HYDROGENS ROLLE I LONGYEARBYENS ENERGIFORSYNING

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Renewable energy

- Wind
- Solar
- Geothermal
- Ocean (tidal, wave, …)
- Hydropower
- Bioenergy
- ……

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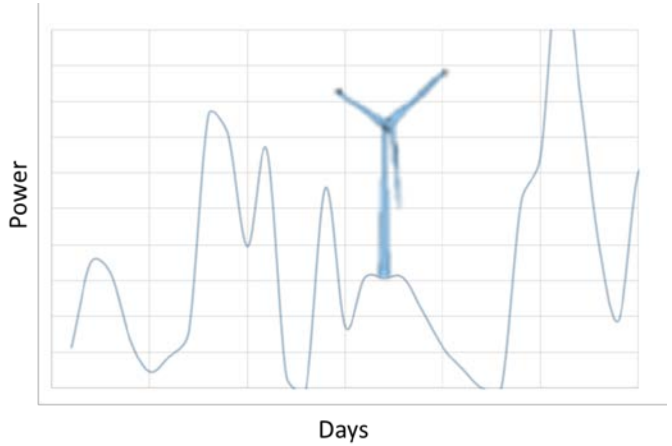
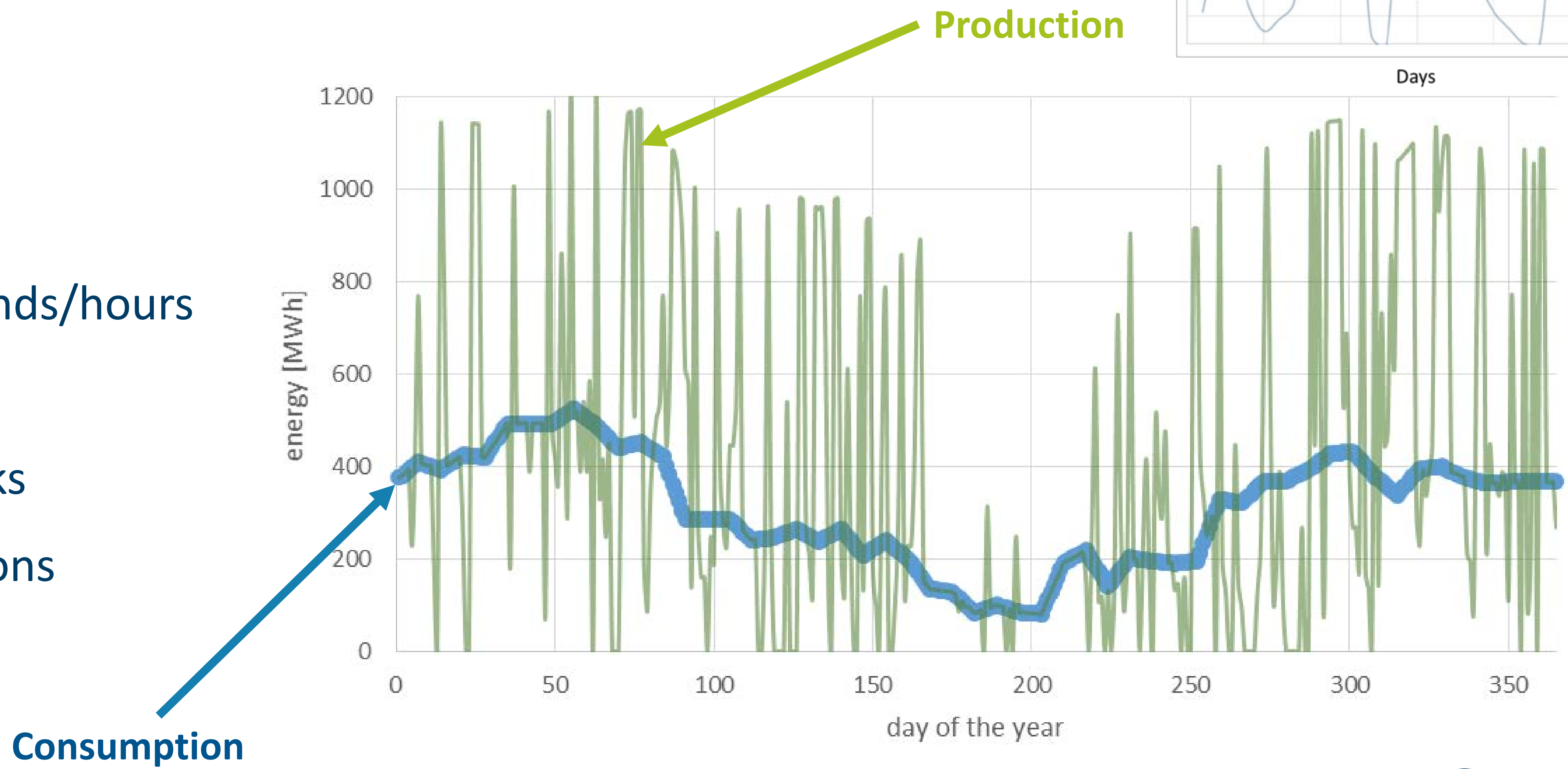
Wind power vs power consumption



Vary in

- Seconds/hours
- Days
- Weeks
- Seasons



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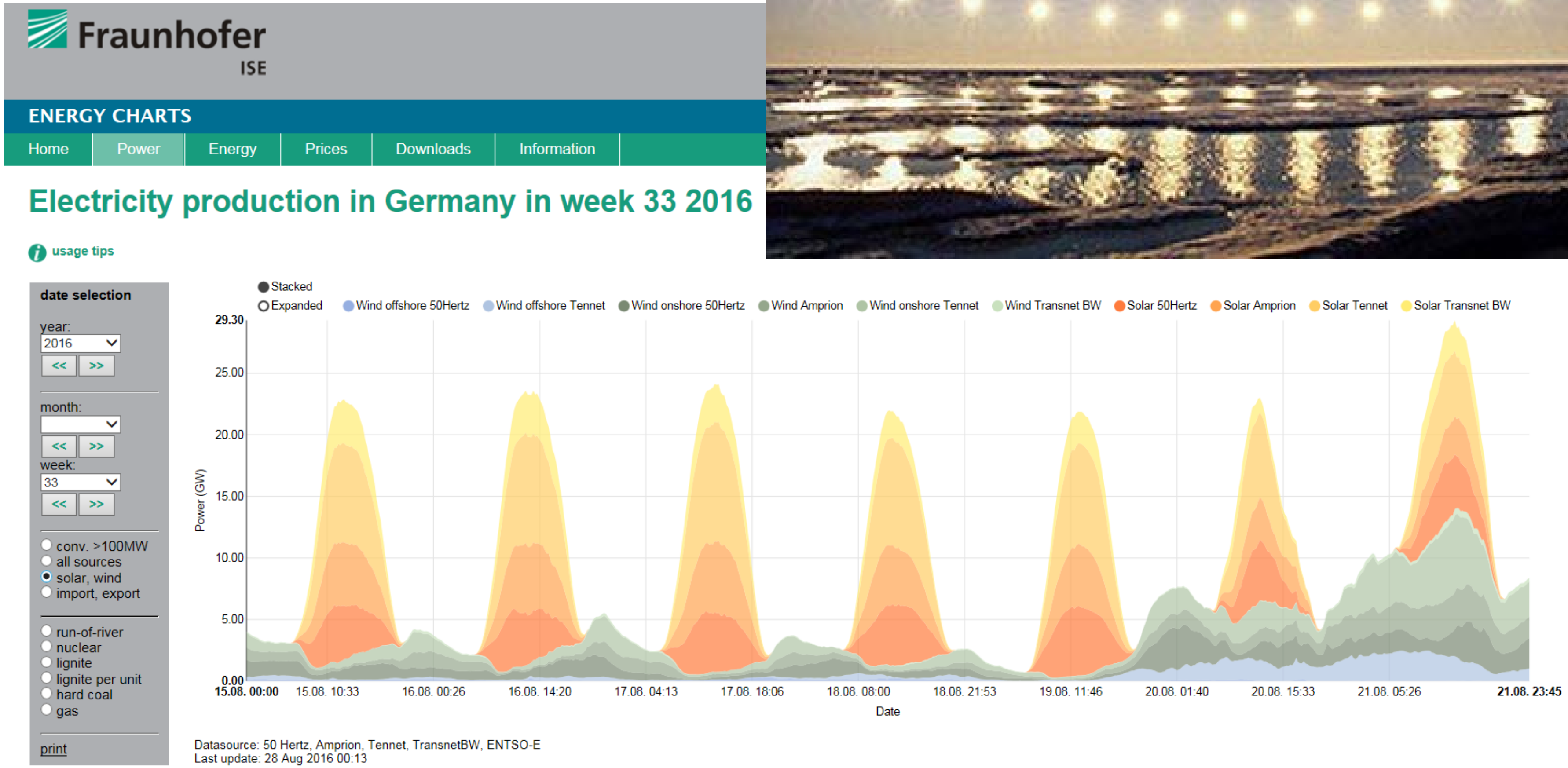
Solar power

Vary in

- Seconds/hours
- Days
- Weeks
- Seasons

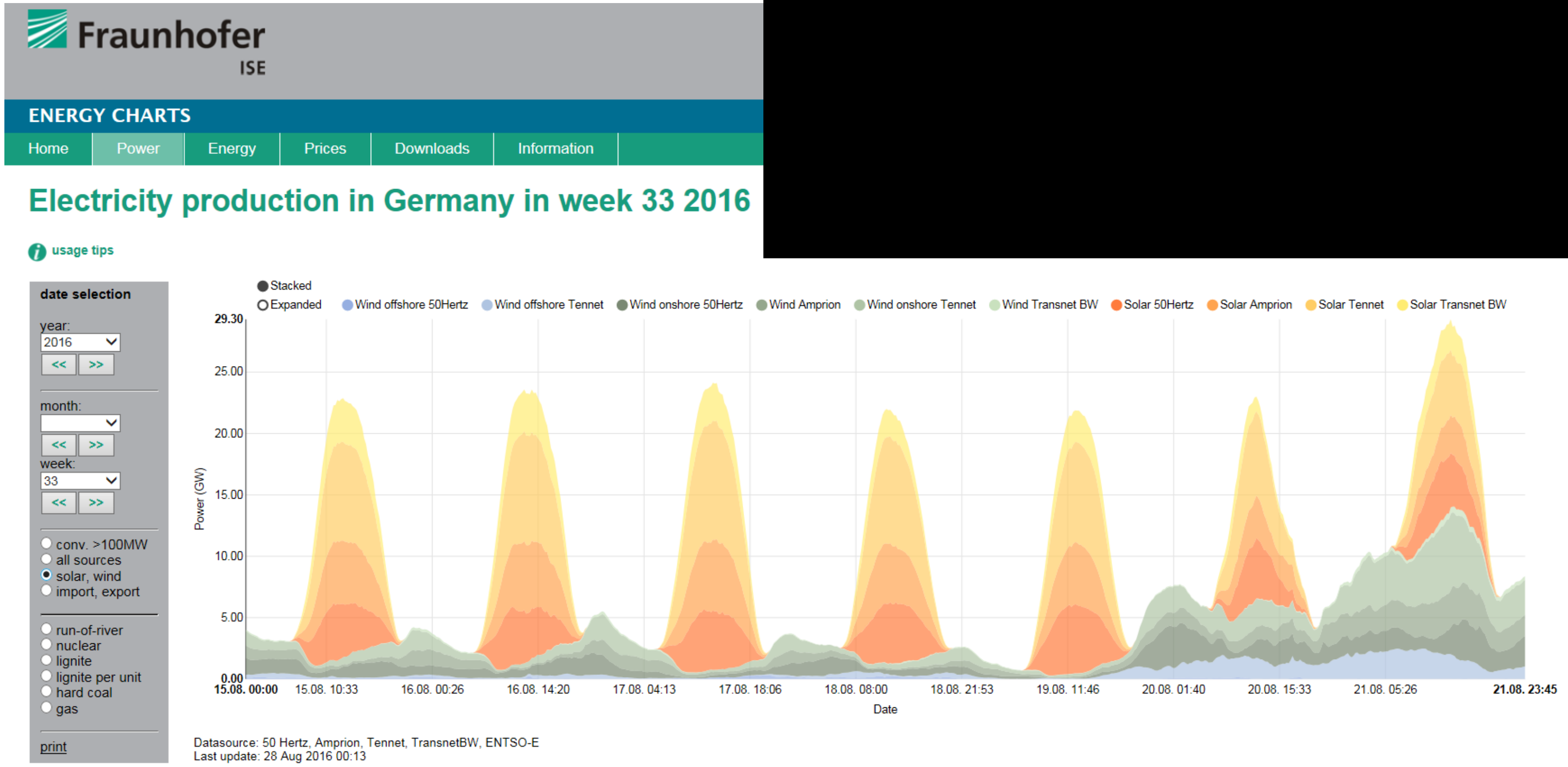


Solar power

November – March….

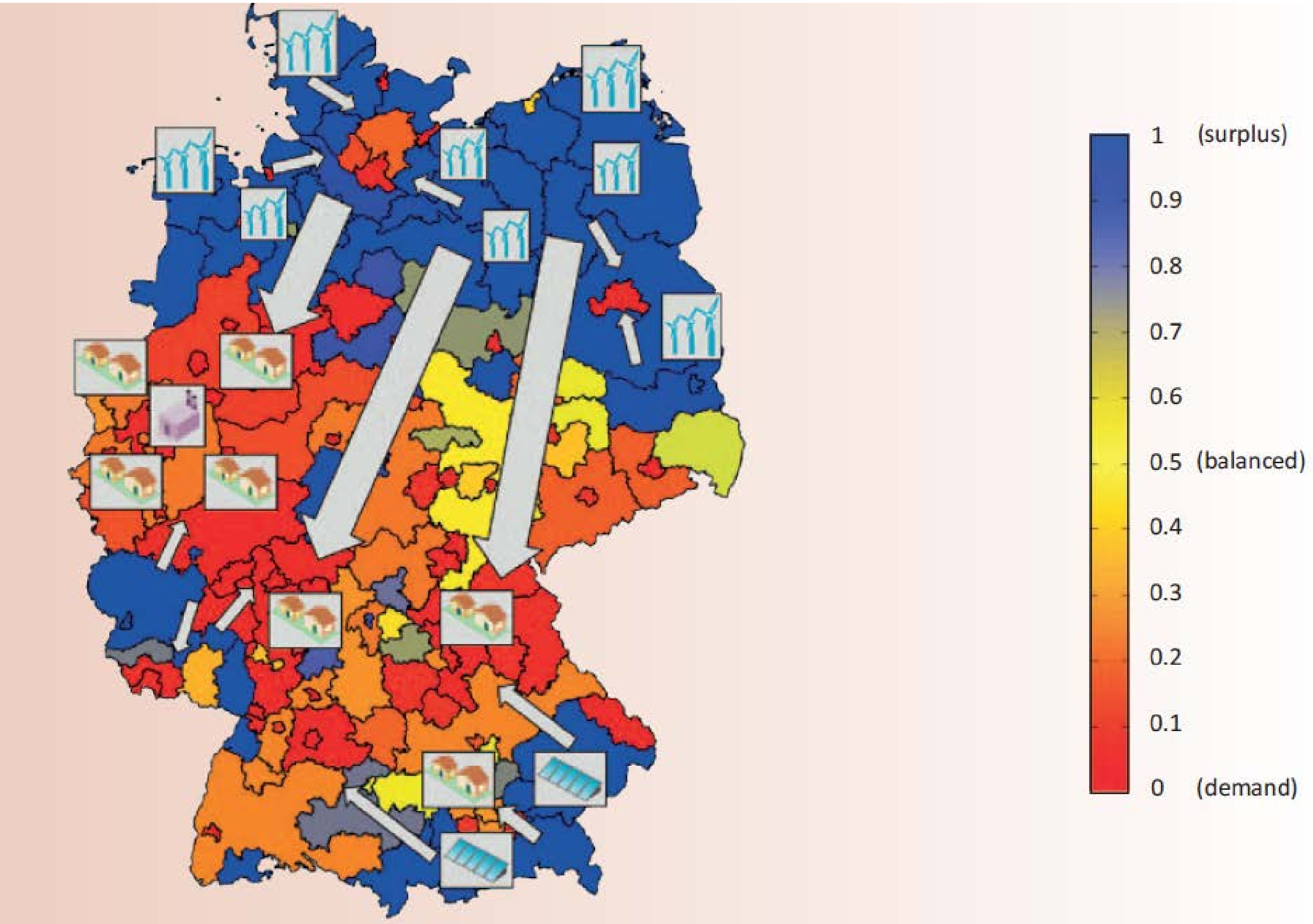
Vary in

- Seconds/hours
- Days
- Weeks
- Seasons

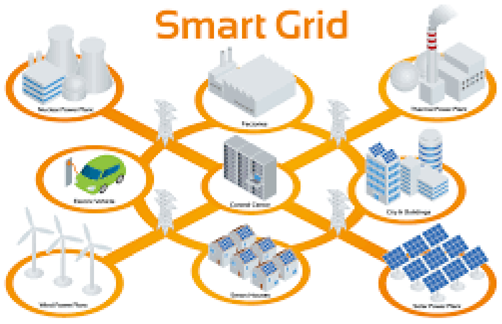


Renewable energy – distribution (& storage)

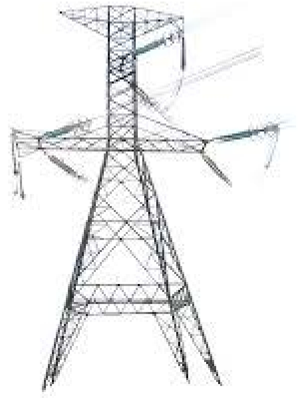
- Surplus and shortage
- Flow/export between regions



Alternatives to increase flexibility in the power system



- Smart grid - demand side management
- Transmission and distribution expansion (import/export)
- Energy storage
  - Thermal (e.g. molten salts, phase-transition materials)
  - Electrochemical (e.g batteries, capacitors) – MW plants
  - Chemical (e.g hydrogen: Power-to-gas, storage or processing)
  - Mechanical (e.g. pumped hydro, flywheel) – GW plants



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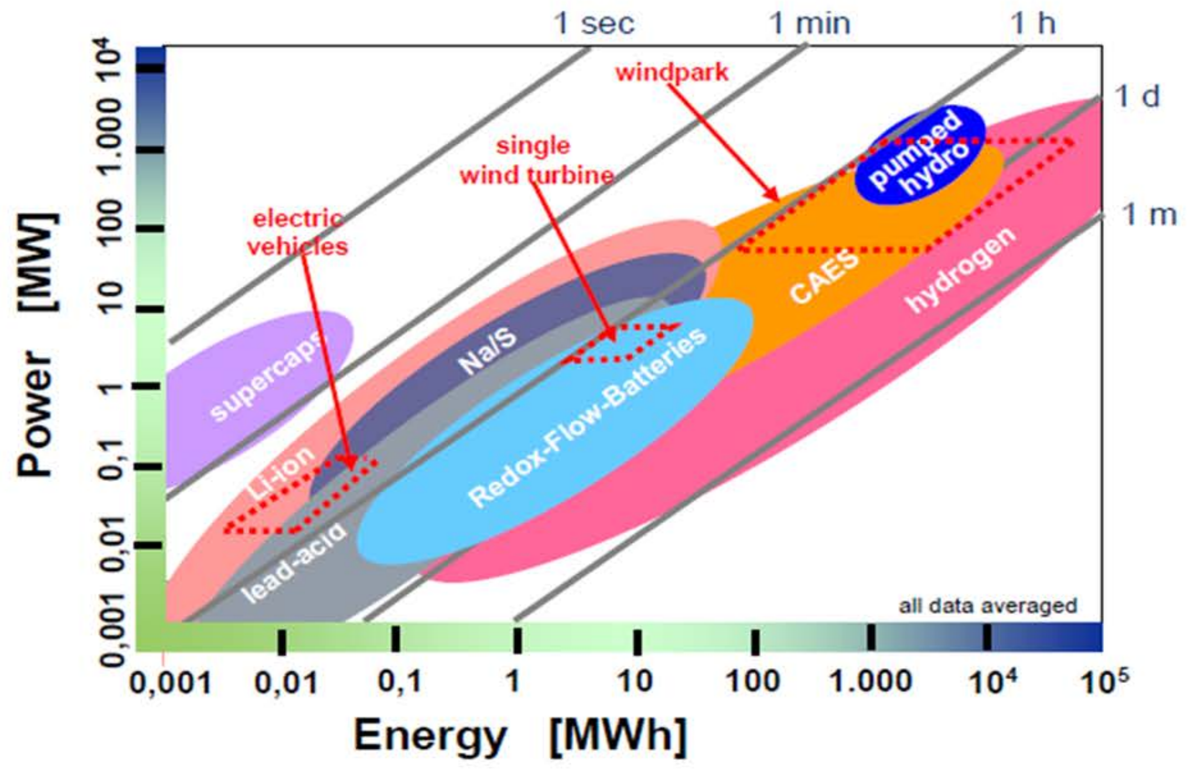
Large Scale Energy Storage
Options to address `grid storage´ are limited

SIEMENS

segmentation of large-scale (electrical) energy storage



key statements:

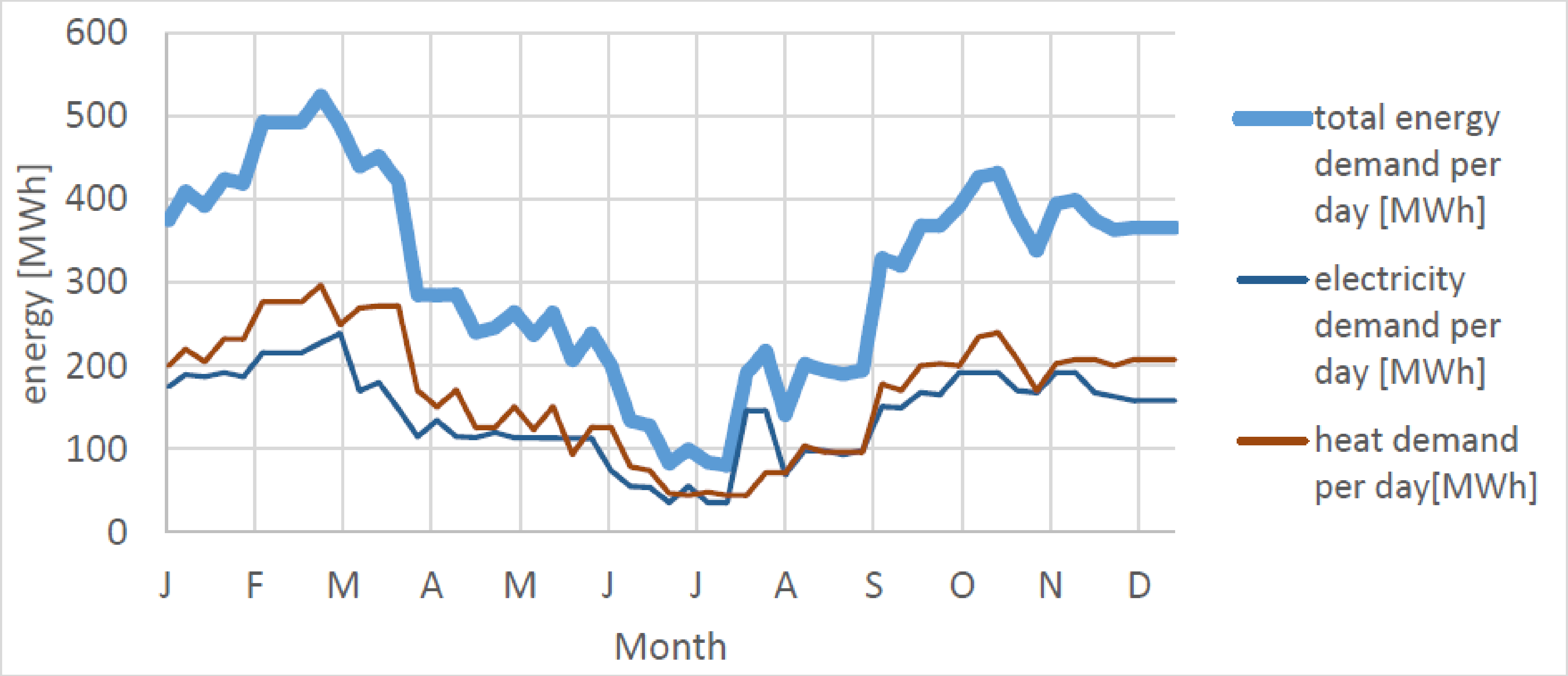
- Battery storage applications are limited in the hour range
- Energy storage >100 MW can only be addressed by Pumped Hydro, Compressed Air (CAES) and Hydrogen
- The potential to extend pumped hydro capacities is very limited
- CAES has limitations in operational flexibility and capacity

Hydrogen is the only option to cover energy capacities > 10 GWh

Challenges at Svalbard

- Large variations between seasons, summer – winter, production and consume
- Supply safety extremely important, requires much back-up power
- Harsh climate

Power consumption of Longyearbyen



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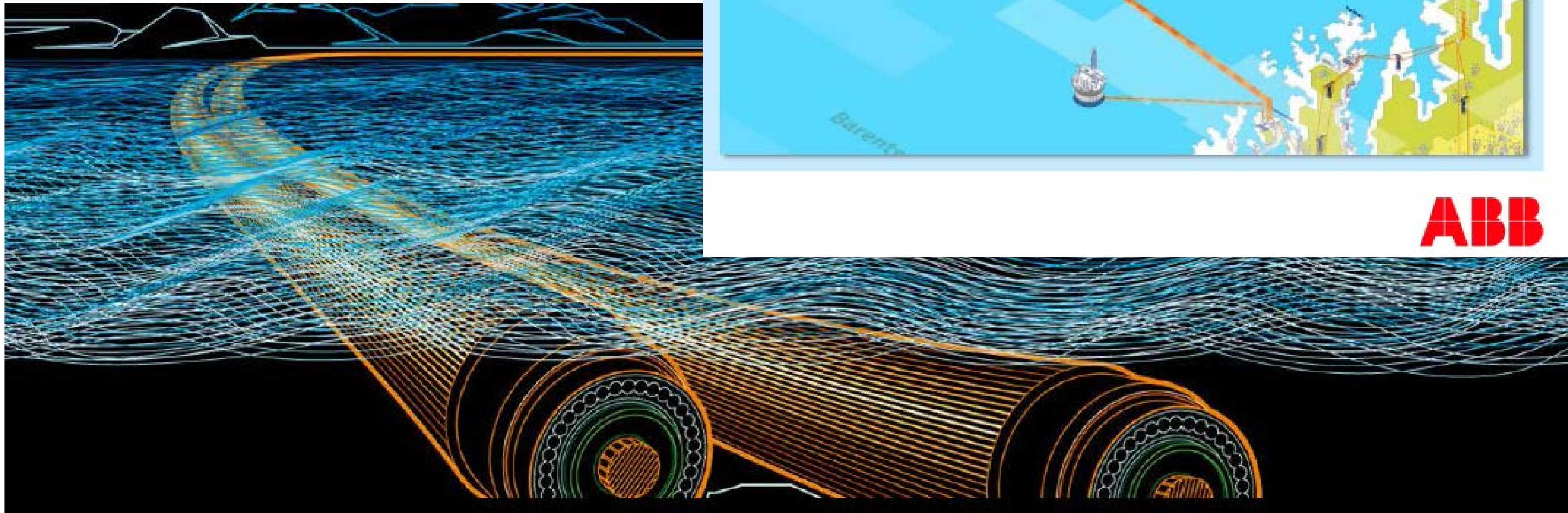
Longyearbyen connected to mainland

- ~ 5 billion NOK investment
- No need for energy storage (back-up?)
- ~ 400 mill NOK/year

ABB



Longyearbyen powered by wind

- 100 stk à 3 MW, 115 m diameter
- ~ 4 billion NOK
- Area covering more than 1200 soccer fields

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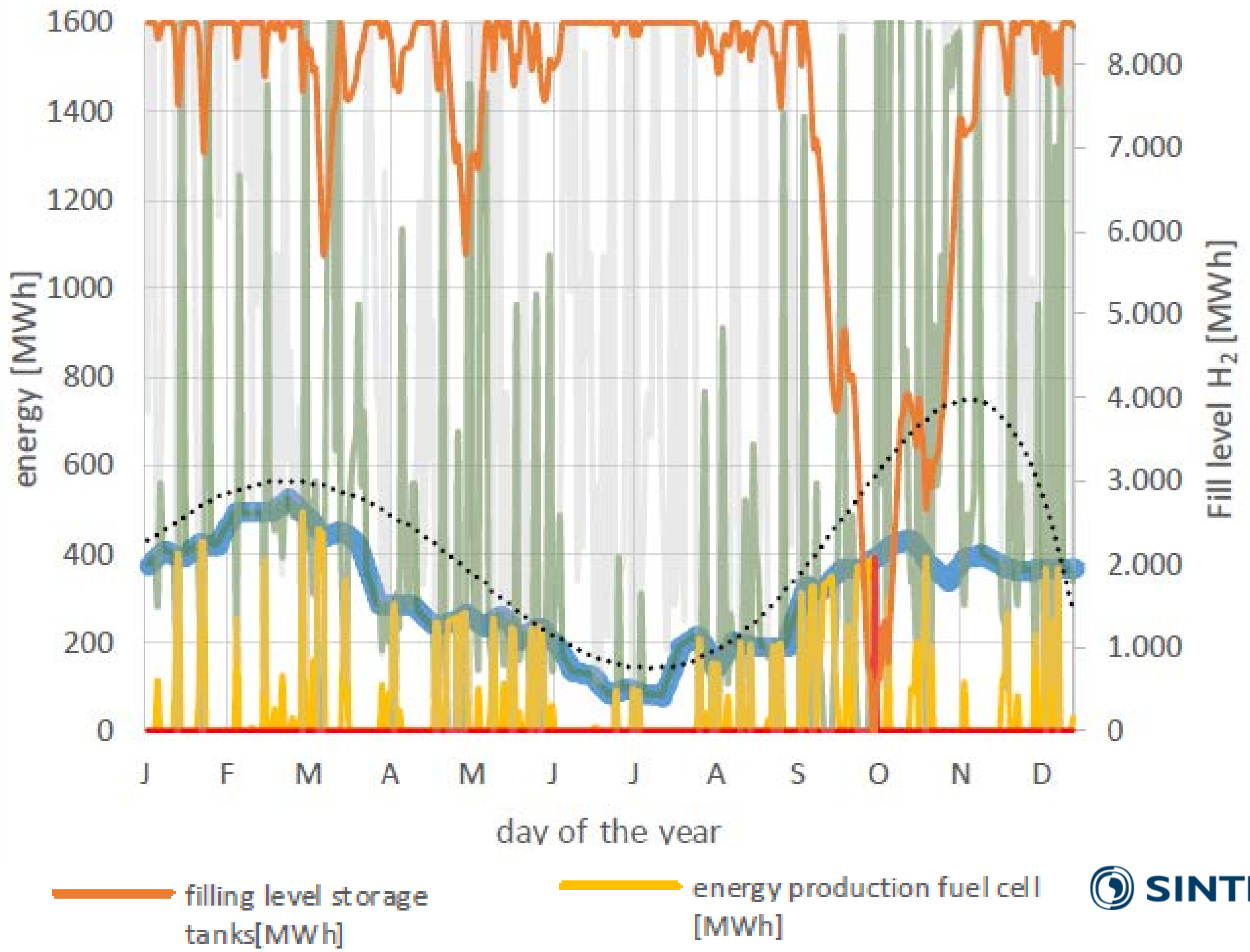
Need for energy storage

- Storage requirement 8.5 GWh
- ~ 100 000 Tesla S
- LH_2-plant ~ 1.5 billion NOK
- ~ 530 mill NOK/year
- Batteries ~ 2-400 $/kWh
  => ~ 10-20 billion NOK



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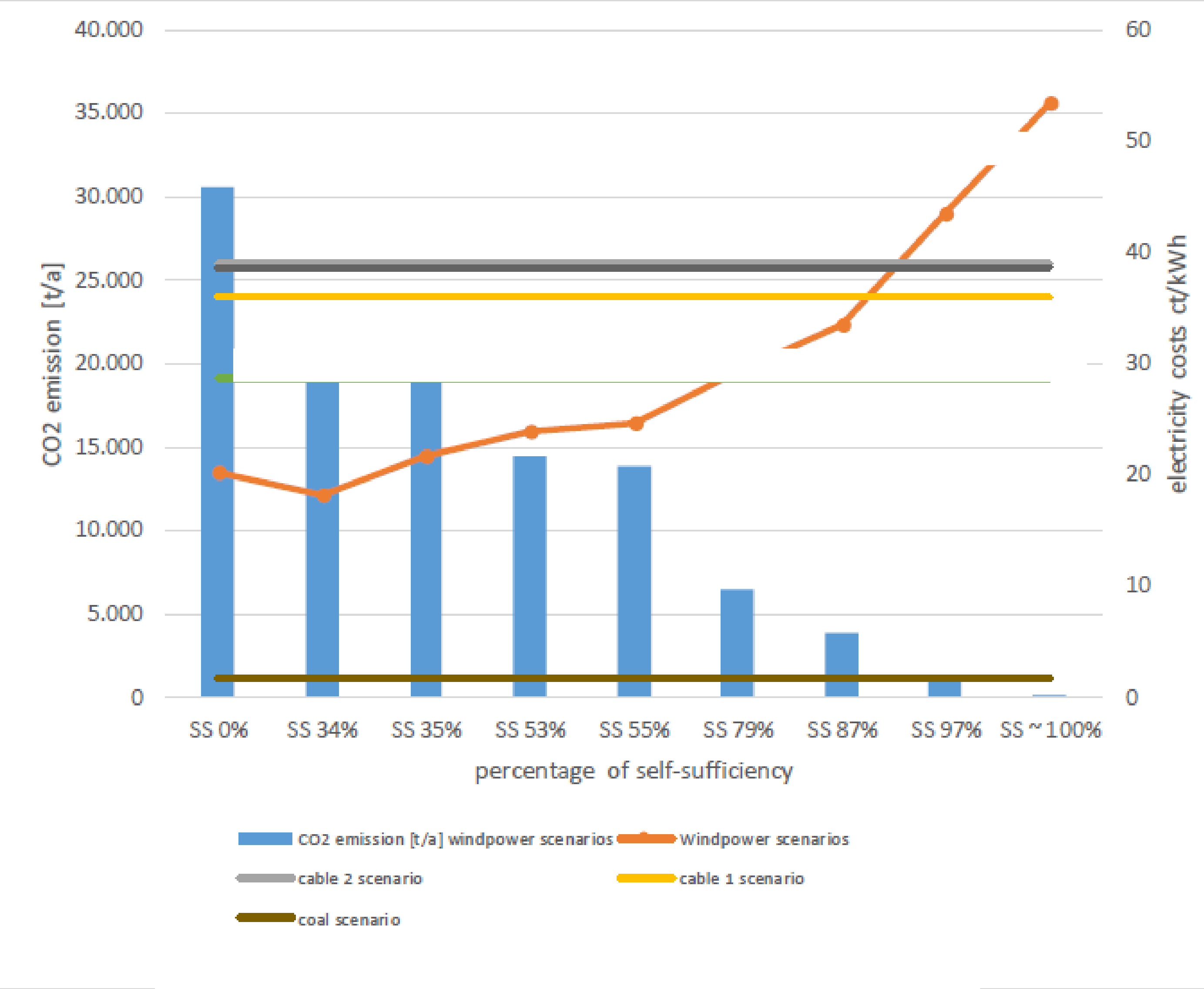
From 0-100% wind

- Wind-diesel hybrid
- Increasing costs vs decreasing CO_2
- Competitive with cable up to about 90 % self sufficiency



Longyearbyen powered by the sun

- Possibly low cost electricity
- 210 000 panels, ~ 57 MW_p
  covers May to August
- ~ 0.7 billion NOK
- Area covering more than 120 soccer fields
- Problem from November to March…

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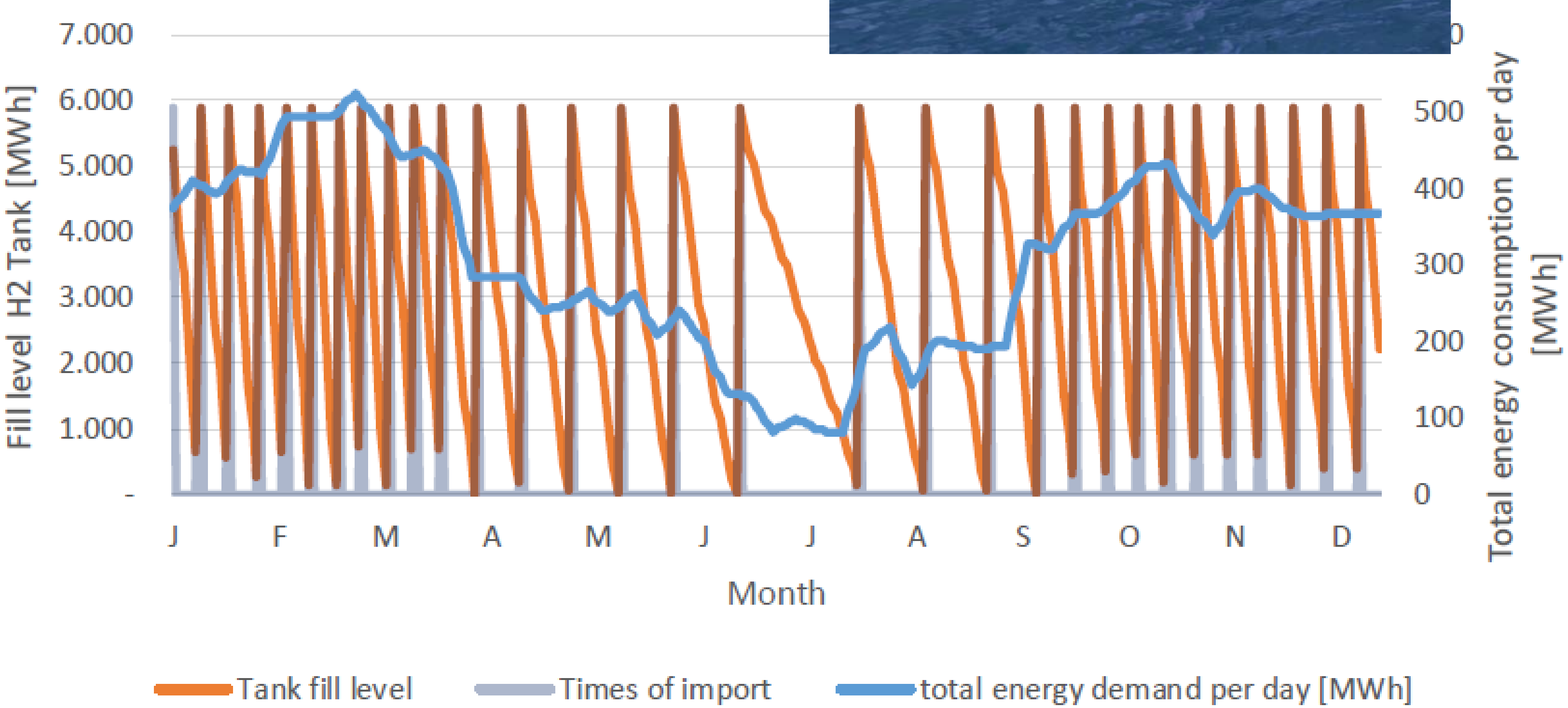
Import of hydrogen

- From mainland
- 1 billion NOK
- 35 NOK/kg H_2

=> ~ 290 mill NOK/year

5-6 000 tonn H_2 per year



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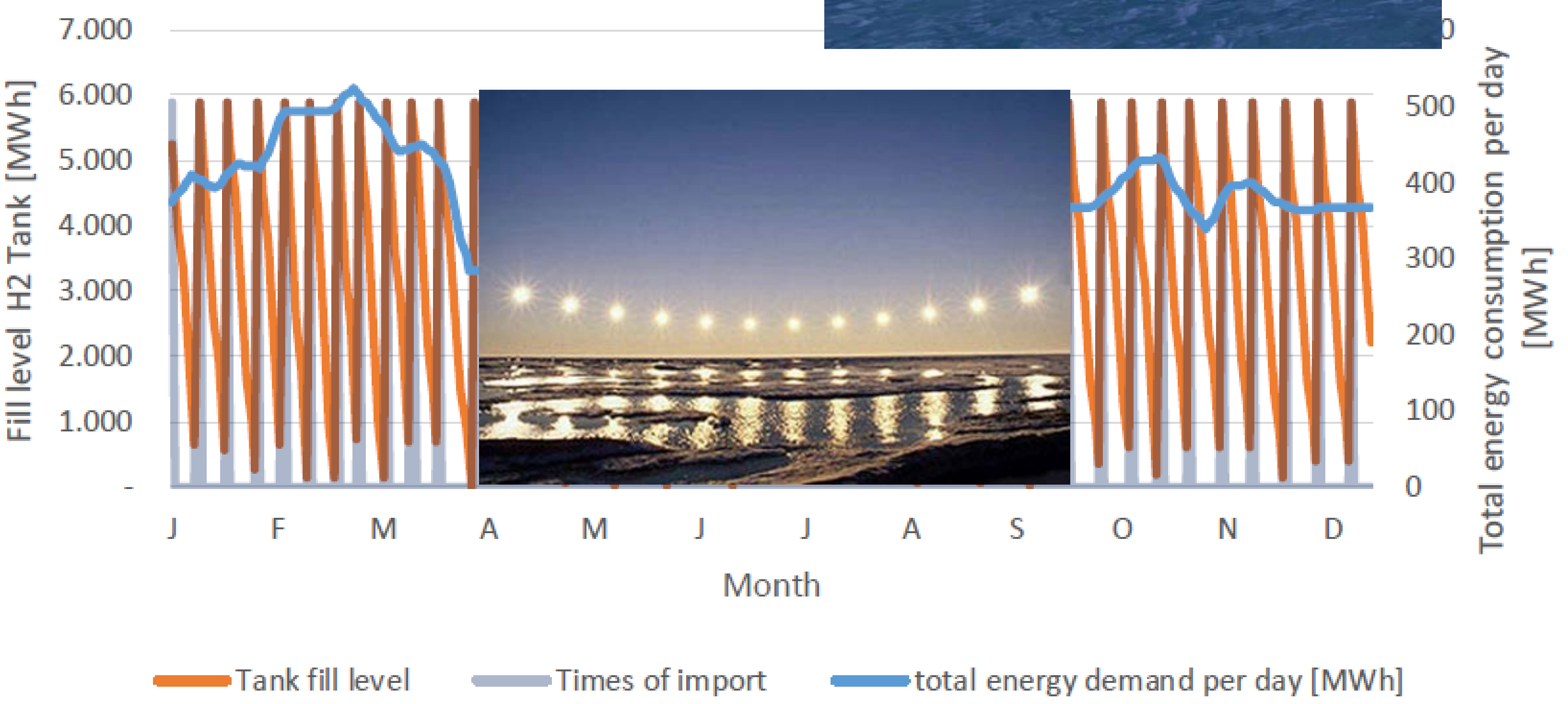
Import of hydrogen + solar

- From mainland
- **1.5 billion NOK**
- 35 NOK/kg H_2

=> ~ 270 mill NOK/year



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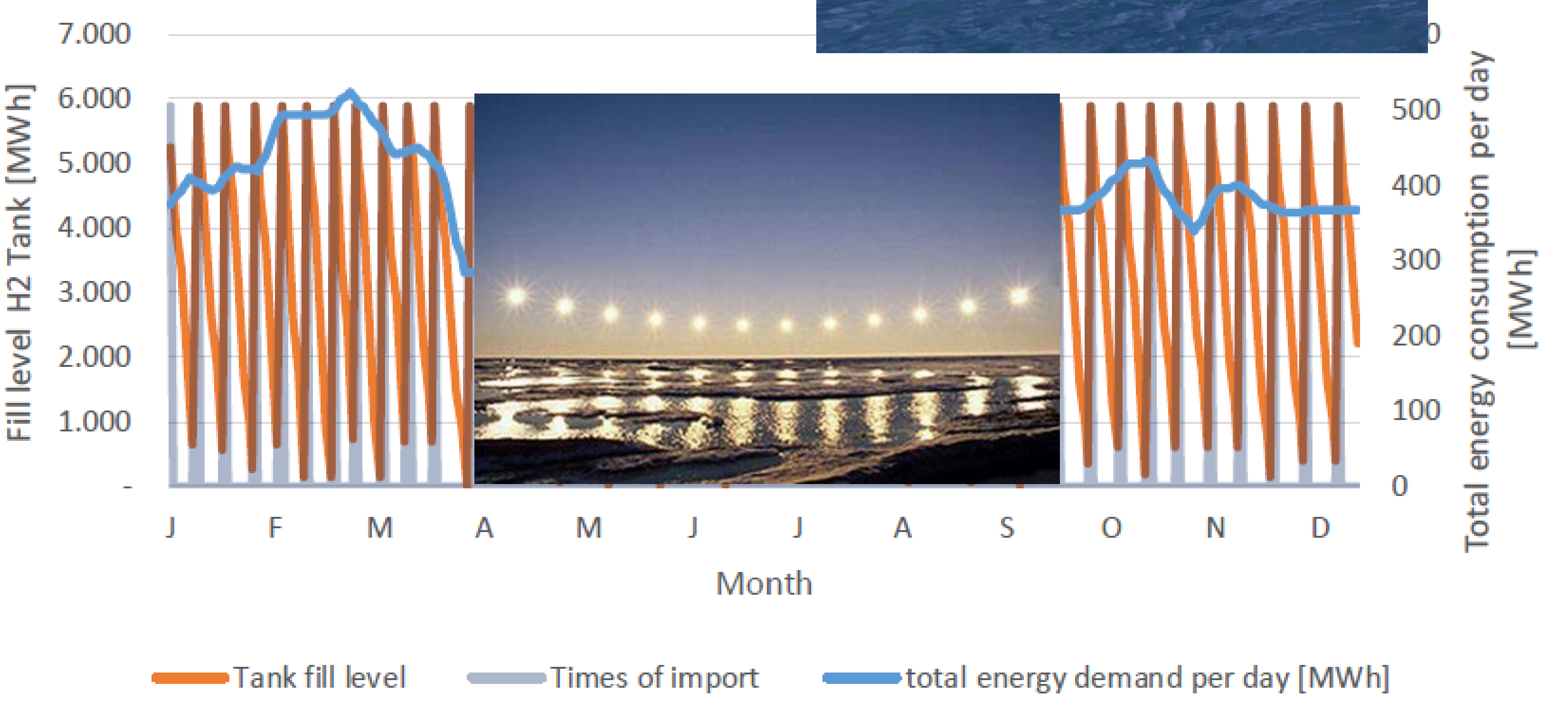

With recovery of FC losses => heat, another ~20 mill NOK/year saved.

Summary

- Renewable, zero emission Svalbard is possible
- Many relevant sources/technologies
  - practical, economical and environmental limitations…
- Some kind of mix probably the best

=> Study and early small scale demonstration to find the optimal solution.

	CO_2-utslipp (tonn/år)	Strømpris (kr/kWh)	Investeringskostnad (i millioner kr)	Årlig kostnad (i millioner kr)
Dieselaggregat	60 000	1,80	30	200
Sjøkabel	0	3,60	5 000	400
Vind + H_2	0	4,80	5 500	530
H_2-import	0	2,60	1 000	290
Sol + H_2-import	0	2,40	1 500	270 (250)

Figure: Knut Gangåssæter/SINTEF

Teknologi for et bedre samfunn