacity by end of 2015 [MW]		Forecasted capacity by end of 2020 [MW]	
Low temperature	Icing*	Low temperature	Icing*
40 500	86 500	62 500	123 000
Total 127 000		Total 185 500	

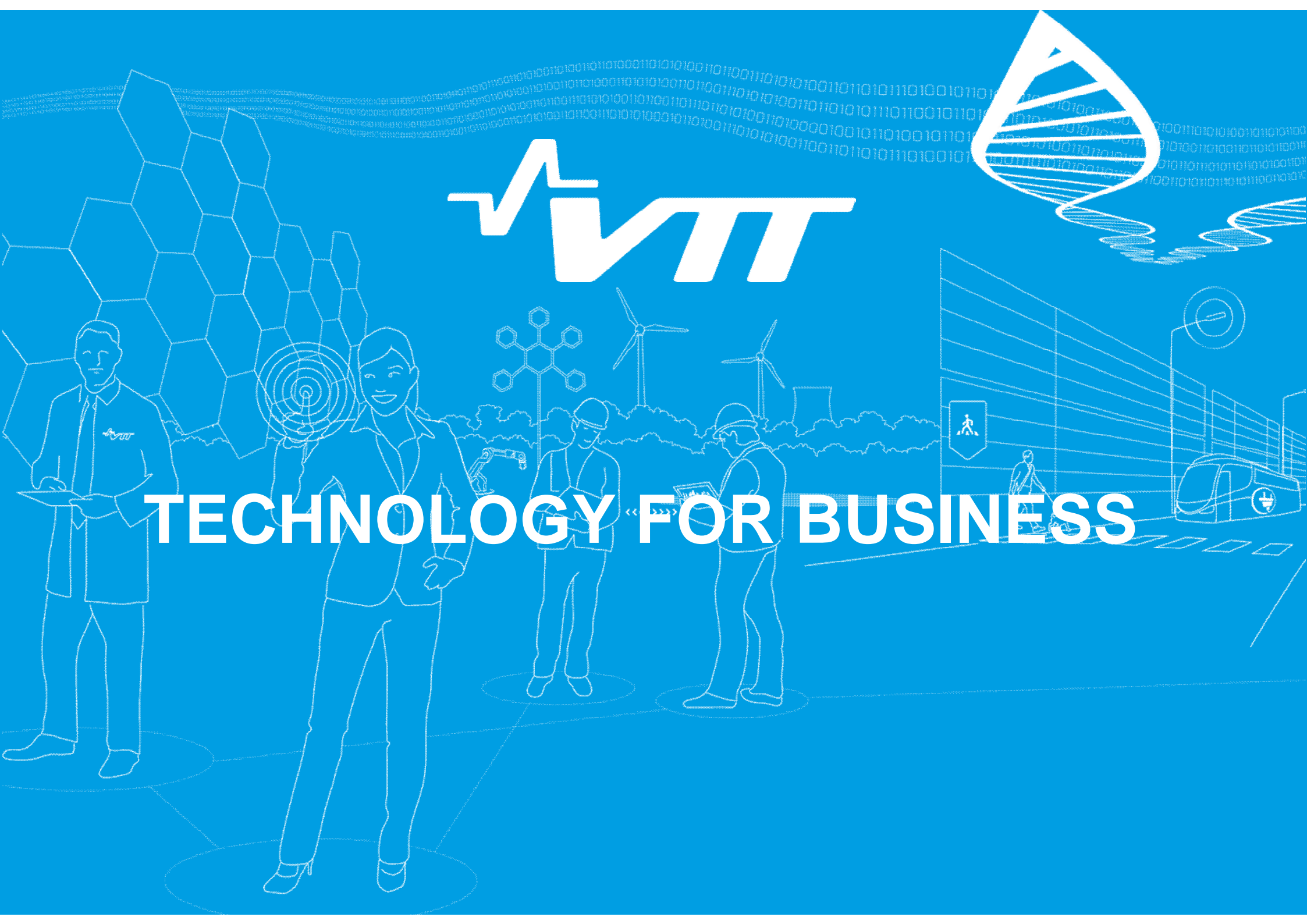
*: IEA Ice Classification ≥ 2 meaning $> 44\text{h/a}$ of meteorological (in-cloud) icing

+12GW/a -> 59GW of new installations to cold climates by 2020!

Ø Compare: new offshore +4GW/a -> 20GW by 2020



TECHNOLOGY <>>> FOR BUSINESS





Data sources

§ VTT WiceAtlas

§ <http://www.vtt.fi/sites/wiceatlas/>

§ Global windfarm database

§ <http://www.thewindpower.net>

§ MERRA

§ <https://gmao.gsfc.nasa.gov/reanalysis/MERRA/>

§ NAVIGANT world wind energy market update

§ <https://www.navigantresearch.com/research/world-wind-energy-market-update-2016>

§ GWEC Global wind report

§ <http://www.gwec.net/publications/global-wind-report-2/global-wind-report-2015-annual-market-update/>

capacity by country in MW

	icing		low temperature	
	2015	2020	2015	2020
Austria	1373	2426	0	0
Belgium	564	959	0	0
Bulgaria	477	585	0	0
Czech rep.	295	617	0	0
Denmark	482	666	0	0
Estonia	161	338	0	0
Finland	773	2120	472	1294
France	3273	5360	0	0
Germany	19138	25281	0	0
Greece	251	307	0	0
Hungary	137	313	0	0
Ireland (Rep.)	6	10	0	0
Italy	188	223	0	0
Latvia	52	173	0	0
Lithuania	95	171	0	0
Netherlands	552	995	0	0
Norway	549	1330	34	82
Poland	1696	2835	0	0
Portugal	0	0	0	0
Romania	2018	3543	0	0
Spain	3993	4029	0	0
Sweden	4537	7088	1192	1862
Switzerland	68	202	0	0
Turkey	101	215	0	0
UK	2036	3604	0	0
Rest of Europe (Luxembourg, Cyprus, Malta, Iceland & Balkan states etc.)	170	451	0	0
Argentina	0	0	0	0
Brazil	0	0	0	0
Canada	5483	8550	4800	7486
Chile	0	0	0	0
Mexico	0	0	0	0
USA	33049	44272	10227	13699
Other Americas	0	0	0	0
P.R.China	4818	7791	26231	42422
India	0	0	0	0
Pakistan	0	0	0	0
Taiwan	0	0	0	0
Rest of Asia	17	55	0	0
Japan	165	289	0	0
South Korea	143	262	0	0
Australia	0	0	0	0
New Zealand	0	0	0	0