

# Winterwind 2011

- ▶ International experiences – NORWAY
  
- ▶ Agenda
  1. NORWEA, who are we?
  2. Norway: Status today, where are we going?
  3. Potential wind energy production in Northern Norway.
  4. Lessons from Havøygavlen.
  5. R&D in Norway.



# 1. Norwea, who are we?

- ▶ Norwegian Wind Energy Association.
- ▶ A combined members- and lobbying organization.
- ▶ Our aim: To influence decision makers and promote new, renewable energy in Norway.
- ▶ Market orientated: May the best man win!
  
- ▶ Wind – Wave – Tidal

**CODAN** 

**SIEMENS**  
Siemens Wind Power

 **EGL** networking  
energies

**HgCapital** }

 **Statoil**

**ABB** Power and productivity  
for a better world™

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 **SSE**  
Renewables

**VATTENFALL** 

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**DONG**  
energy

 **GE**  
Energy

 **REpower**  
Systems

 **Nexans**

**Vestas**®

 **NORDEX**

 **Fred.Olsen Renewables**

## 2. Norway:

### Status today, where are we going?

- ▶ Installed capacity  $\approx$  450 MW (end 2010)
- ▶ 1 TWh production (2009)
- ▶ Joint green certificate market with Sweden from 1.1.2012. (Thanks!)
- ▶ 26.4 TWh new, renewable electricity production by 2020.
- ▶ 14–15 TWh wind?

# 3. Potential Northern Norway

- ▶ Estimated theoretical potential in Finnmark:
  - 349 TWh (Kjeller Vindteknikk 2009)
- ▶ Hofstad et al (2005) estimated that 70 % of Norway's potential lies in Finnmark.
- ▶ Finnmark..?



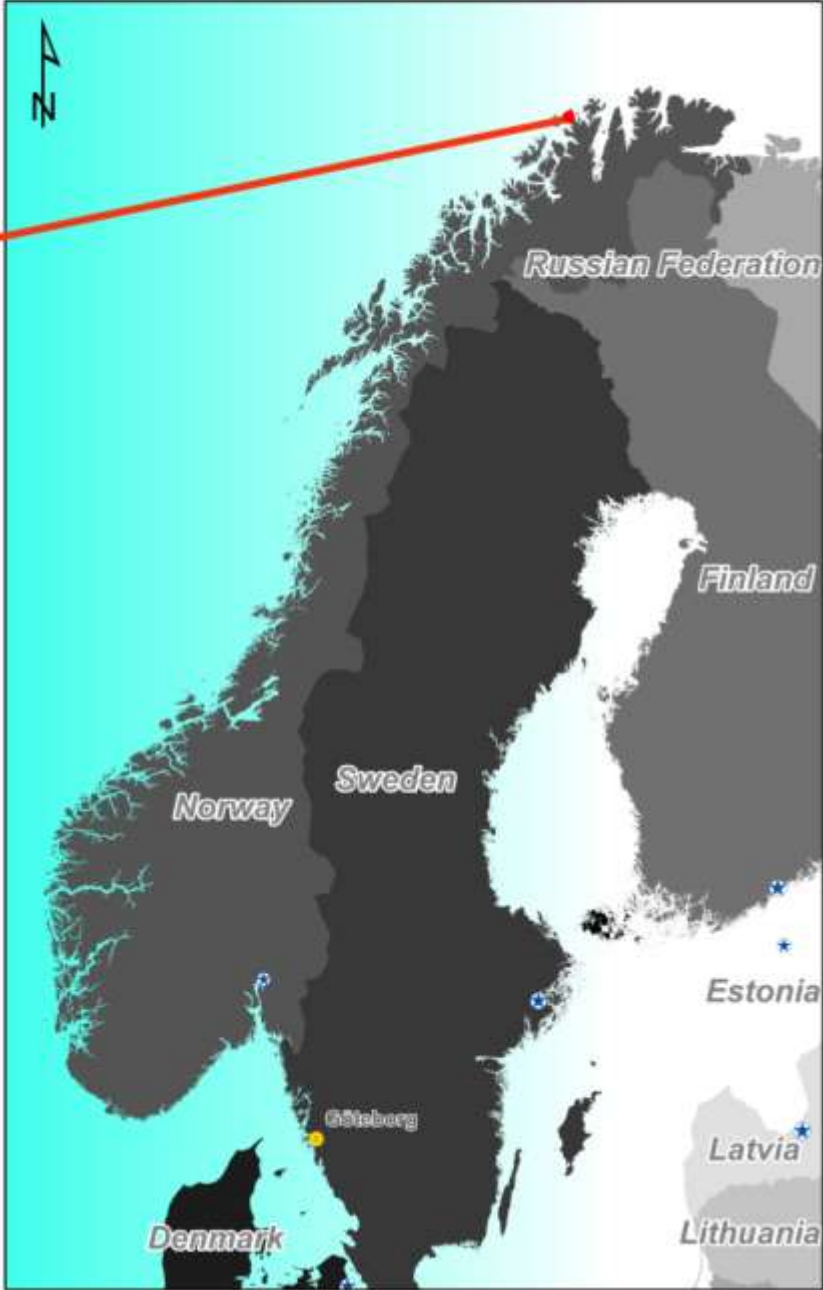


# 4. Lessons from Havøygavlen.

- ▶ 16 Nordex 2.5MW wind turbines
- ▶ Hub height 80m and rotor diameter 80m
- ▶ Installed Summer 2002.
- ▶ Located at 71 deg north
- ▶ Altitude 280 m above sea level.



# Havøygavlen wind farm



# Climatic overview

- ▶ Costal climate.
  - Annual mean temperature 0 °C
  - Monthly average during winter -6°C
  - Monthly average during summer 8°C
- ▶ In-cloud icing events registered in about 9 days/year.
  - Short periods, and light icing.
- ▶ Estimated annual average wind speed at most favorable location; 8.9m/s 50m above ground.
- ▶ 46.6m/s was observed during measurement period. (Beaufort scale hurricane: 32,7m/s)

# Lessons learned

- ▶ Complex site, with high wind speeds and high turbulence.
- ▶ Icing not the biggest problem:
- ▶ Cold, rough climate, difficult to access site during winter.
- ▶ High wind speed and fog – hindering logistics and crane operations. → Difficult maintenance.
- ▶ Difficult to repair blades and gearboxes → requiring warm and dry weather.
  
- ▶ Rough weather. Extreme wind speeds, cold climate, lightning(?).



# 5. R&D in Norway

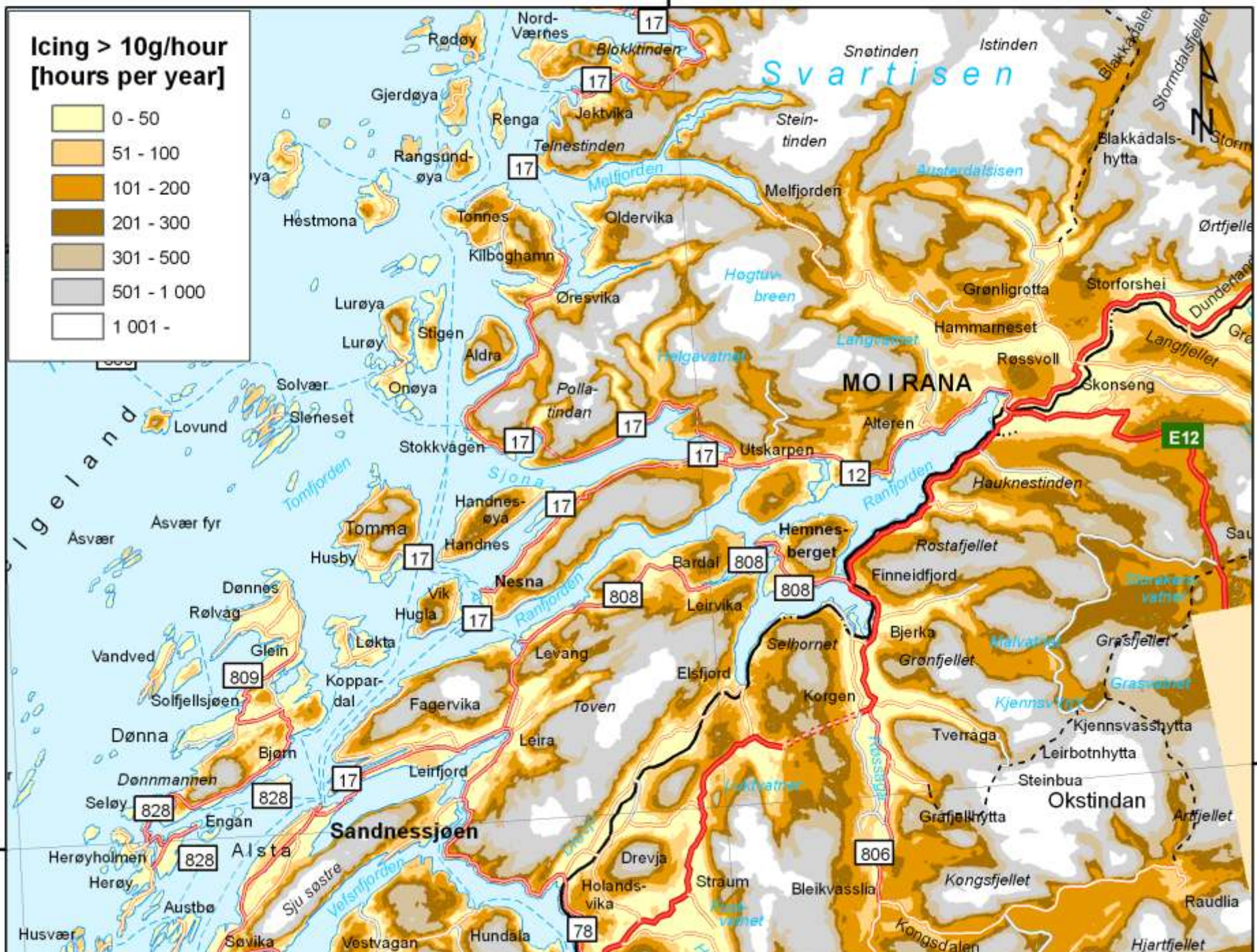
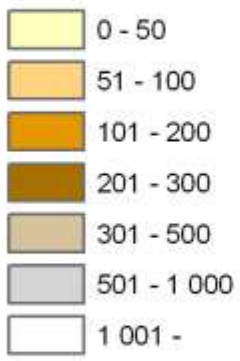
- ▶ Kjeller Vindteknikk.
  - Icing map.
- ▶ Is icing a problem in Norway?
- ▶ Let's look at Kjeller's icing map.
  - Area around Mo i Rana (almost randomly chosen)



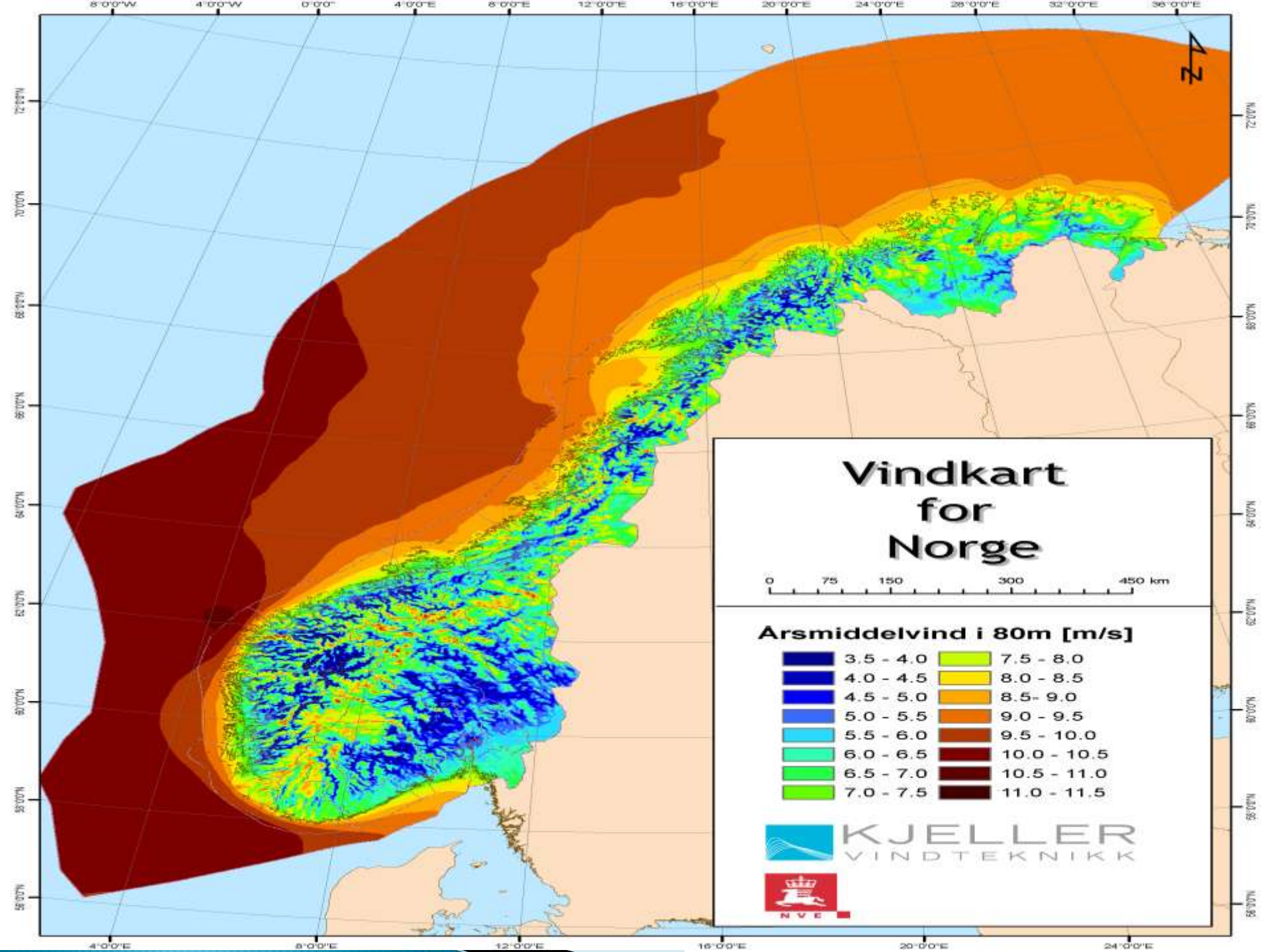
# Icing map

- ▶ Kjeller does calculations on a cylinder (30mm \* 1M)
- ▶ Defines an icing period as: Icing load of 10 grams of ice per hour.
- ▶ Hours of icing on the map: Hours with ice load > 10 grams/hour
- ▶ Is it a problem?

**Icing > 10g/hour  
[hours per year]**







# Vindkart for Norge

0 75 150 300 450 km

## Arsmiddelvind i 80m [m/s]

3.5 - 4.0	7.5 - 8.0
4.0 - 4.5	8.0 - 8.5
4.5 - 5.0	8.5 - 9.0
5.0 - 5.5	9.0 - 9.5
5.5 - 6.0	9.5 - 10.0
6.0 - 6.5	10.0 - 10.5
6.5 - 7.0	10.5 - 11.0
7.0 - 7.5	11.0 - 11.5

 **KJELLER**  
VINDTEKNIKK



# 5. R&D in Norway

- ▶ Is icing a problem in Norway?
- ▶ Should be enough potential in coastal areas with small icing problems.
  - Other problems do arise.
- ▶ Extreme wind, corrosion, for example.

# Thank you for your attention.

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**NORWEA**  
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