St1 Nordic Energy Outlook

2017 Edition

February 2, 2017

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The Paris Agreement in November 2016 is an important milestone in combating climate change. However, it's still far from being enough to limit the average global temperature increase in 2100 to 2° Celsius above pre-industrial levels (IEA World Energy Outlook 2016, 450 Scenario), not to mention the agreed 1,5 degree objective. Already in 2016 the global consumption of oil exceeded the level of IEA's 450 Scenario.

The population growth and GDP growth are the key drivers of increased energy demand, and the steep upward trend in all of them will continue for decades to come. The world does not have technological solutions needed to annihilate climate change. Major technological breakthroughs are needed in every segment, which underlines the need to step up R&D investments significantly from the current levels. At the same time it's paramount to find ways to change our behaviour, in other words, to simply use less energy in our daily lives. For example a modal shift from flying to rail would be such change that would have an impact, if it happened at a larger scale.

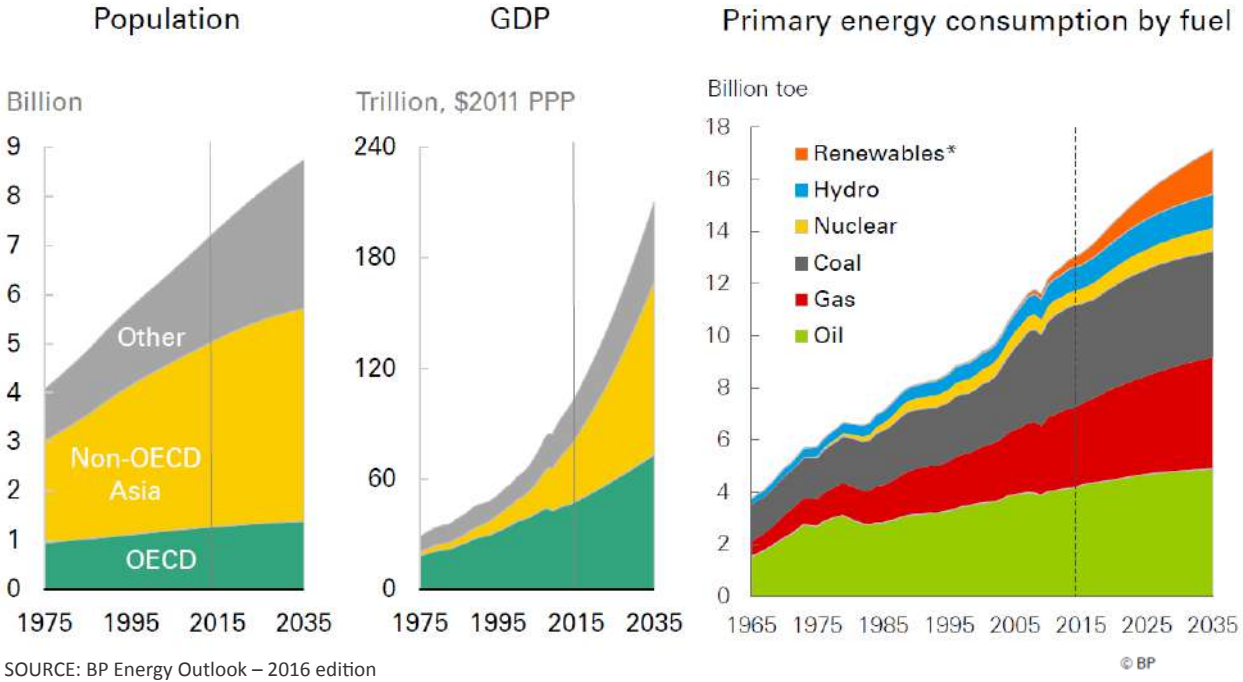
The change relies on global international agreements, implemented through regional and national policies. The recent global political development seems to be leading towards protectionism and at some degree watering down global agreement structures. For the open Nordic democracies, the EU regulation is the core regulatory framework. EU's energy and climate regulation for 2030 is under construction, probably for another 2-3 years, which limits the ability of the Nordic countries to pursue several of their ambitious national decarbonizing measures.

It would not be wise national energy or industrial policy to create a new national legislation for 2020's, before the EU framework is clear and binding. You have to know the rules of the game before you play it. Otherwise the risk of stranded investment is real and substantial.

We do believe that the Nordic countries should be in the forefront the of development. It is our responsibility. However, our efforts should be focused on segments and activities where we can truly make a difference by creating world class competence. We as nations have to maintain our competitiveness by not wasting our scarce resources in activities where we have little to gain, and at the same time would have only negligible impact on the climate change. For example, incentivizing electric vehicles substantially, at this early stage of technological development in Finland, with nothing to gain industrially and with no real climate impact, would not be the right use of tax payers money.

As always, we are open to dialogue, and we love to be proven wrong in any of our analysis and claims. Thus, we invite you all to join the ride of continuous improvement of St1 Nordic Energy Outlook!

The global energy challenge



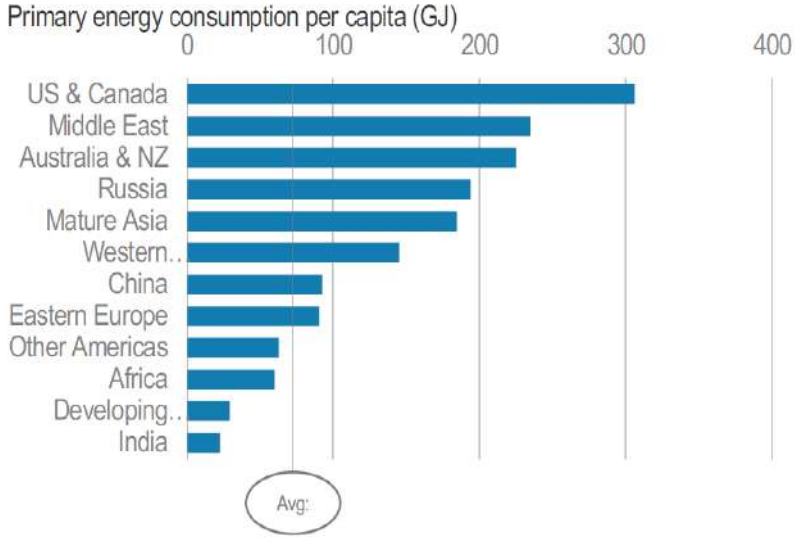
SOURCE: BP Energy Outlook – 2016 edition

	Energy Demand (Mtoe) Current Policies Scenario		
Fuel	**2020**	**2030**	**2040**
Coal	4 051	4 710	5 327
Oil	4 548	4 960	5 402
Gas	3 194	3 898	4 718
Nuclear	793	936	1 032
Hydro	375	450	515
Bioenergy	1 540	1 695	1 834
Other Renewable	319	535	809
Total	**14 819**	**17 183**	**19 636**

IEA: World Energy Outlook 2016

Population and GDP growth drive global energy demand

- Population increase and GDP development are the key drivers behind growing demand for energy
- World's population is expected to reach 9,2 billion by 2040, an increase of 1,9 billion vs. 2014
- Over the same period GDP is expected to more than double
- China and India alone would account for almost half of the increase in global GDP growth
- Africa is expected to account for nearly half of the population growth. However, it would account less than 10% of the global GDP growth



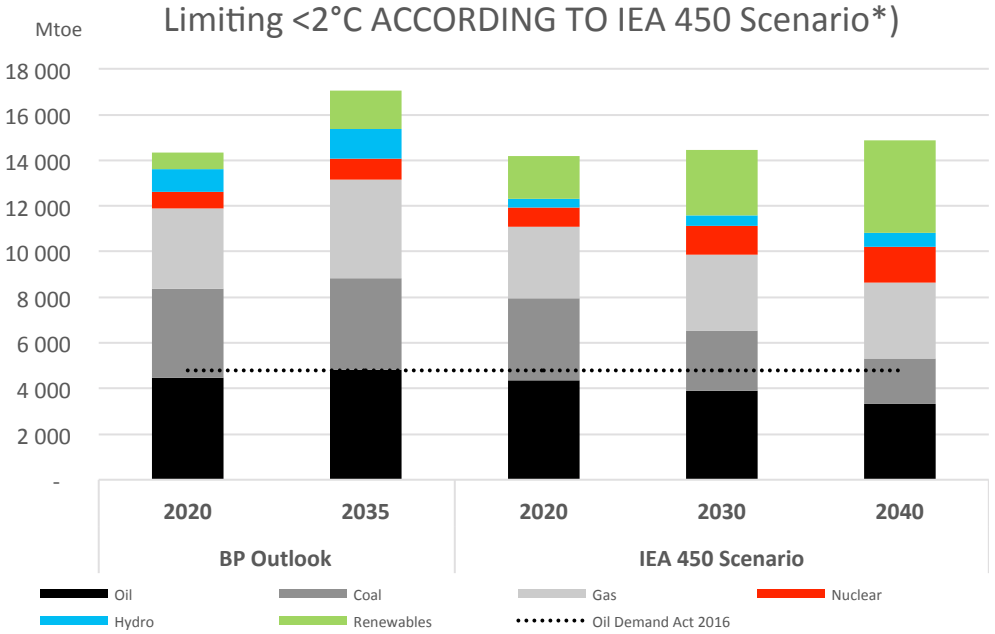
MORGAN STANLEY RESEARCH:
Download the complete report

Oil & Gas: From Molecules to Electrons - What Energy Transition Means for Oil & Gas Investors - January 5, 2017 GMT (22 pgs/ 911 kb)

SOURCEs: World Energy Outlook 2016, Morgan Stanley

To stay under 2° Celsius temperature increase is a huge challenge

- According to IEA the global energy demand would have to flatten out at the estimated 2020 level in order to limit the global warming to 2° Celsius vs. pre-industrial levels (IEA 450 Scenario)
- It would require decoupling of the GDP and the energy demand growth at the global level
- Also a major shift from fossil to renewable energy and to nuclear production would be needed simultaneously
- Already in 2016 the global oil demand (97,8 mmb/d) exceeded the targeted 2020 level making the challenge even harder.



*) 450 Scenario has the objective of limiting the average global temperature increase in 2100 to 2° Celsius above pre-industrial levels

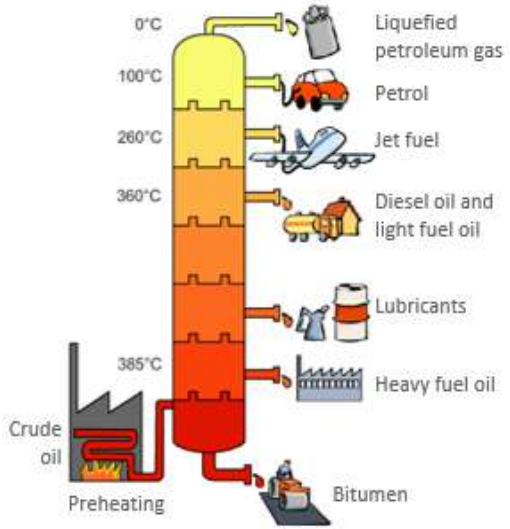
WORLD DOES NOT YET HAVE TECHNOLOGICAL SOLUTIONS NEEDED, THUS A SIGNIFICANT INCREASE IN R&D IS IMPERATIVE

SOURCES: BP Energy Outlook 2016 and 2017, IEA World Energy Outlook 2016 and PIRA Global Oil World Market Forecast

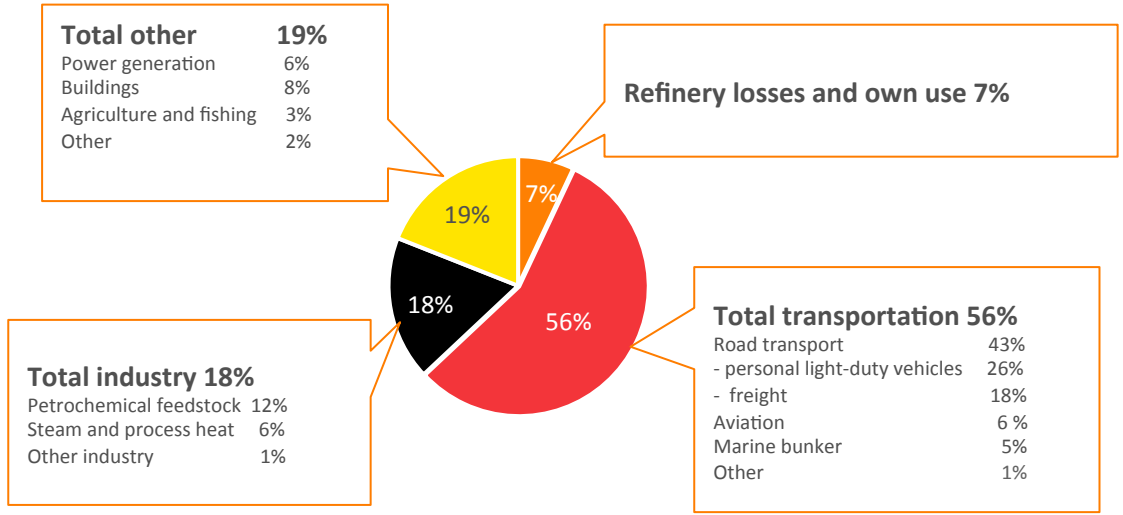
“The distillation curve challenge”

- Crude oil refining produces always the same product slate: light distillates, middle distillates, heavy distillates and residuum
  - i.e. if you produce Jet fuel, the process produces the other products as well

Crude oil product slate



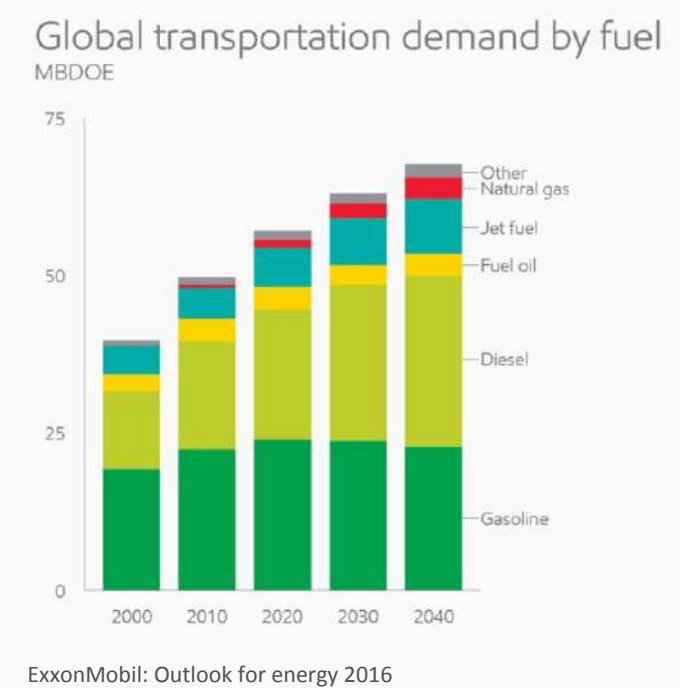
How oil is used mb/d



Source: Morgan Stanley Research, Petroleum & Biofuels Association Finland, Economic Information Office

“The distillation curve challenge”: Demand for Jet fuel

- Jet fuel demand is expected to rise up to 200% in next 30 years (from 260 mt/a to over 500 mt/a) as global air travel keeps growing.
- A typical yield from crude oil to Jet fuel is 5-8%.
  - Heavier components (e.g. VGO) could further be cracked into Jet and other lighter products, which would slightly increase the Jet output.
- Biojet can replace fossil Jet only marginally, with no real impact on emissions.
- Growing demand of Jet increases the demand for the crude oil, which in turn will be refined into the whole product slate. All the refined petroleum products will always be marketed to some geographical market to be used in some application.
- Cutting the demand of just one product (e.g. gasoline through electrification of passenger vehicles), will not cut the overall GHG emissions per se, as the use of crude continues at the same level.
- The only way to cut emissions from oil products is to cut the demand for all oil products with no alternative low carbon solution available, and to simultaneously replace products with alternatives available.
  - Different technologies develop at uneven pace and synchronization of decarbonisation measures is impossible. Thus it’s important to keep decarbonizing in segments where ever and whenever that is possible, and to step up R&D efforts in segments with no available solutions yet.



ExxonMobil: Outlook for energy 2016

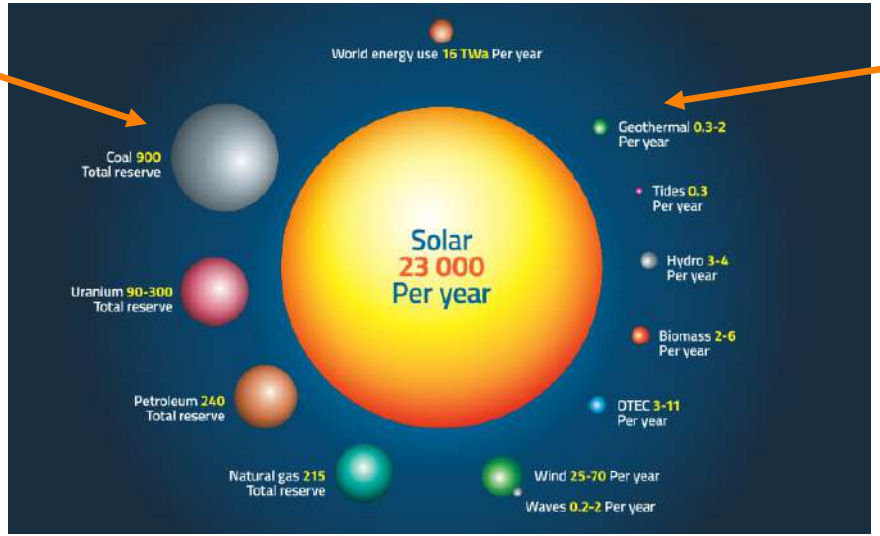
There is an urgent need to create new cost-efficient renewable energy solutions

- Although the share of renewable energy is growing, fossil energy continues to grow much faster, creating increased amount of emissions
  - Emissions trading has proven to be an ineffective mechanism that has not triggered the needed investments fast enough
- Most countries do not have the ability to offer incentives to convert fossil energy to renewables
- Emissions reduction obligations should be set to the companies producing and selling fossil energy. Such obligations would trigger companies with significant financial and human resources to step up market driven R&D efforts on low carbon solutions
- Fossil energy has high price flexibility. Increases in CO_2 taxes in developed countries should be used to promote the development of the use of renewable energy and new low-carbon technologies
- Development of new cost efficient renewable energy technologies is the key in the battle against climate change
- Developed countries need to increase resources in R&D and demonstrations of new technologies

WE HAVE TO STEP UP EFFORTS NOW - BECAUSE THE FUTURE IS DECIDED TODAY

Renewable energy potential does not limit its use

Fossil energy: total estimated resources



Renewable energy: estimated annual potential

As a comparison, the Nordics' annual energy use is ~0,1 TWa

LIMITS COME FROM A LACK OF SPEED IN LEVERAGING EXISTING ADVANCED RENEWABLE ENERGY SOLUTIONS AND DEMONSTRATING NEW ONES

http://www.asrc.albany.edu/people/faculty/perez/Kit/pdf/a-fundamental-look-at%20the-planetary-energy-reserves.pdf

Transition to renewable energy is driven by political decisions

- Key in the transition to renewable energy is the relative price competitiveness
  - In the longer term, renewable energy has to be competitive without subsidies, both nationally and globally
  - The most cost efficient forms of renewable energy will set the benchmark and will lead in replacing fossil energy
- The envisaged technology development, taking into account the estimated population increase, is not likely to enable the world to stay under the agreed cap of 1,5° Celsius
- Significant investments (private and public) and incentives for R&D and demonstrations are needed to speed up the development of cost efficient renewable energy technologies and solutions
- Fossil energy prices have to include GHG emission-based direct taxes and societal costs caused by global warming (e.g. provisions for extreme weather conditions, floods, droughts, international migration)
- Renewable energy prices will decrease and production capacity increase due to technology development through the learning curve, mandates and incentives
  - The US ethanol industry as well as the EU wind and solar industry have shown that a significant increase in production capacity is possible provided the right policy framework is in place*

THE CHOICES OF INDIVIDUALS ARE UNPREDICTABLE AND WILL NOT SOLELY DRIVE THE TRANSITION TO THE SUSTAINABLE RENEWABLE ENERGY SYSTEM

Source: University of Sussex: http://www.sciencedirect.com/science/article/pii/S2214629615300827

Renewable Energy Incentive Schemes

Energy policy should generate new, smart energy solutions without wasting future generations' opportunities

Objectives and political decisions should ensure short- and long-term continuity, energy efficiency and development of cost-efficient new solutions by

- Ensuring the availability of competitive local renewable energy for the entire economy and using energy cost-efficiently, resulting in a
  - Reduction of carbon dioxide emissions and costs
  - Reduction of imports, which will improve the trade balance

- Enabling fair and technology-neutral competition between renewable energy alternatives, which results in a diverse energy mix (required levels of baseload power – adjusting power – flexible production – reserves)
- Leveraging existing advanced renewable energy business and technologies and at the same investing in R&D and demonstrations of new technologies

A SMART ENERGY POLICY WILL CREATE NEW PROFITABLE BUSINESS, EXPERTISE AND EMPLOYMENT

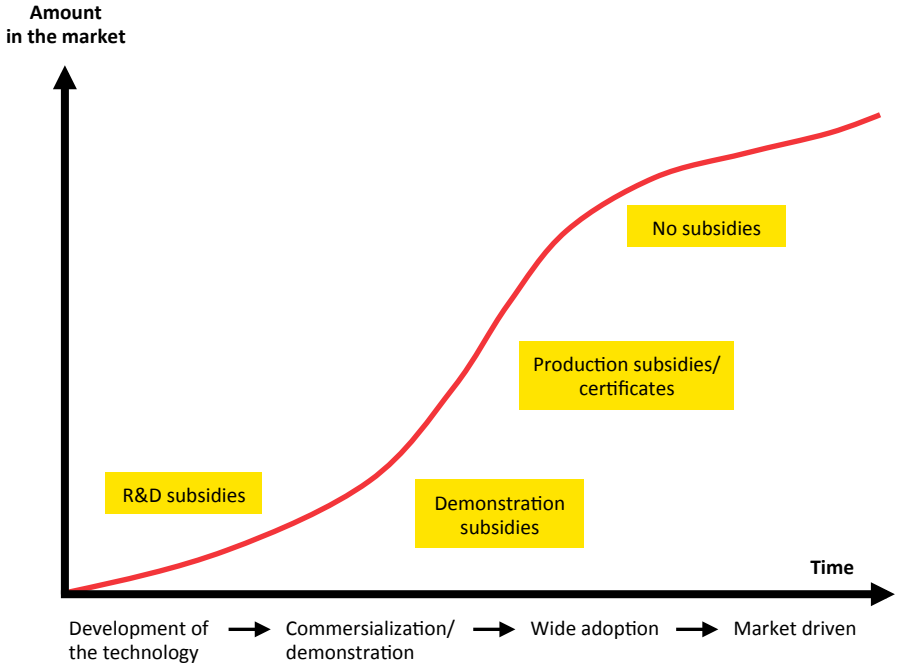
Several support systems are in use in the Nordics

	NEUTRALITY		EFFECTIVENESS				NORDIC COUNTRY EXPERIENCE			
	Technology	Competiton	Cost efficient	Creates investments	Volume effect	Environmental effect	Transport	Electricity	Heating	R&D, Demonstrations
Emissions trading										
Energy tax							*			
CO_2 tax							*		*	
Volume mandate							*			
'Mand.+ double count.							*			
Green certificates										
Sliding premium										
Sliding premium + auction								*		
Investment support							*			*
Investment support + auction							*			*
Fixed premium										
Fixed premium+ auction										
Investment mandate										

Not effective
Moderate
Effective

* THE BEST PROVEN SYSTEMS SHOULD BE APPLIED AT THE NORDIC LEVEL

A smart energy policy will enhance introduction of new technologies and business models



THE TARGETED SUBSIDIES CREATE NEW COST EFFICIENT TECHNOLOGY AND PROFITABLE BUSINESS

Renewable energy investments and R&D require a long-term stable political investment environment 1/2

Biofuels

- The biofuels mandate combined with tax incentives, dedicated sub target for advanced biofuels and CO_2 taxes are the most cost efficient and technology neutral incentive system
- Mandates need to be aligned with vehicle and fuels standards to ensure the ability to use high concentrate biofuels

Power

- A sliding premium based on the auction of cost per produced MWh leads to the most cost efficient local and technology neutral production of defined renewable capacity and portfolio

Heat

- The long-term stable outlook of increasing fossil CO_2 taxes will lead to a cost efficient and technology neutral transition to energy efficient renewable heat production

Renewable energy investments and R&D require a long-term stable political investment environment 2/2

R&D

- Investment support to R&D is needed to accelerate development and market entry

Demonstrations

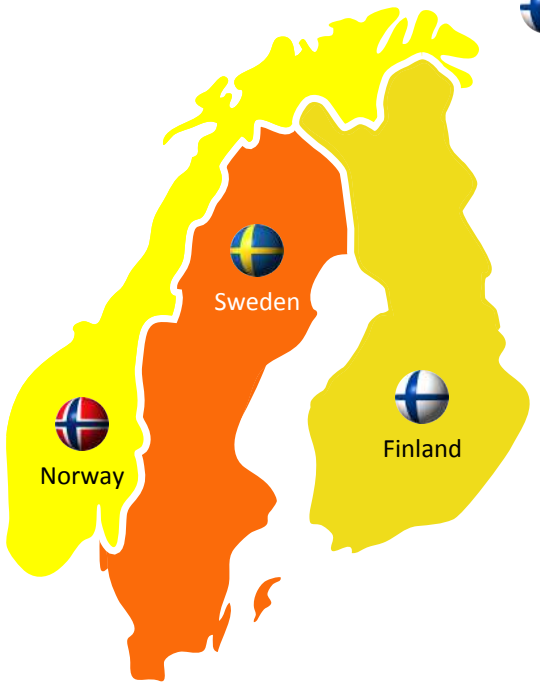
- Investment support based on the auction system to demonstrations lead to the most cost efficient development of new renewable business models and technologies

INCENTIVES TO REPLACE FOSSIL ENERGY SHOULD INCLUDE COST EFFICIENCY AND TECHNOLOGY NEUTRALITY

Nordic Energy Market

The Nordics in a nutshell

	Norway	Sweden	Finland
Population million	5.2	10	5.5
Area km^2	323,802	450,295	338,145
Population density/km^2	15.5	21.8	16.2
GDP (nom.) USD million	522.3	579.7	267.3
GDP (nom.) per capita USD	103,586	60,566	49,265
GDP (PPP) per capita USD	64,363	43,407	40,045
Real GDP growth rate %	1.6	0.9	-0.6
Labour force million	2.7	5.1	2.7



THE NORDICS HAS BEEN AND SHOULD CONTINUE TO BE THE GLOBAL LEADER IN TRANSITION TO LOW CARBON ENERGY SYSTEM

Energy taxes finance a great share of welfare society

FINLAND: Tax revenues (2014)

- Road transport related EUR 7.9 bn (incl. fuels & VAT)
- Electricity & Heat EUR 1.9 bn

SWEDEN: Tax revenues (2014)

- Road transport related EUR 10.1 bn (incl. fuels & VAT)
- Electricity & Heat EUR 2.3 bn

NORWAY

- Road transport related EUR 5.6 bn (incl. fuels & VAT)
- Electricity EUR 0.9 bn

RENEWABLE ENERGY INCENTIVE SCHEMES SHOULD BE FINANCED TROUGH CO_2 TAXES

	Norway	Sweden	Finland
Energy and transport related taxes	EUR 6,5 bn	EUR 12,4 bn	EUR 9,8 bn
Central Goverment tax revenues	EUR 106 bn	EUR 85 bn	EUR 40 bn
Share of total tax revenue	6.1%	14.6%	24.5%

Nordic energy system and its significance 1/2

- Cold climate, low population density, long distances, the dark winter period and energy intensive industry have forced the building of efficient, robust and well functioning energy systems during the past 100+ years, offering an excellent platform for further decarbonization of the energy sector
- Geopolitical development underlines the need for enhanced energy security
- Energy related taxes form a significant share of the total taxes collected in each country
- Nordics has been able to de-couple CO_2 emissions from GDP growth already two decades ago, facilitated by ambitious carbon taxation and renewable energy incentives
- Regional electricity market with common electricity grid has been in pivotal role in decarbonizing the Nordic electricity market. The carbon intensity of 59 gCO_2/kWh (2013) is at the level the world must reach in 2045 to realise 2° C scenario*)

*Source: Nordic Energy Technology Perspectives 2016

Nordic energy system and its significance 1/2

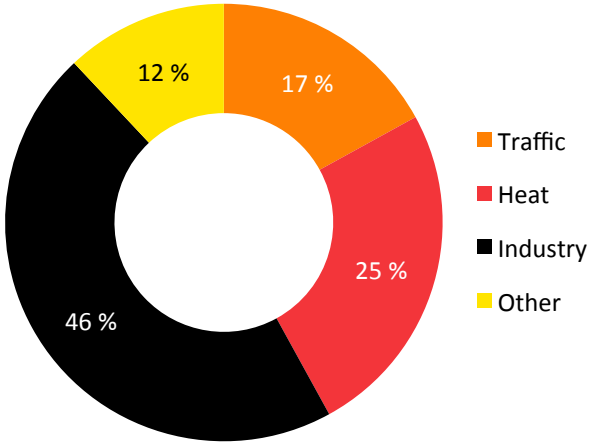
- As the most cost effective opportunities has been captured, the transport's share of CO_2 emissions has reached almost 40%
- Industry (incl. oil and gas) is the second biggest emitter with 28% share of all CO_2 emissions. Challenge is to combine the decarbonization activities with the objective of maintaining the competitiveness of the industry.
- A well designed transition to carbon-independent energy system would improve direct employment and the trade balance, and in addition helps to decouple local energy prices from global energy price fluctuations
- However, it's essential to ensure the relative competitiveness of the Nordic countries, thus selecting cost efficient measures and the right timing of the execution are pivotal success factors.

THE INTEGRATION OF ELECTRICITY MARKETS SHOULD BE DEEPENED TO ENABLE FURTHER EMISSION REDUCTIONS AND IMPROVED ENERGY SECURITY IN THE REGION

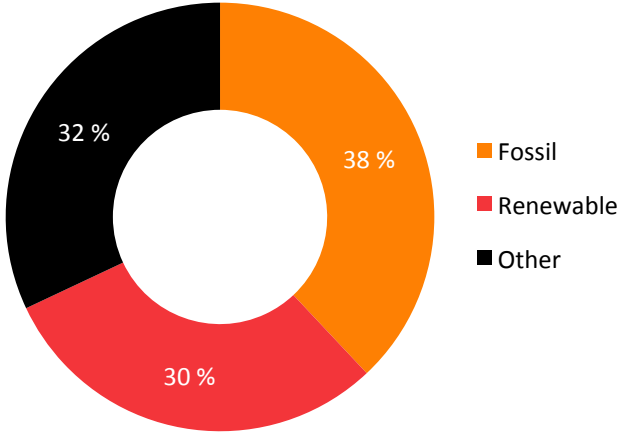
Source: Nordic Energy Technology Perspectives 2016

Fossil and nuclear represent 60% of Finnish energy consumption

2015 Net energy use by sector 293 TWh



Gross energy consumption by energy source 362 TWh



40% FROM GROSS ENERGY CONSUMPTION TODAY IN FINLAND IS FOSSIL,
CREATING A HUGE POTENTIAL FOR LOCAL RENEWABLE ENERGY INVESTMENTS

Source: Statistics Finland

Finland has met its 2020 renewable energy targets already in 2014 1/2

- In road transport 22.3% (target 20% including double counting) and in general 39% (target 38%) share of renewable energy out of total energy end-use was achieved already in 2014
- Finland is among world leaders in biofuels technology development due to a long-term quota obligation of renewable energy in transport since 2009
  - Neste and UPM in renewable diesel
  - St1 in waste and wood residue based advanced ethanol production and development
- 6 TWh wind power will be built by the end of 2017, based on existing feed-in tariff system (2.3 TWh -15)
- Olkiluoto 3 nuclear power plant 1.600 MW is estimated to be in production 2018/2019

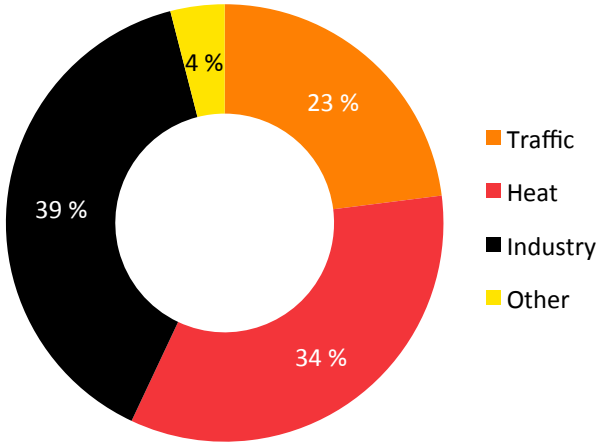
Finland has met its 2020 renewable energy targets already in 2014 2/2

- 2030 objectives set by government in the national energy and climate strategy 2030
  - Renewable energy share to exceed 50% and domestic energy share to exceed 55% (including peat)
  - No fossil coal in use
  - 50% reduction of mineral oil in energy use (reference year 2005)
  - 30% share of renewable energy in transport
- Government assigned EUR 100 M€ to investment grants for the demonstration of renewable energy technologies and projects. Grants will be awarded through competitive tender in 2016–2018
- However, EU Commission's proposal on renewable energy directive to 2030 (RED II) poses significant threat Finland's ability to fulfil the non ETS sector GHG requirement of 39% in 2030.
  - Advanced biofuels restricted only to ones produced from feedstock listed in an exclusive list. Should be based on definition
  - Share of 1st generation biofuels and certain waste based biofuels limited. Restriction leaves a potential **gap of 1 million tons** of biofuels vs. currently available

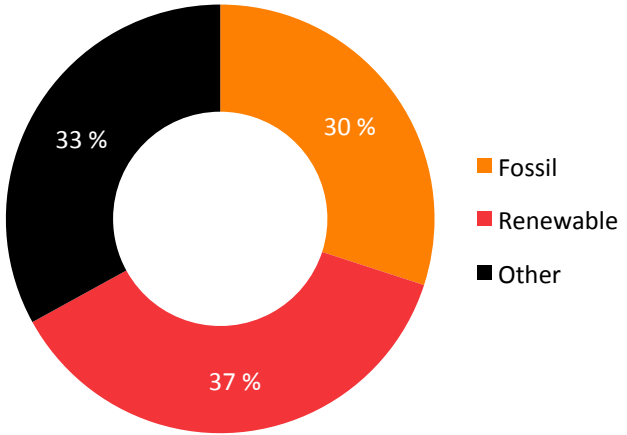
HOWEVER, THE NATIONAL TARGET FOR 2030 SHOULD NOT BE BINDING BEFORE RENEWABLE ENERGY DIRECTIVE FOR 2030 IS LEGALLY IN FORCE AND BINDING

Fossil and nuclear represent 63% of Swedish energy consumption

2014 net energy use by sector 373 TWh



2014 gross energy consumption by energy source 555 TWh



30% FROM GROSS ENERGY CONSUMPTION TODAY IN SWEDEN IS FOSSIL, CREATING A GREAT POTENTIAL FOR LOCAL RENEWABLE ENERGY INVESTMENTS

Sweden will meet its 2020 renewable targets 1/2

- 50% of renewable energy and 10% of renewable in the transport sector
- Renewable wind power 2020 target is 30 TWh
- Potential in changing district heating sector
  - Geothermal to replace forest-based biomass/waste
  - Potential to free up waste and forest based material for renewable fuels
- Investment programs from government
  - Solar PV = 1,400 MSEK 2016–2018
  - “Klimatklivet” = Appr. 600 MSEK/year 2016–2018
    - Open for two to three 1 months’ periods/year
    - GHG-related local initiatives to be supported for lowering of emissions according to target -40%
    - Examples of supported investment: upgraded district heating, biogas, electricity chargers

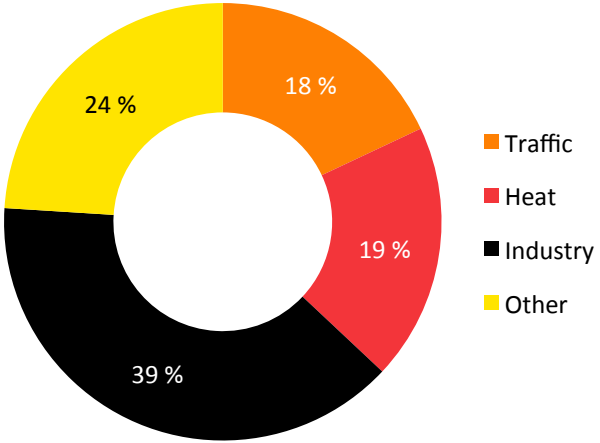
Sweden will meet its 2020 renewable targets 2/2

- 2030 objectives
  - Sweden suffers from a lack of overall energy strategy for the whole energy sector, no clear targets for 2030
  - New Energy Commission to deliver Strategy update latest by 1/1 2017
  - Shift in nuclear dependency for overall electricity forecast, varies from 0 to reduction of 10–30 TWh/a nuclear in 2030
    - Hydropower development during the period will be limited due to regulations

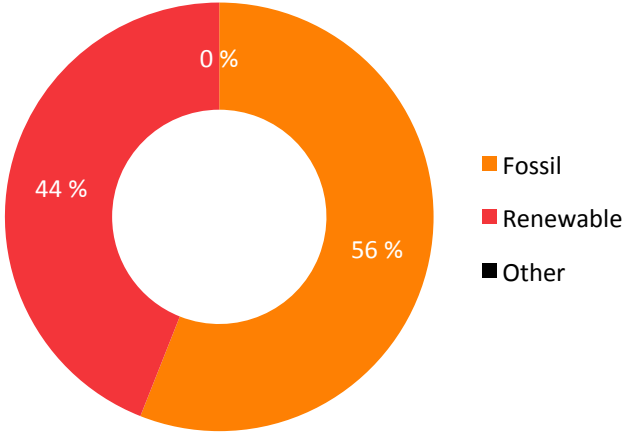
SWEDEN IS THE LEADING COUNTRY IN THE NORDICS IN UTILISING HEAT PUMPS AND WIND RESOURCES

Norway uses the highest relative share of fossil energy in the Nordics due to its offshore industry

2014 net energy use by sector 231 TWh



2014 gross energy consumption by energy source 315 TWh



ELECTRIFICATION OF THE OFFSHORE INDUSTRY REPRESENTS A HUGE OPPORTUNITY FOR RENEWABLE ENERGY

Low crude oil price effects the Norwegian energy policy 1/2

- 2020 targets, 30% reduction in CO_2 emissions not met by local production
- EU energy directives are generally introduced into Norwegian law through the EEC framework, although with a delay
- Norway is currently negotiating to be part of the EU climate policy framework (Energy union) and the EU Targets and schemes
- Transport is the biggest emitter of GHG (1/3) in Norway
  - Heavy subsidies for electric vehicles extended – but running into capacity issues
- Electricity generation is based on hydropower
  - Heavy investment in grid infrastructure, and 1.4 x 2 GW connections to UK and Germany will impact market outlook

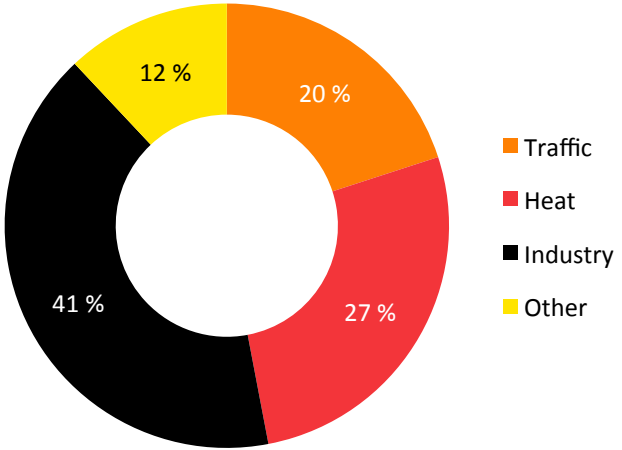
Low crude oil price effects the Norwegian energy policy 2/2

- Heating/cooling has been historically electric
  - Investment in remote heating Infrastructure & production in last 5–8 years, production dominated by waste incineration
- Political mechanisms in use are taxes, various incentive schemes and to a large extent, direct investment supports
- Preliminary 2030 targets set
  - 40% reduction in CO_2 emissions through reductions in the transport sector, increased use of electricity in oil/gas production, Carbon capture storage (CCS) and quota purchases
  - Expressed target is to have all new cars emission free from 2025

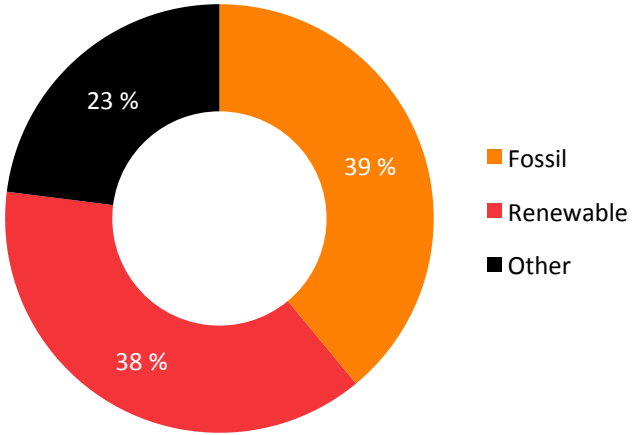
NORWAY HAS THE BEST WIND AND HYDRO RESOURCES IN EUROPE

39% of gross energy consumption today in the Nordics is fossil

2014 net energy use by sector (908 TWh)



Nordic 2014 gross energy consumption by energy source (1,242 TWh)



TRANSITION TO RENEWABLE ENERGY IS LEAD BY POLITICAL DECISIONS AND REPRESENT SIGNIFICANT POTENTIAL FOR LOCAL ENERGY INVESTMENTS

Nordic liquid fuel supply logistics is based on international shipping

Example

BIOFUELS LOGISTICS' COST EFFICIENCY IS BASED ON EXISTING INFRASTRUCTURE

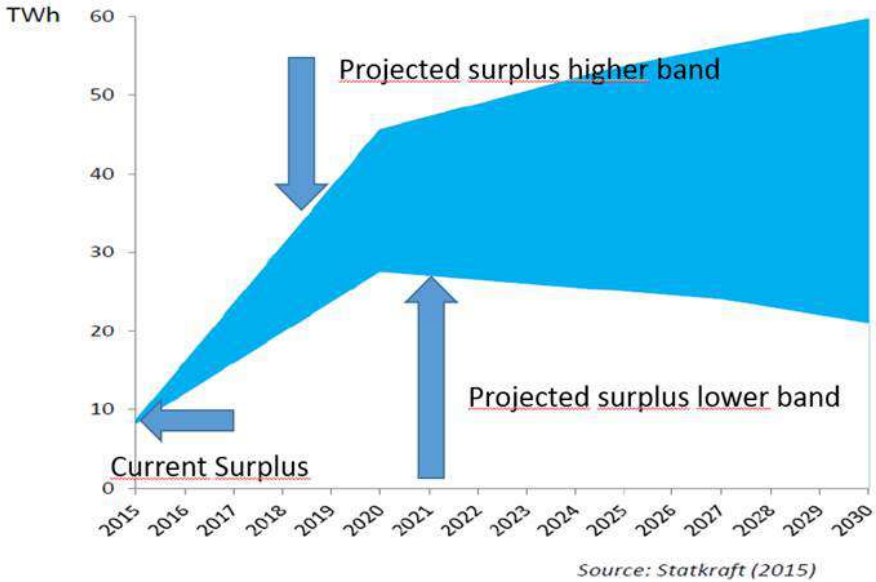
Nordic countries including the Baltic states form together the Nord Pool Power system, however…

The price difference between Finland and Sweden was in 2015 ~EUR 10 per MWh

- That equals ~EUR 800 million/a, which has respectively weakened Finland's competitiveness

…ELECTRICITY PRICE IS BASED ON HIGHEST PRODUCTION COST IN THE MARKET AREA, WHILE BOTTLENECKS IN GRID CONNECTIONS LIMIT FREE TRANSFER

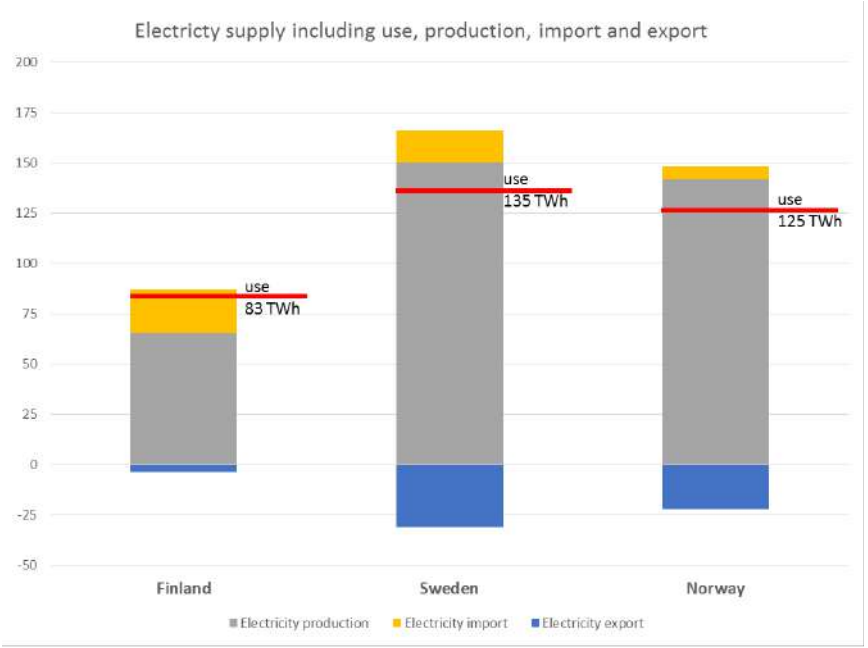
The Nordics electricity surplus is estimated to increase



Source: Statkraft (2015)

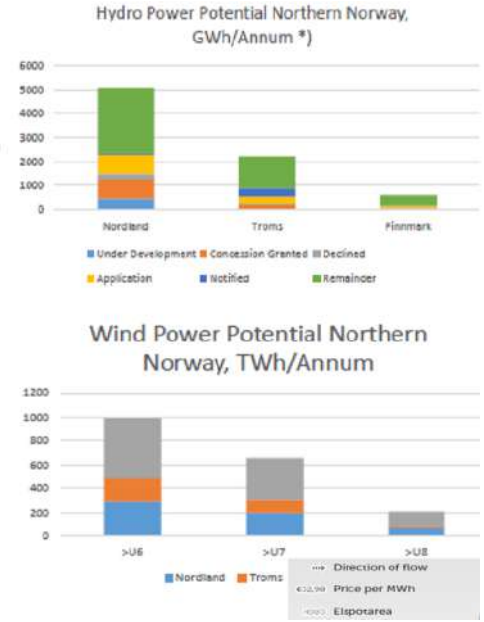
THE NORDICS HAS BECOME THE RESERVE OF ELECTRICITY BALANCING POWER, CREATING SIGNIFICANT EXPORT POTENTIAL

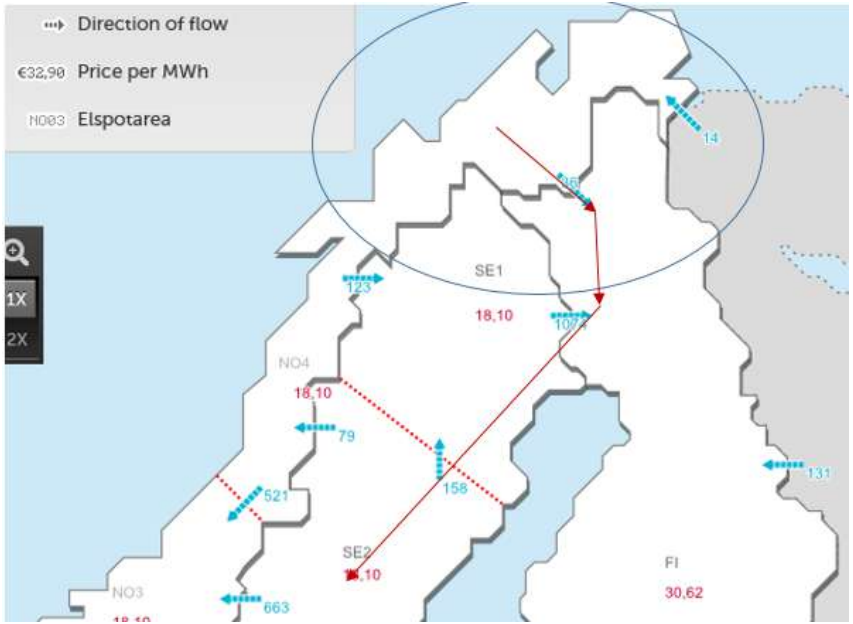
Norway and Sweden are CO_2-free electricity exporters already today



BOTH NORWAY AND SWEDEN WILL CONTINUE TO BE NET EXPORTERS AS HYDRO AND WIND HAVE GOOD POTENTIAL IN THE NORDICS

Norway has the highest hydro and wind power potential in Europe

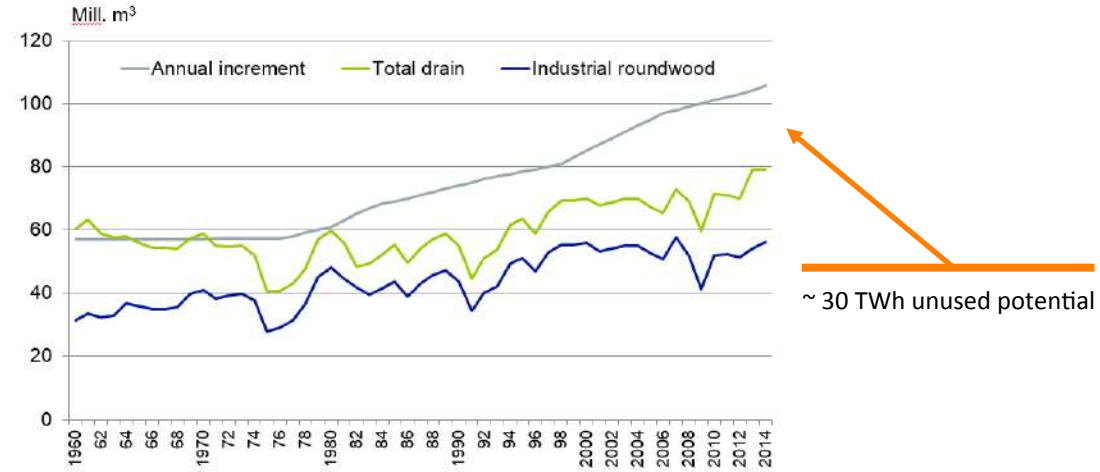




GRID CONNECTION IS THE BOTTLENECK IN UTILISING HYDRO AND WIND RESOURCES IN NORTHERN PARTS OF THE NORDICS

Unused biomass offers a growth potential in the Nordics
~ 60% from the annual growth of forests in Finland is used

The growth of Finnish forests is over 100 mill. M3 per year
Forest Balance in Finland 1960 – 2014

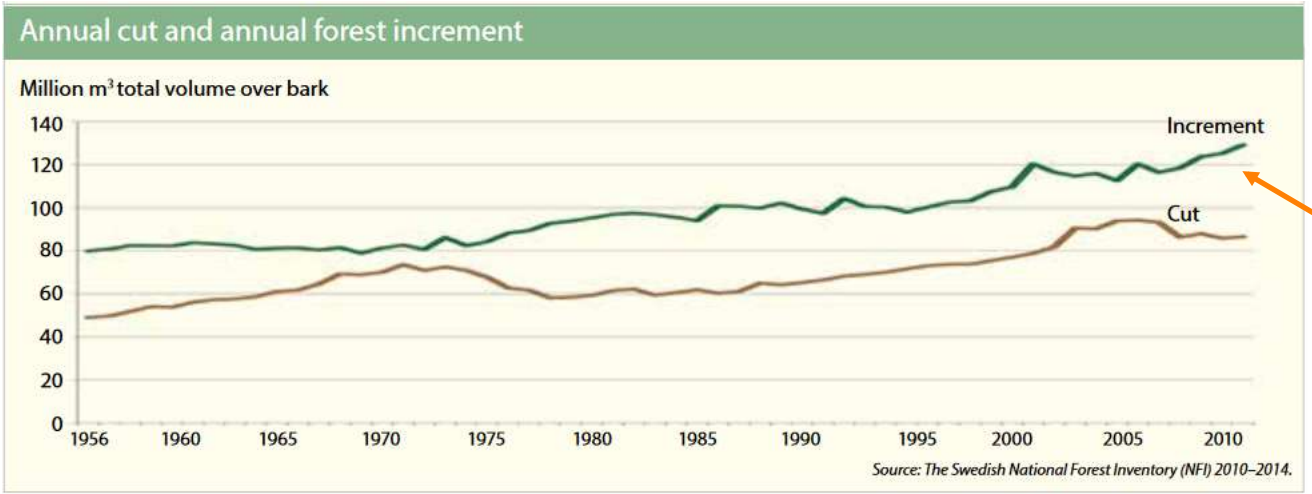


13.8.2015
SOURCE: Luke

EVOLVING FOREST INDUSTRY
PROSPEROUS BIOECONOMY

NORDIC FOREST RESOURCES HAVE INCREASED OVER 30% IN THE PAST 40 YEARS

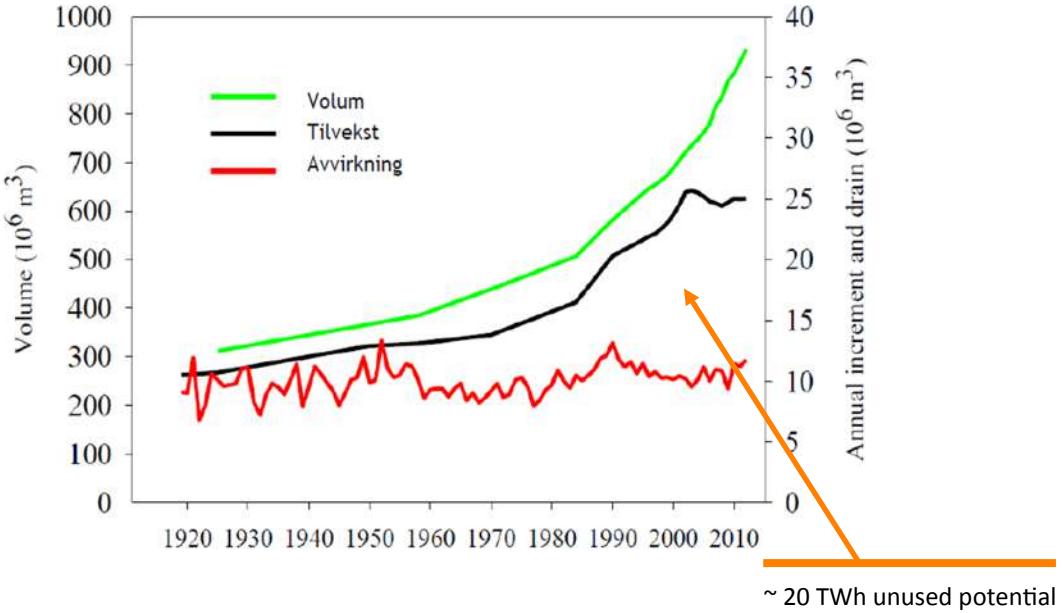
About 65% of annual growth of forests in Sweden is utilized



~ 30 TWh unused potential

NORDIC FORESTS ARE GROWING MORE THAN THEY ARE USED

Forest growth, utilization and potential in Norway



ANNUAL NORDIC FOREST BIOMASS GROWTH EQUALS MORE THAN 80 TWH, OFFERING A GROWTH POTENTIAL FOR RENEWABLE ENERGY

The Nordic countries are the forerunners in renewable energy use

- 2020 renewable targets will be met without any major additional investments, despite a relatively low fossil energy price outlook in the short-term
- However, reaching 2030 target with the proposed RED II mechanism is very challenging in the non ETS sector
- Surplus supply of electricity in the Nordic markets is increasing in the short-term
  - Olkiluoto 3 nuclear plant start up estimated 2018/2019
  - Wind power investments 2016–2017 ~ 2,000 MW
  - Low electricity prices up to 2025
  - Finland moving from import parity to export
  - Electricity use has been declining and is estimated to be stable, while additional use is offset
- Role of electricity is changing slowly (heat pumps, electric cars)
- New buildings will gradually transfer from being energy users to energy producers

… AND COULD MAINTAIN THE POLE POSITION ALSO IN THE FUTURE

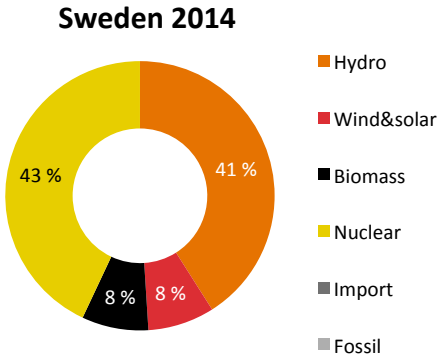
Challenges & opportunities during the transition need to be recognized upfront

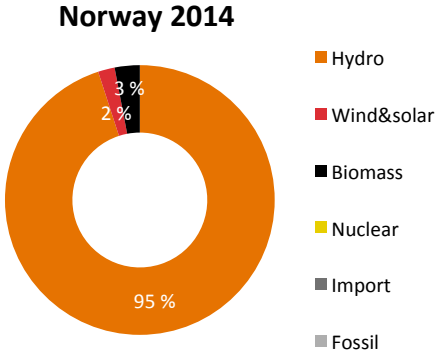
- Renewable energy development does not support CHP investments
- Decentralized renewable energy is challenging district heating networks
- Uncertainty about who decides customers' needs is increasing – the energy company or customer?
- Uncertainty and volatility in the overall economy and energy markets is increasing
- Removing bottlenecks in the grid will reduce in the short- and medium-term the need for energy storage options in the Nordic markets

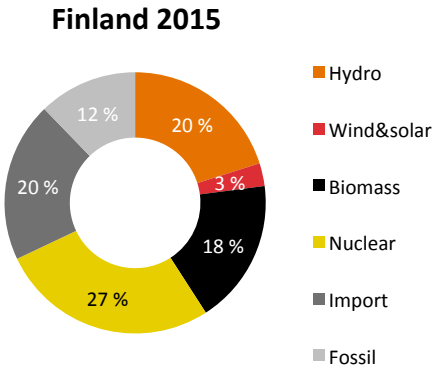
SLOW ECONOMIC GROWTH AND ENERGY EFFICIENCY IMPROVEMENTS HAVE LED TO DECREASING ENERGY CONSUMPTION

Electricity Outlook 2030

In Norway and Sweden, electricity production is already fossil CO_2 free



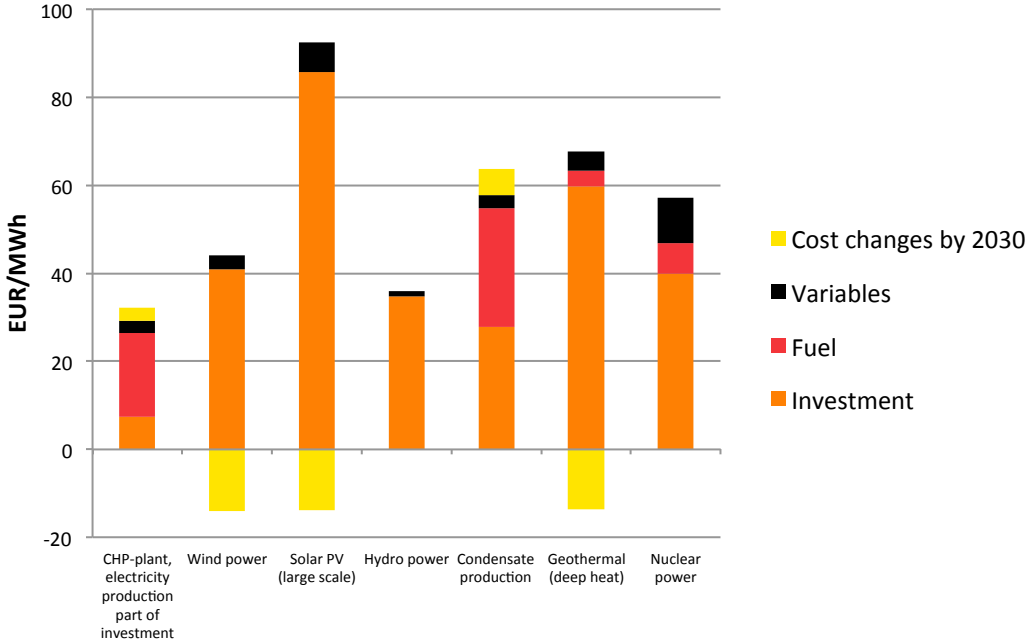




NORWAY AND SWEDEN ARE ALSO SIGNIFICANT ELECTRICITY EXPORTERS

Sources: Statistics Finland

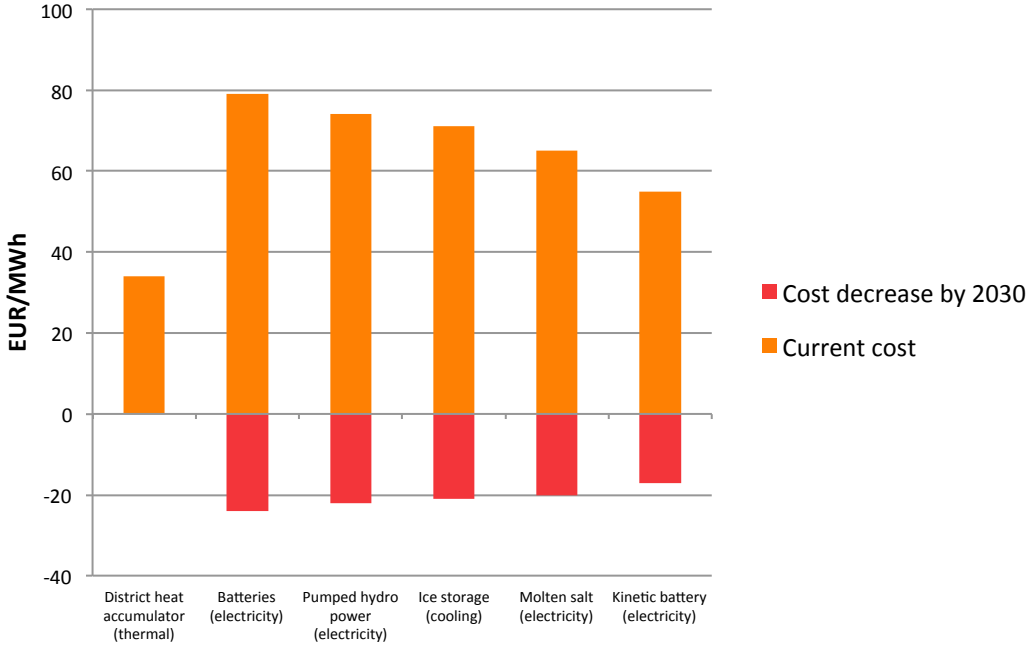
Renewable electricity production costs continue to decrease due to technology development



Source: St1 own analyses

WIND, HYDRO AND BIOMASS ARE THE MOST COST EFFICIENT WAYS TO INCREASE RENEWABLE ELECTRICITY PRODUCTION

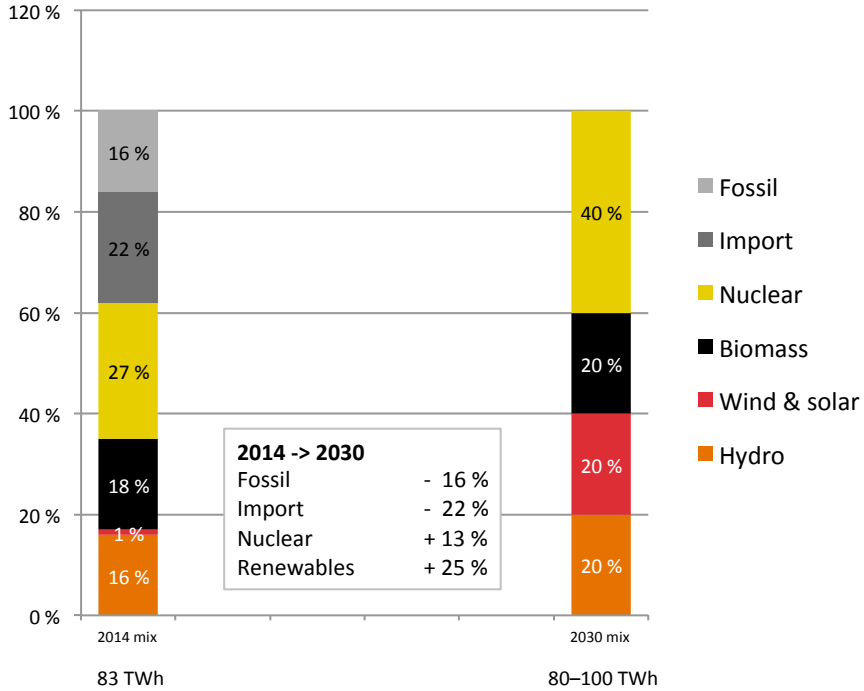
Improved energy storage would enhance even wider use of renewable energy



Note: assumes 30 €/MHh electricity price

ENERGY STORAGE IS STILL EXPENSIVE – R&D IS REQUIRED TO IMPROVE FLEXIBILITY IN THE ELECTRICITY SYSTEM

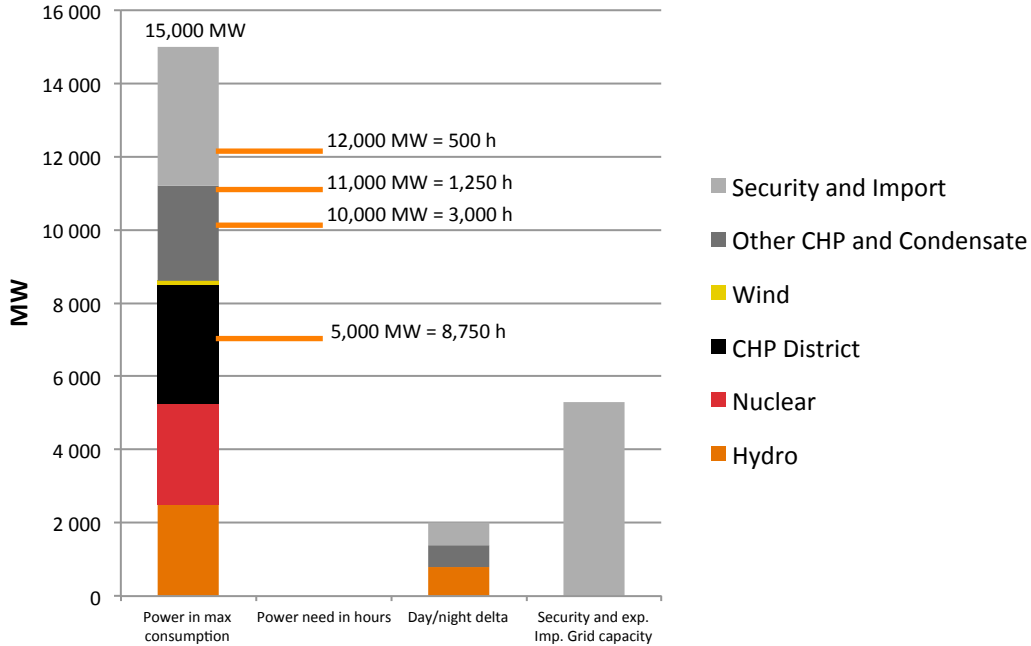
Renewable energy will cover the amount of fossil and imported energy at the annual level in Finnish electricity consumption by 2030 vs. today



OPTIMIZED NORDIC ELECTRICITY SYSTEM ALLOWS FLEXIBLE IMPORT AND EXPORT AND AT THE SAME TIME ENSURES SECURITY OF SUPPLY

Source: Statistics Finland and St1 analysis

Electricity market volatility and peak loads will increase in Finland



PEAK LOAD HOURS NEED TO BE COVERED BY E.G. CAPACITY MARKET

Source: Nord Pool, St1 Analyses

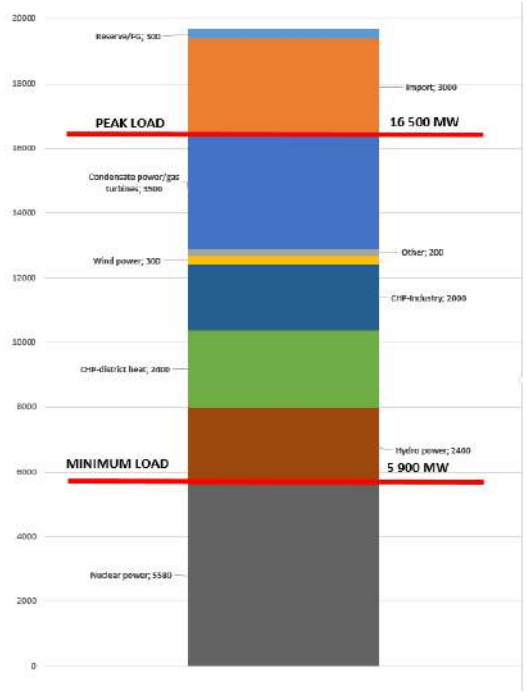
Capacity market to secure the peak loads in Finland

- Capacity market should be established to secure the necessary peak loads
  - Existing natural gas and coal production plants to be utilized as part of capacity market
  - Costs estimated to be marginal
- Diverse local cost-efficient renewable energy portfolio should be secured by political decisions
  - Setting long-term (2030) and annual targets
  - Annual bidding process for renewable base, variable and security loads
  - Bidding of incentives to be based on produced electricity (MWh) to decrease renewable production cost
  - As wind supply increases, biomass has an increasing role to secure variable electricity supply

DIVERSE COST EFFICIENT ELECTRICITY PORTFOLIO WILL BE BASED ON A VARIETY OF LOCAL RENEWABLE ENERGY SOURCES

Peak load power capacity in Finland, year 2030

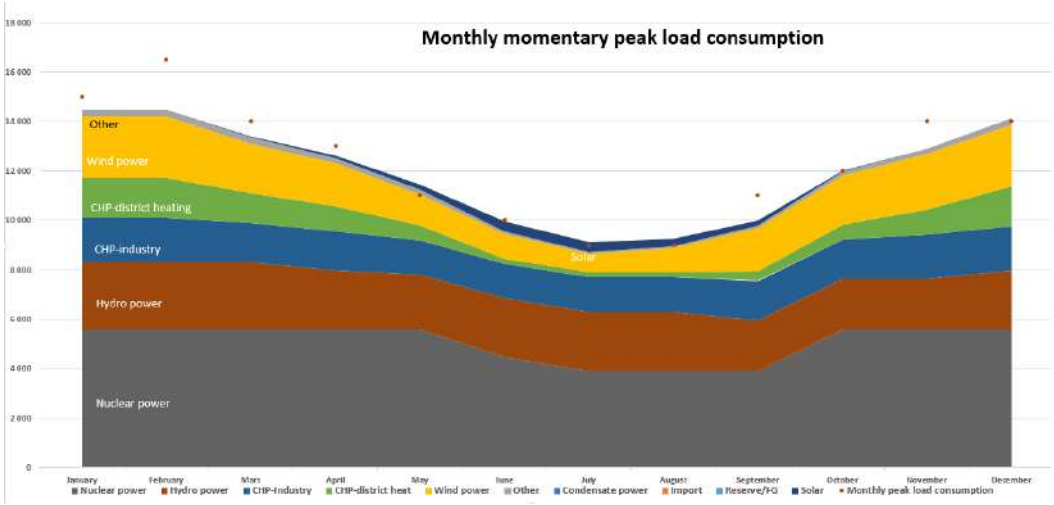
- Electricity production capacity will be able to produce annual energy (MWh) for the market, but in peak load periods, there is a need for peak load power
- Annually, these peak load periods last about 500–800 hours
- Peak load power would be condensate power, gas turbines or partly electricity import



PREPAREDNESS FOR PEAK LOADS WITH A VARIETY OF ENERGY SOURCES ENABLES RUNNING THEM FLEXIBLY IN A COST EFFICIENT ORDER

Source: St1 Analyses

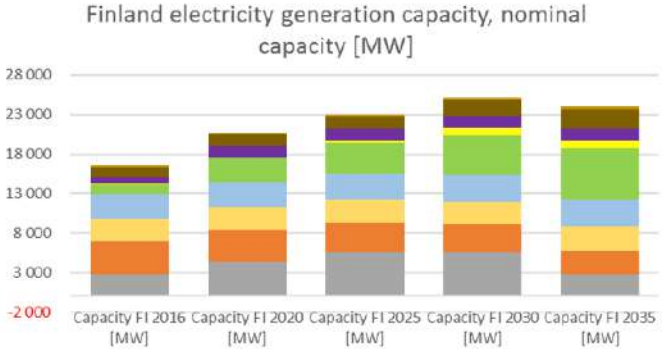
Monthly momentary peak load consumption and average electricity production power in Finland, year 2030

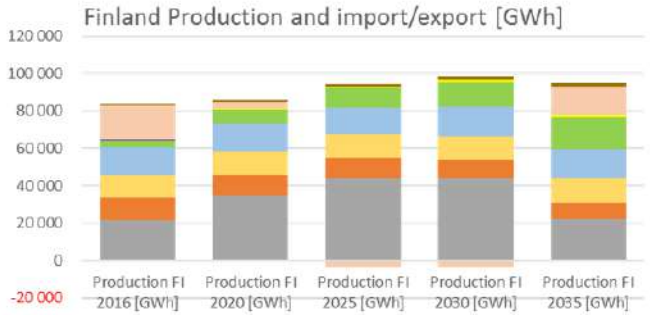


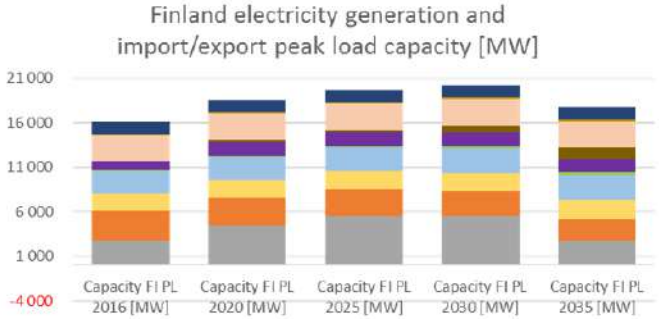
PEAK LOAD CONSUMPTION DELTA VS. DOMESTIC PRODUCTION WILL BE COVERED BY CAPACITY MARKET OR IMPORT

Source: St1 Analyses

A capacity increase of 8,000 MW enables Finland to meet the renewable energy target



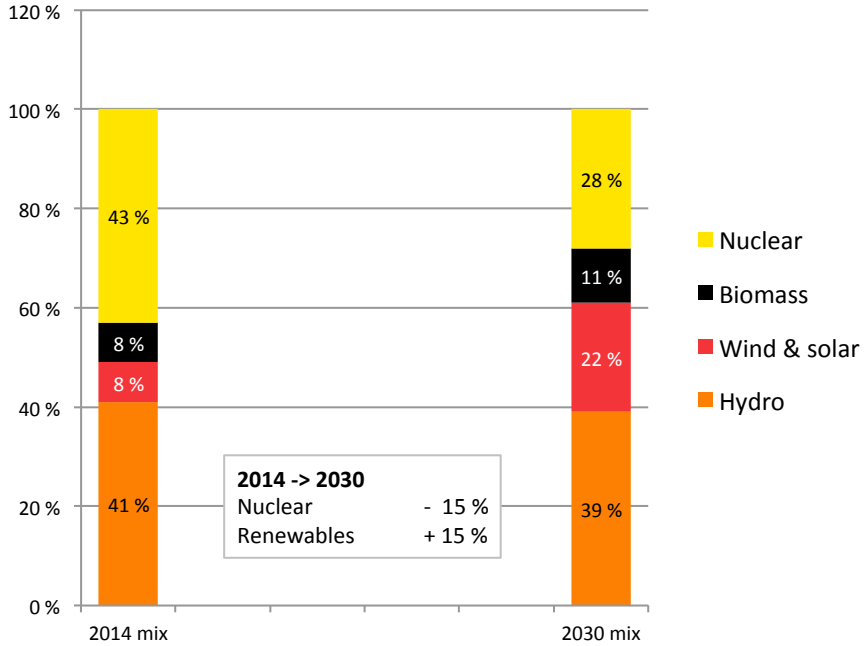




IT WILL ALSO ENSURE THE ENERGY SECURITY

Source: Statistics Finland, St1 Analyses

Swedish electricity production is already fossil CO_2 free

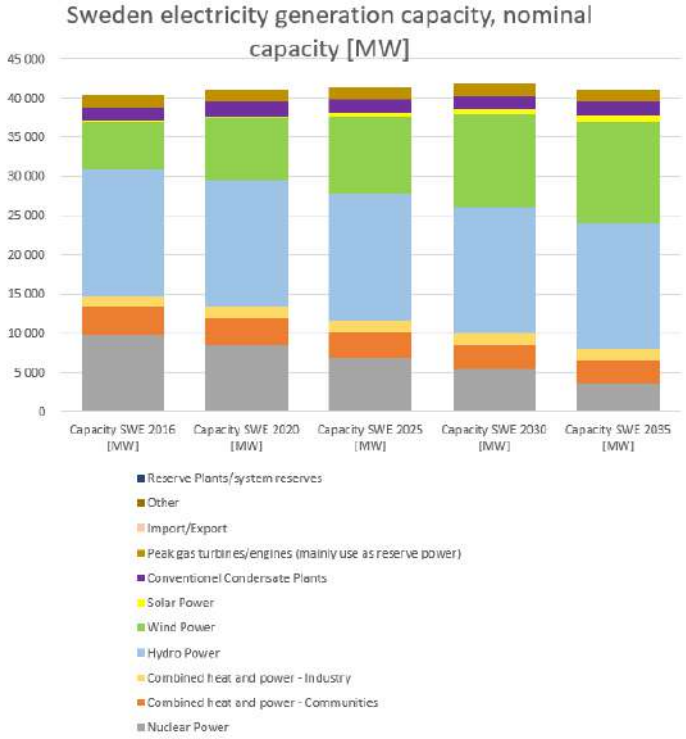


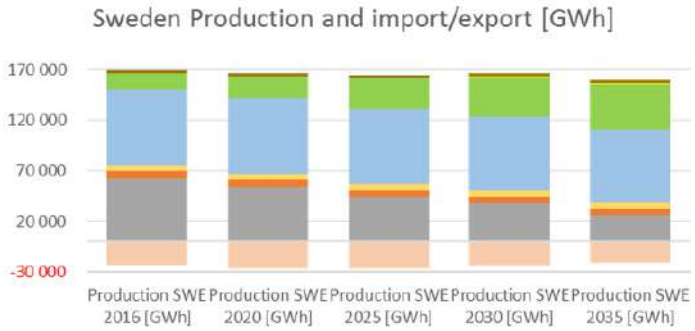
Nuclear future in Sweden is not clear

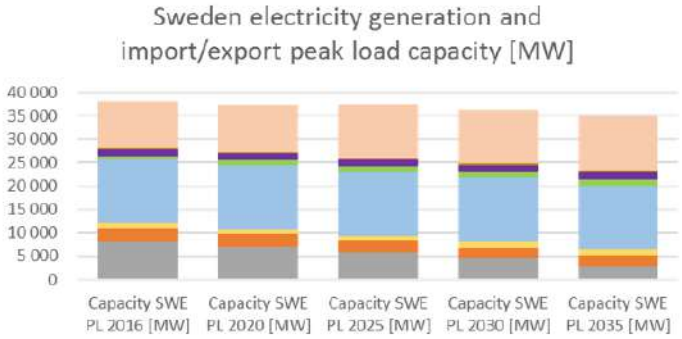
- reduction of 20 TWh after 2020 foreseen due to shut down of 3 plants,
- replaced primarily by wind and solar

SWEDEN WILL CONTINUE TO PRODUCE A SURPLUS OF ELECTRICITY AND BE AN EXPORT MARKET

Nuclear future in Sweden is not clear: reduction of 20 TWh after 2020 foreseen due to shut down of 3 plants, replaced primarily by wind and solar

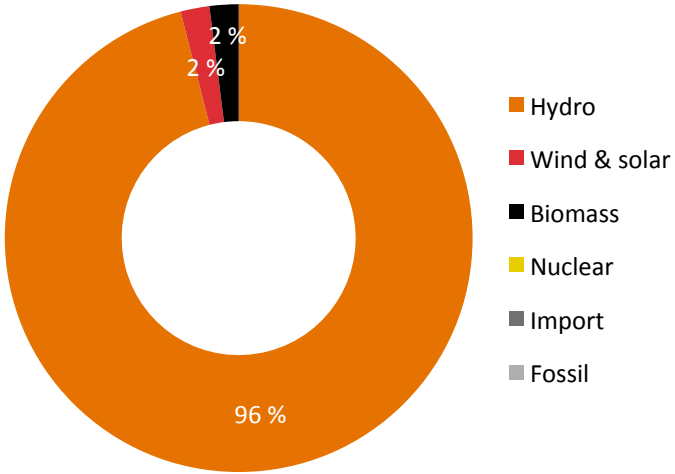






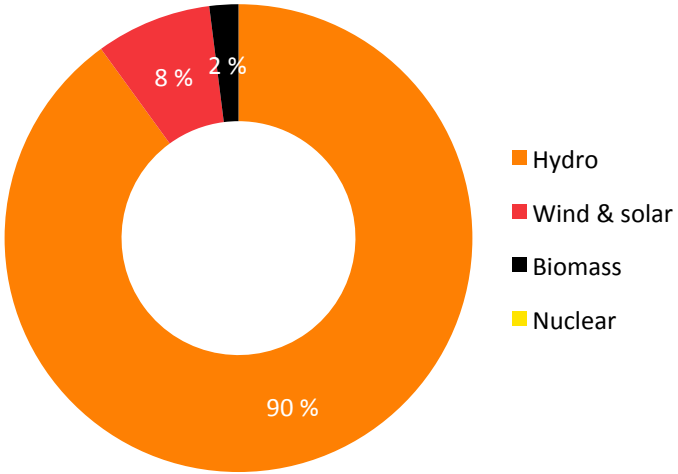
In Norway electricity is already renewable

2014 mix



141 TWh

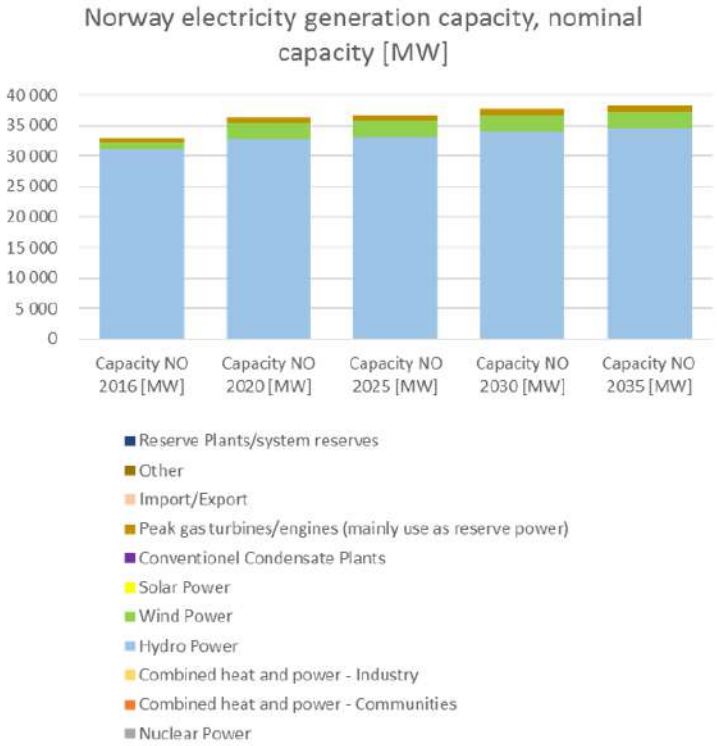
2030 Vision

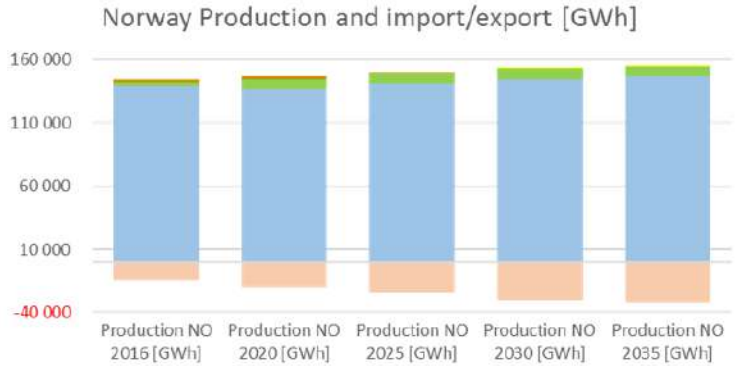


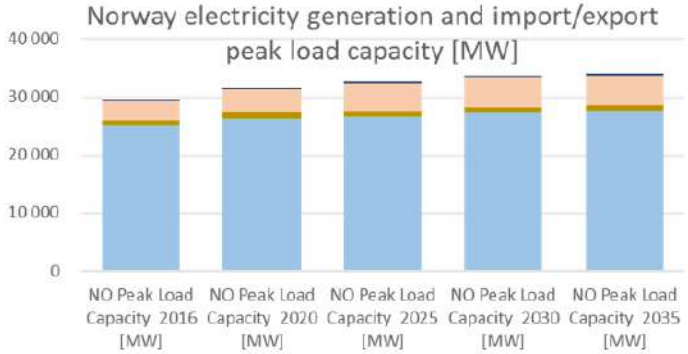
140–150 TWh

HIGH HYDRO AND WIND POTENTIAL ARE INCREASING EXPORT OPPORTUNITIES IN NORWAY

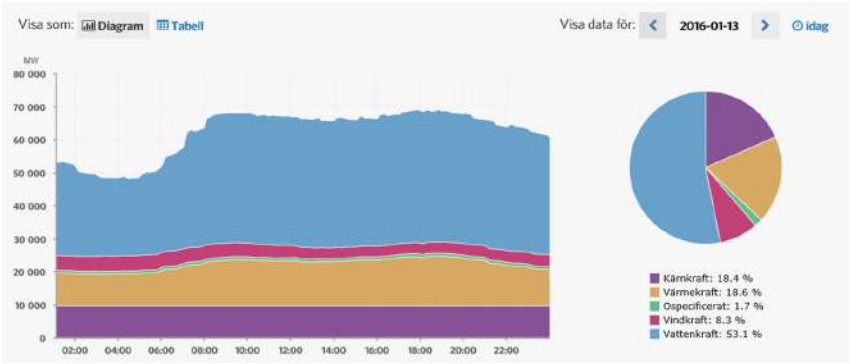
There will be some increase in wind power in Norway



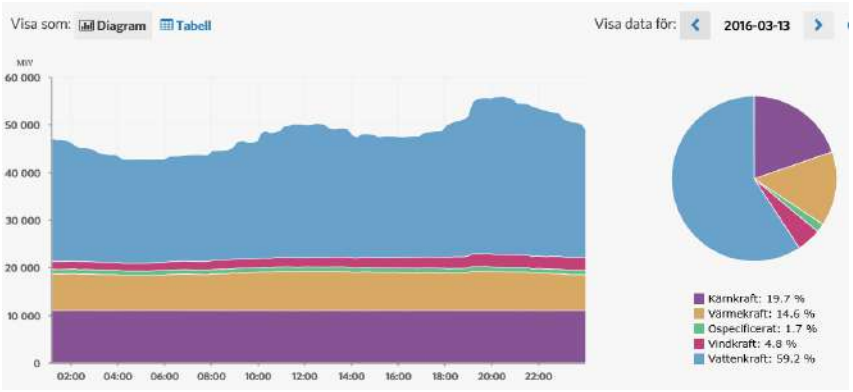




Hydro and nuclear power dominate electricity production (about 80%) in the Nordic electricity market



High consumption situation

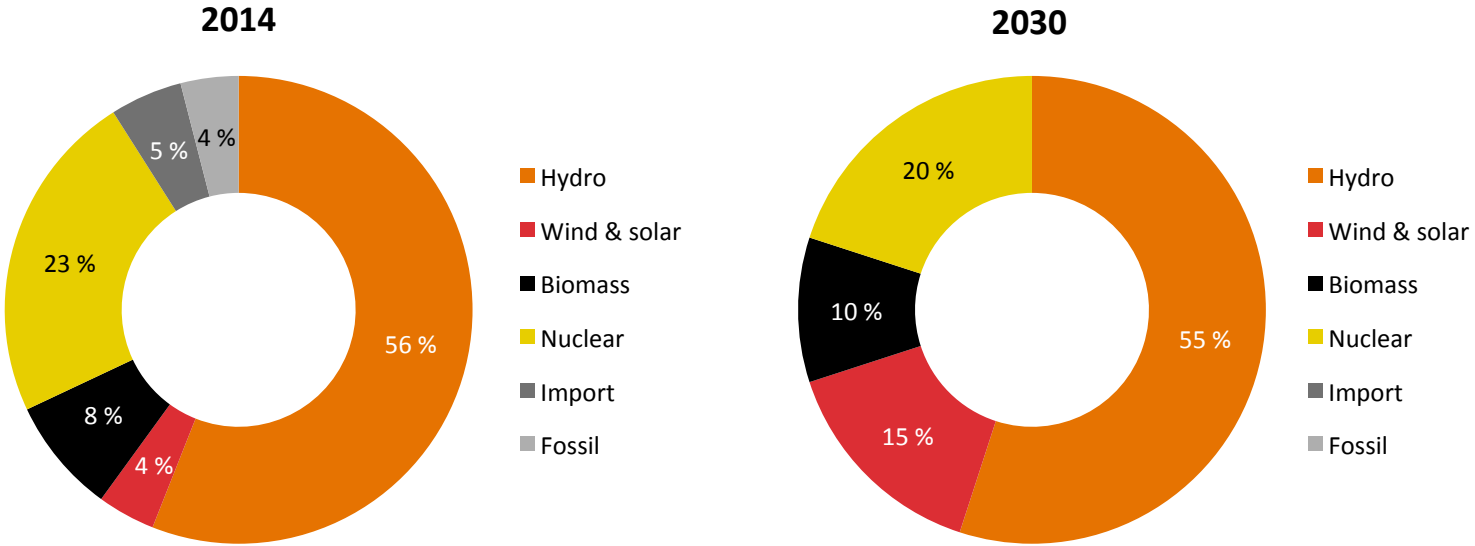


Normal consumption situation

HYDRO DOMINANCE WILL INCREASE IN THE FUTURE AS A QUICKLY ADJUSTABLE REGULATING POWER FOR WIND, SOLAR AND FIXED NUCLEAR POWER

Source: Svenska kraftnät

Fossil energy will be minimized in Nordic electricity supply by 2030

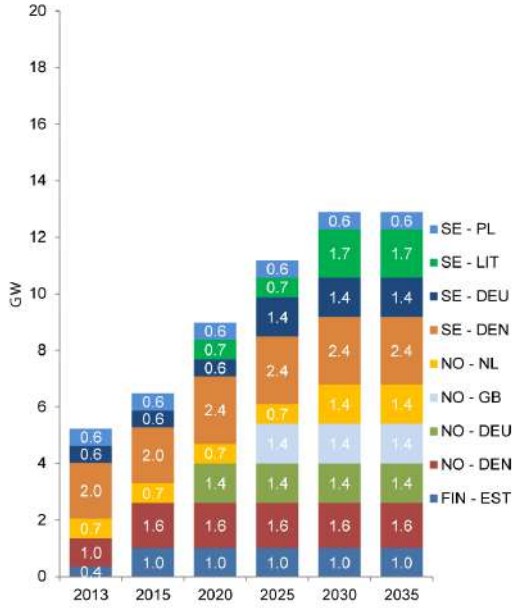


WIND, SOLAR AND BIOMASS WILL INCREASE THEIR SHARE

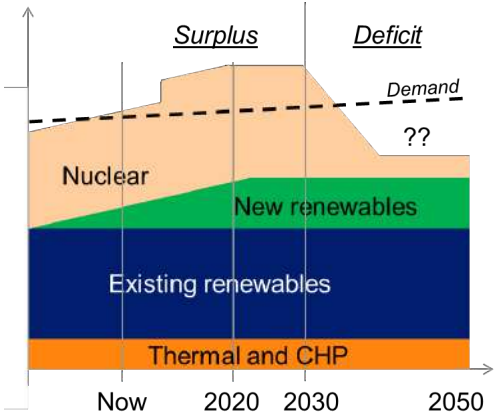
Source: Statistics Finland, Statens Energimyndighet, NVE

In the short- to medium-term, there will be an increasing surplus of electricity in the Nordics

Nordic grid connection plans



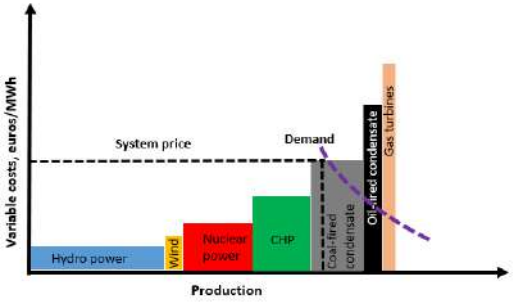
Simplified energy balance in NO-SE-FI

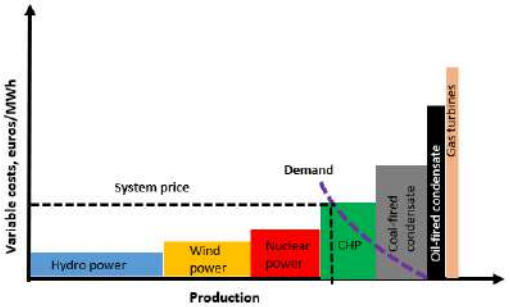


SWEDEN AND NORWAY WILL EXPAND GRID CONNECTIONS TO THE EUROPEAN MARKET

Source: Pöyry

The use of renewable energy in electricity production is increasing due to its price competitiveness

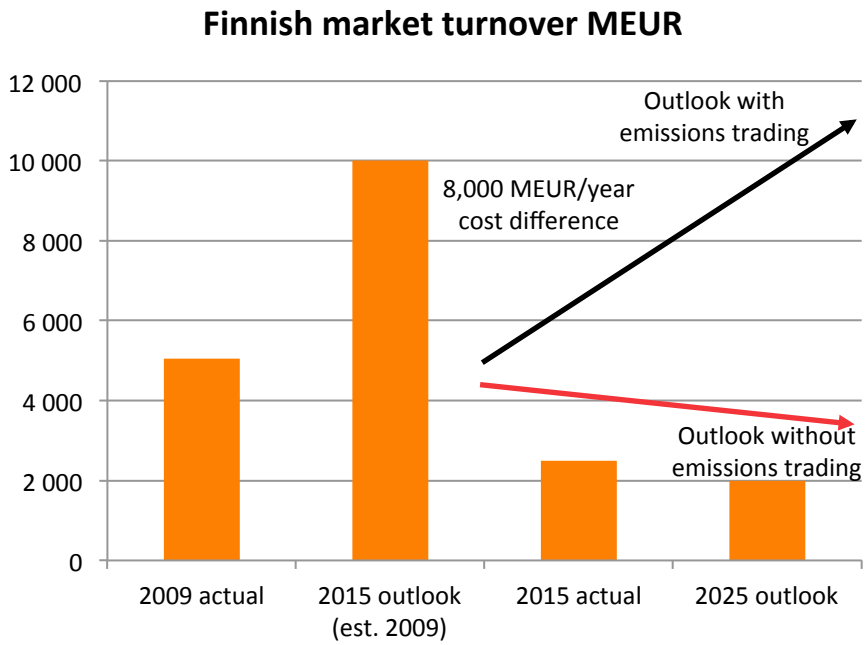




- Electricity price in Nord Pool market is based on the hourly offered supply prices
- Supply is brought to the market in a certain price order until the needed consumption demand is met
- The highest supply price required to meet the consumption demand is the market price for the whole electricity volume required

PLANTS USING MORE EXPENSIVE FOSSIL FUELS WILL INCREASINGLY MOVE TO THE CAPACITY MARKET AS ADJUSTING AND RESERVE POWER

Electricity wholesale market has been changing dramatically since 2009 – Finnish example



EMISSIONS TRADING INCREASES THE OVERALL COST OF ELECTRICITY AND DOES NOT LEAD TO RENEWABLE ENERGY INVESTMENTS IN THE NORDICS

There are several influencing factors on electricity price in the Nordic market

Influencing factor	Long term effect	Temporary / quick term effect
weather: windiness, precipitation, temperature		X
water reservoir level	X	
electricity consumption	X	
electricity producing forms (nuclear, hydro, wind, etc.) and production costs	X	X
CO2-allowance price	X	
coal price	X	
oil price	X	
transmission capacity between Nordic countries and EU	X	X
supply/demand balance	X	X
political issues	X	
economic situation (trend; boom, recession)	X	

St1 view on electricity price

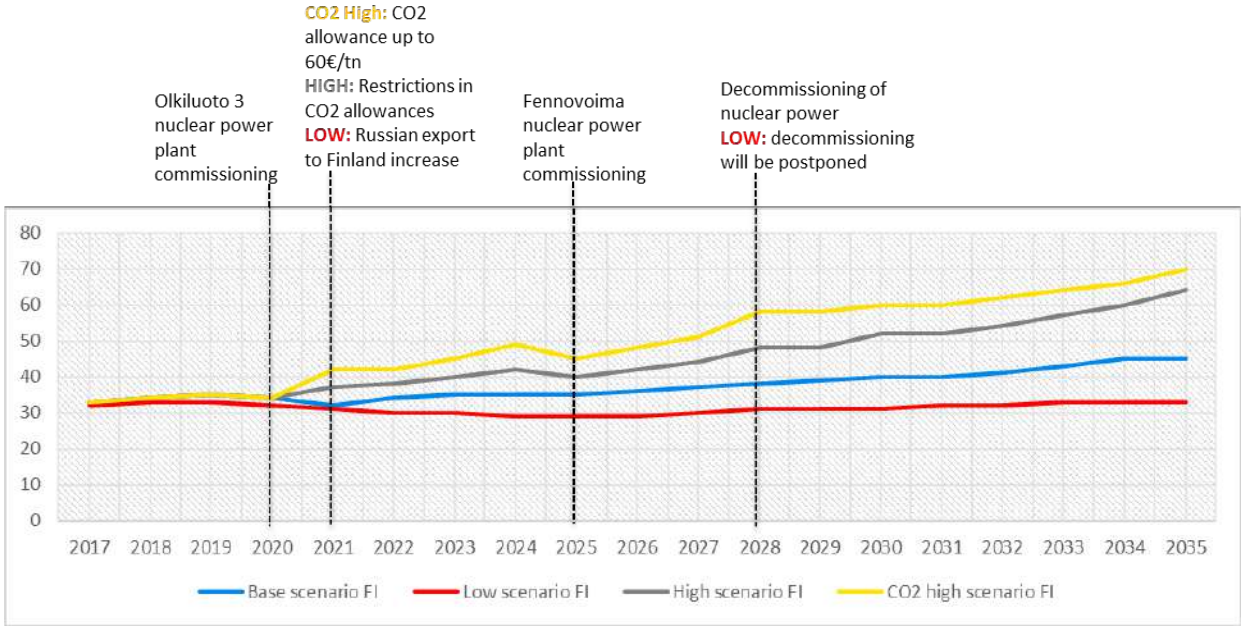
Basic assumption for different price scenarios

- **Finland**
  1. **Base scenario:** St1 Energy Outlook as guideline, no significant changes in economics (drops or booms) or energy politics, no substantial changes in technology development, moderate growth of consumption.
  2. **High scenario:** CO_2 allowances up to 30 euros CO_2/tn
  3. **Low scenario:** Decommissioning of old nuclear power will be postponed for 7 -10 years. The import from Russia will increase when Russian day time export tax will be cancelled
  4. **CO2 high scenario:** CO2 allowance price up to 60€/MWh, but the effect on price decreases over the years because renewable electricity production increases.

- **Sweden**
  1. **Base scenario:** St1 Energy Outlook as guideline, no significant changes in economics (drops or booms) or energy politics, no substantial changes in technology development, moderate growth of consumption.
  2. **High scenario:** CO2 allowances up to 30 euros CO2/tn
  3. **Low scenario:** Decommissioning of old nuclear power will be postponed for 5 -7 years
  4. **CO2 high scenario:** CO2 allowance price up to 60€/MWh, but the effect on price decreases over the years because renewable electricity production increases.

- **Norway**
  1. **Base scenario:** St1 Energy Outlook as guideline, no significant changes in economics (drops or booms) or energy politics, no substantial changes in technology development, moderate growth of consumption.
  2. **High scenario:** More grid connections --> more export to more expensive areas
  3. **Low scenario:** Grid connections won't be commissioned as planned --> 'over production'
  4. **CO2 high scenario:** CO2 allowance price up to 60€/MWh, but the effect on price decreases over the years because renewable electricity production increases.

Finland electricity price view 2017-2035



Base scenario: St1 Energy Outlook as guideline, no significant changes in economics (drops or booms) or energy politics, no substantial changes in technology development, moderate growth of consumption.

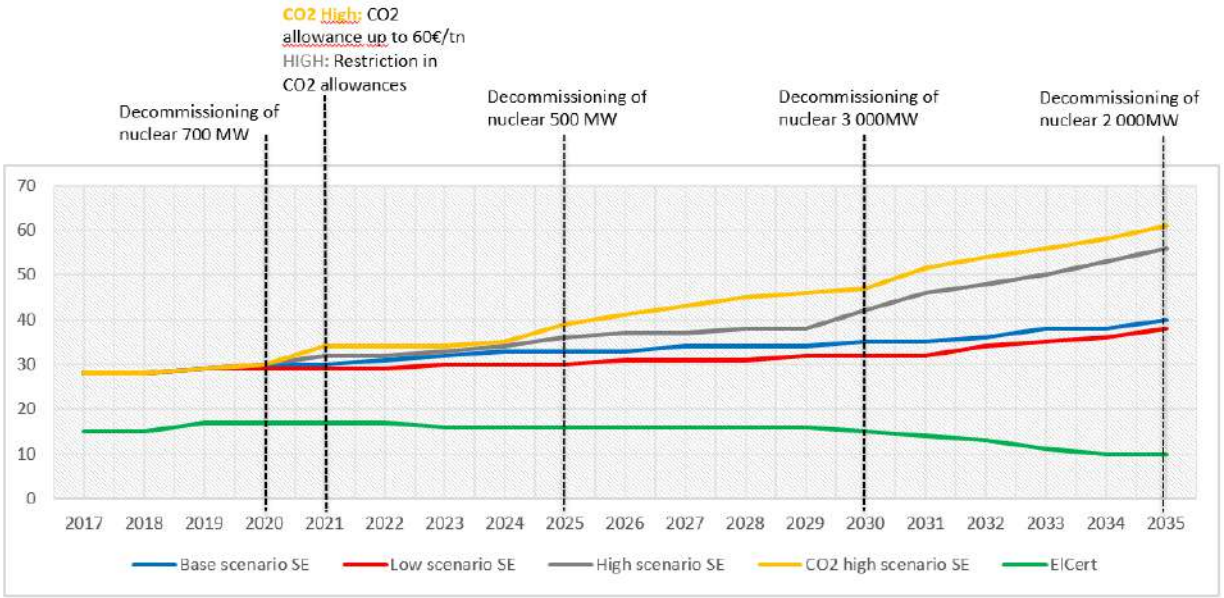
Low scenario: Decommissioning of old nuclear power will be postponed for 7 -10 years. The import from Russia will increase when Russian day time export tax will be cancelled.

High scenario: CO_2 allowances up to 30 euros CO_2/tn

CO_2 High scenario: CO_2 allowance price up to 60€/tn, but the effect on price decreases over the years because renewable electricity production increases.

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Base	33	34	35	34	32	34	35	35	35	36	37	38	39	40	40	41	43	45	45
Low	32	33	33	32	31	30	30	29	29	29	30	31	31	31	32	32	33	33	33
High	33	34	35	34	37	38	40	42	40	42	44	48	48	52	52	54	57	60	64
CO_2 High	33	34	35	34	42	42	45	49	45	48	51	58	58	60	60	62	64	66	70

Sweden electricity price view 2017-2035



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Base	28	28	29	30	30	31	32	33	33	33	34	34	34	35	35	36	38	38	40
Low	28	28	29	29	29	29	30	30	30	31	31	31	32	32	32	34	35	36	38
High	28	28	29	30	32	32	33	34	36	37	37	38	38	42	46	48	50	53	56
CO_2 High	28	28	29	30	34	34	34	35	39	41	43	45	46	47	51	54	56	58	61

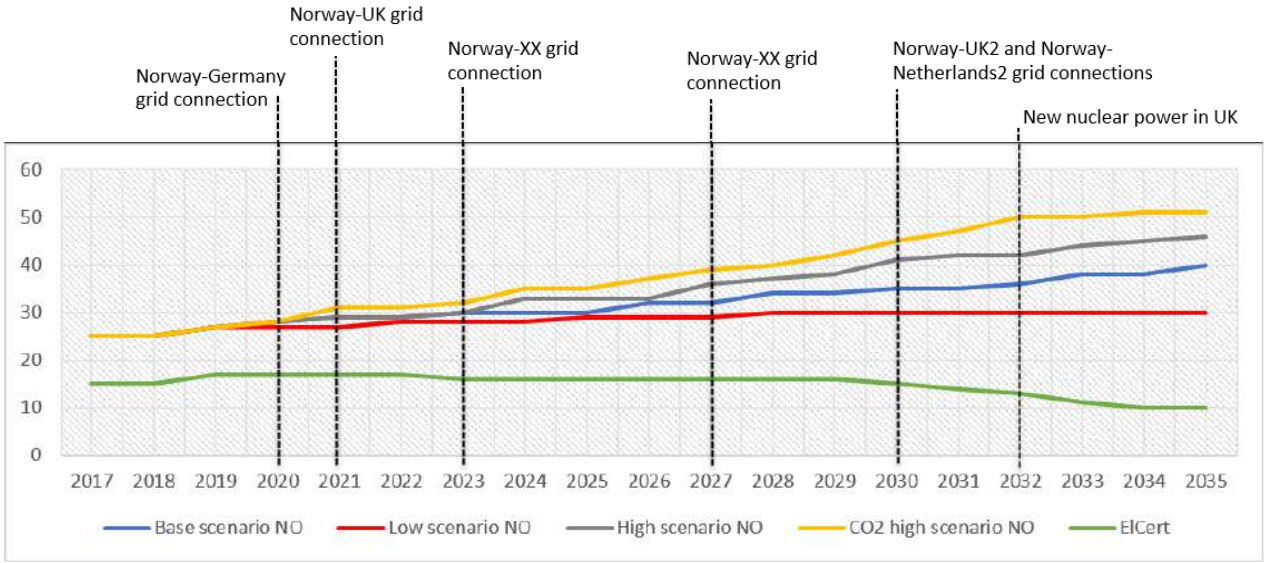
Base scenario: St1 Energy Outlook as guideline, no significant changes in economics (drops or booms) or energy politics, no substantial changes in technology development, moderate growth of consumption.

Low scenario: Decommissioning of old nuclear power will be postponed for 5-7 years

High scenario: CO_2 allowances up to 30 euros CO_2/tn

CO_2 High scenario: CO_2 allowance price up to 60€/tn, but the effect on price decreases over the years because renewable electricity production increases.

Norway electricity price view 2017-2035



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Base	25	25	27	28	29	29	30	30	30	32	32	34	34	35	35	36	38	38	40
Low	25	25	27	27	27	28	28	28	29	29	29	30	30	30	30	30	30	30	30
High	25	25	27	28	29	29	30	33	33	33	36	37	38	41	42	42	44	45	46
CO_2 High	25	25	27	28	31	31	32	35	35	37	39	40	42	45	47	50	50	51	51

Base scenario: St1 Energy Outlook as guideline, no significant changes in economics (drops or booms) or energy politics, no substantial changes in technology development, moderate growth of consumption.

Low scenario: Grid connections won't be commissioned as planned → 'over production'

High scenario: More grid connections → more export to more expensive areas

CO_2 High scenario: CO_2 allowance price up to 60€/tn, but the effect on price decreases over the years because renewable electricity production increases.

St1 future electricity price view conclusions

- According to our studies and analyses it seem that with current circumstances (political, economical, etc.) and St1 Energy Outlook vision, there aren't significant factors that would change the electricity price by 2030.
- If nuclear power plants are decommissioned by 2030, electricity price will increase if there won't come new base load power.
- Price volatility will increase; there will be even lower and higher prices. On the other hand demand-side management will stabilize the price volatility in long run.
- St1 view: CO_2 allowance price will be between 10 and 30 euros. The effect on electricity price will be around 3-8 euros/MWh
- The yearly average will be:

Country	Average price 2016-2028 [€]				Average price 2029-2035 [€]			
	Base	High	Low	CO2 High	Base	High	Low	CO2 high
Finland	33-38	33-48	32-31	33-58	39-45	48-64	31-33	58-70
Norway	25-34	25-37	25-30	25-40	34-40	38-46	30-30	42-50
Sweden	28-34	28-38	28-31	28-45	34-40	38-56	32-38	45-61

Electricity market reform is unavoidable 1/2

- The targets of CO_2 emissions reduction and renewable energy strengthens the change in the power production structure
- The growth of renewable energy forces the current electricity market mechanism to change
  - Fixed running order of resources needs to become flexible to enhance the efficient use of the future energy portfolio
    - E.g. biomass capacity should be adjustable to better meet the variable need for electricity
- There is also an increasing need to maintain existing fossil electricity production capacity in the capacity market
  - For peak load and reserve use
  - To mitigate the effects of variable renewable electricity production and import disturbances

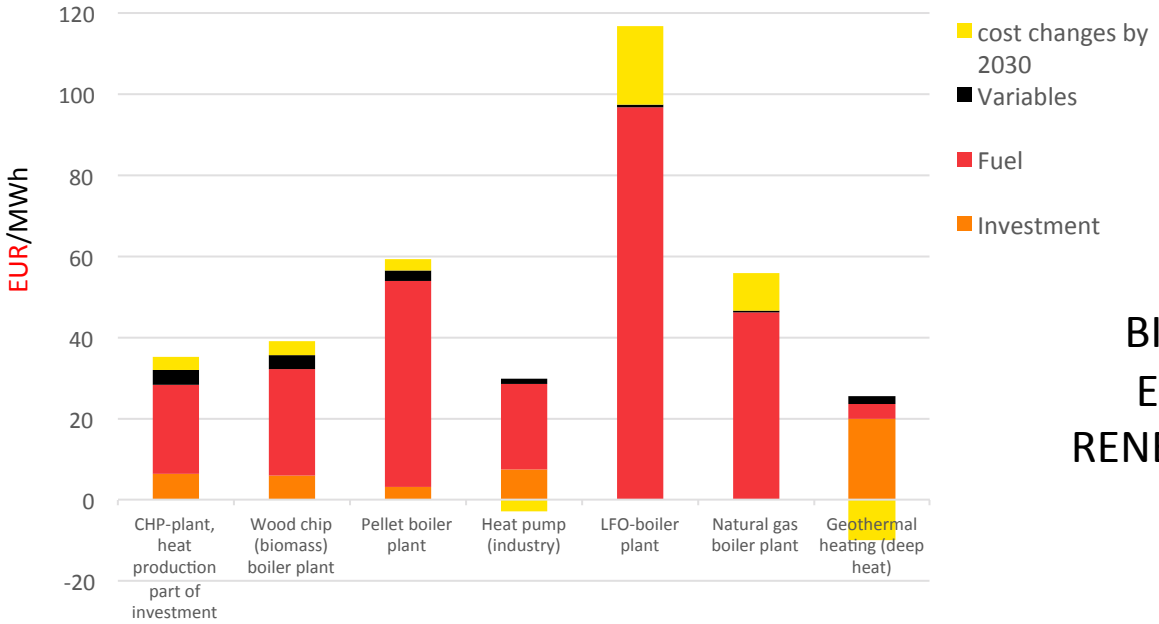
Electricity market reform is unavoidable 2/2

- The capacity market would guarantee electricity security without an excessive burden on electricity companies' balance sheet in changing future market situations
  - Securing reserve capacity could be established from existing gas turbine plants and coal condensate plants
- At the Nordic level there is also demand for
  - Increasing hydro power capacity
  - Increased transmission capacity to allow for flexible import and export in the region and to Europe
  - Different kinds of energy storage, such as pumped hydro and battery storages

NORDIC POWER PRODUCTION COULD EFFECTIVELY UTILISE INCREASED TRANSMISSION CAPACITY

Heat Energy Outlook 2030

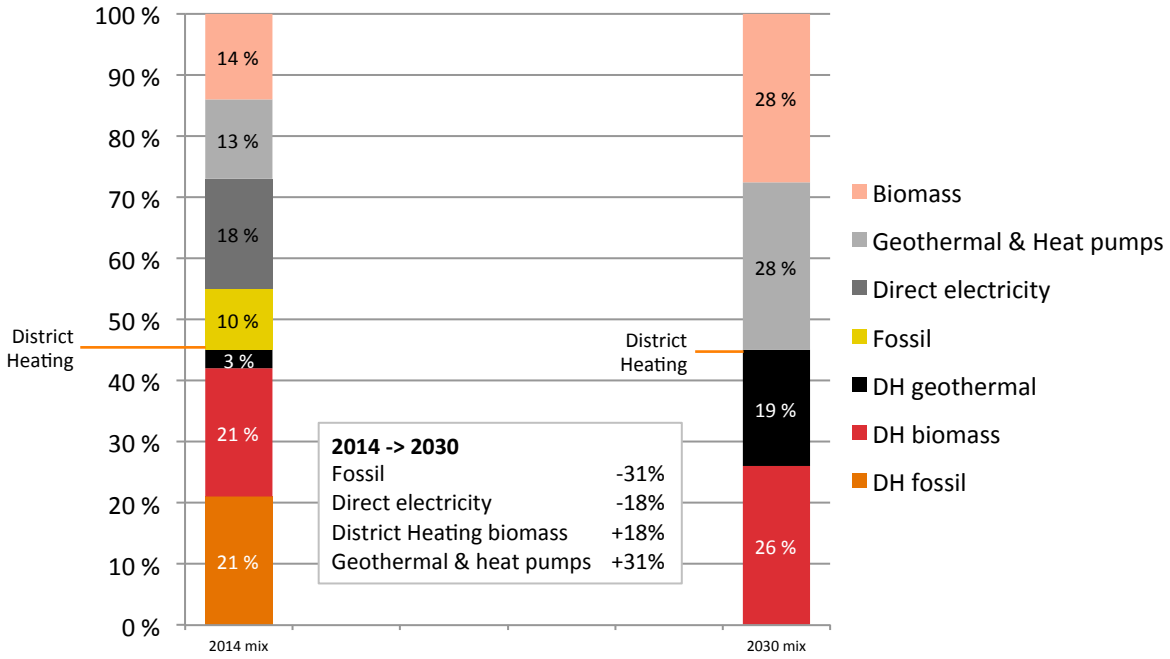
Competitiveness of renewable energy is improving in heating



GEOTHERMAL ENERGY AND BIOMASS ARE THE MOST COST EFFICIENT WAYS TO INCREASE RENEWABLE ENERGY IN HEATING

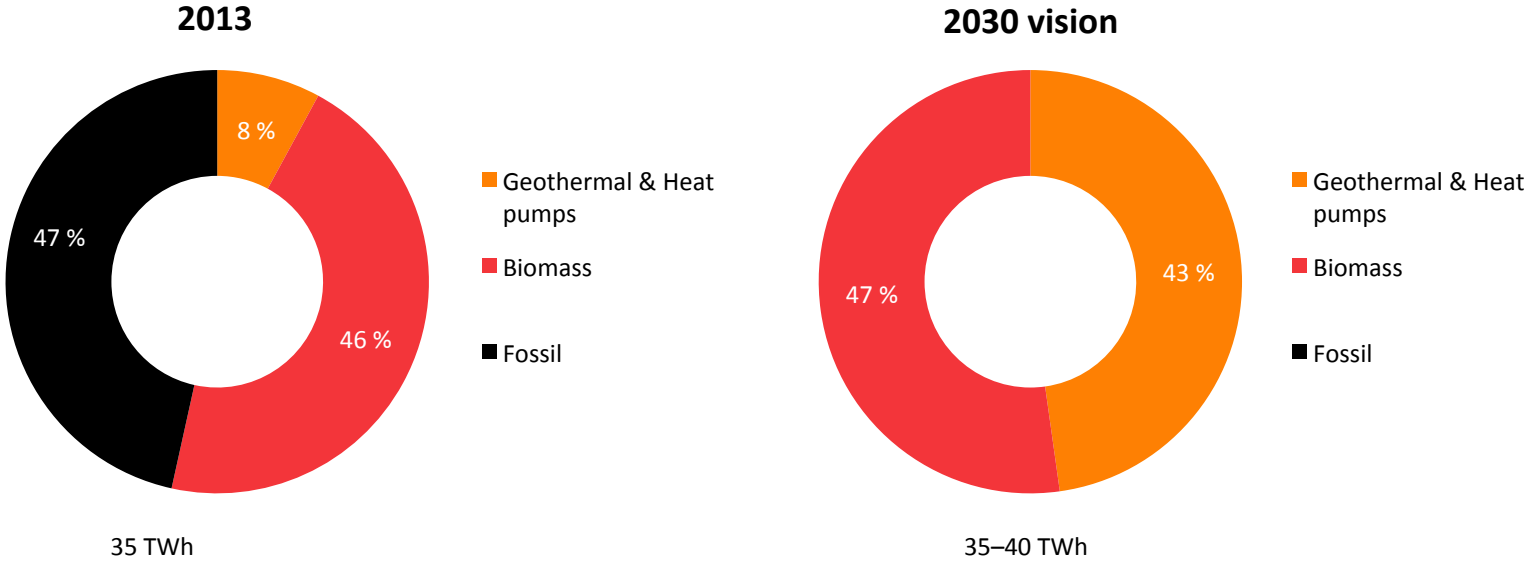
SOURCE: St1's own analysis based on data from several sources

Fossil fuels and direct electric heating will be replaced by renewables in heating in Finland by 2030



FOSSIL FUELS REPLACEMENT WITH LOCAL RENEWABLE ENERGY CREATES APPEALING BUSINESS AND EMPLOYMENT POTENTIAL

Oil, coal and natural gas will be replaced by renewables in district heating in Finland



FUTURE DISTRICT HEATING WILL BE BASED ON GEOTHERMAL AND HEAT PUMPS AND BIOMASS

Heating in Finland will face significant changes

In district heating, fossil energy will be replaced by

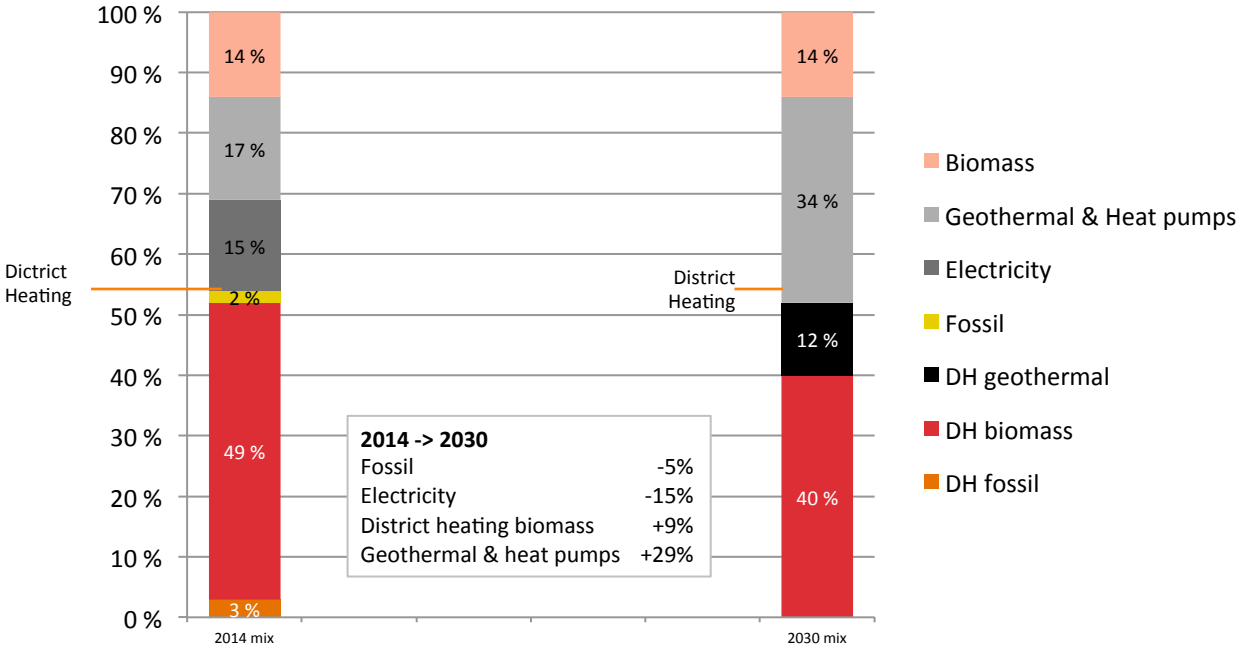
- Heat pumps and geothermal energy up to 12 TWh
  - Geothermal energy has the highest potential in existing 150 district heating networks producing base loads
    - Estimated potential in 2030 is in total 200 MW, consisting of 50*40 MW plants
  - New residential areas will use competitive local low-temperature small-scale heating and cooling networks provided by heat pumps
- Biomass is estimated to increase by 4 TWh
  - increasing role especially in peak load heat production

Outside district heating network, fossil fuels and direct electrical heating are estimated to be replaced by an increase of

- Biomass by 9 TWh
- Heat pump applications by 10 TWh
  - Total heat pump increase potential is estimated to be up to 15 TWh

GEOTHERMAL, HEAT PUMPS AND BIOMASS EXPECTED TO REPLACE FOSSIL ENERGY IN FINLAND BY 2030

Heating in Sweden is already almost fossil-free



GEOTHERMAL ENERGY WILL ENTER THE SWEDISH HEATING MARKET BY 2020 AND THEN GROW TOWARDS 2030

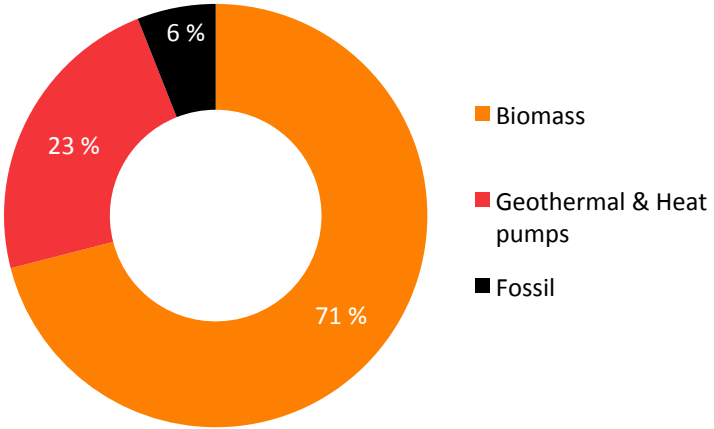
Geothermal energy has high potential in Sweden

- Geothermal energy use is estimated to increase 10 TWh by 2030
  - Fossil energy will be replaced by geothermal in district heating
  - Part of the biomass base load use will be converted to peak load use in district heating
- Political decisions are needed to improve the energy efficiency of direct electric heating in rural areas
- The transition will mainly be seen towards local geothermal heating, air-water pumps, solar and wind solutions
- Heat pump potential is increasing due to the technology development and new business models

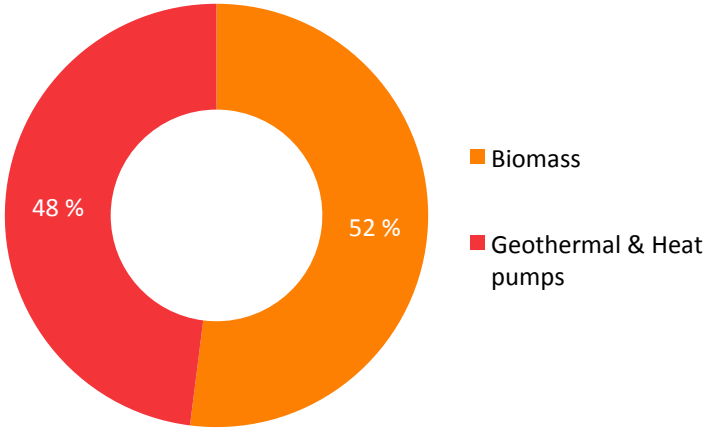
OTHER NEW HEATING SOLUTIONS ARE NOT FORESEEN TO PLAY AN IMPORTANT ROLE BY 2030

Fossil energy will be replaced by geothermal energy in district heating in Sweden

2014: 46 TWh

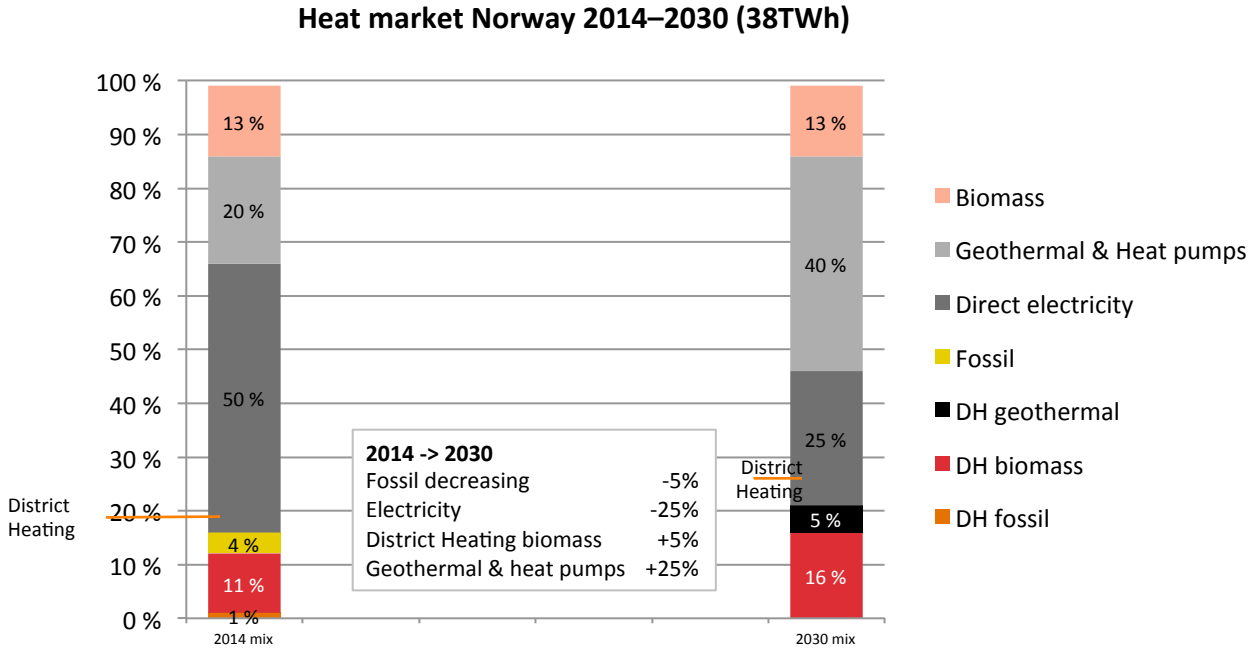


2030 Vision: 45–55 TWh



DISTRICT HEATING IS ESTIMATED TO KEEP ITS SHARE AS GEOTHERMAL DEEP HEAT IS EXPECTED TO IMPROVE ITS' COST EFFICIENCY

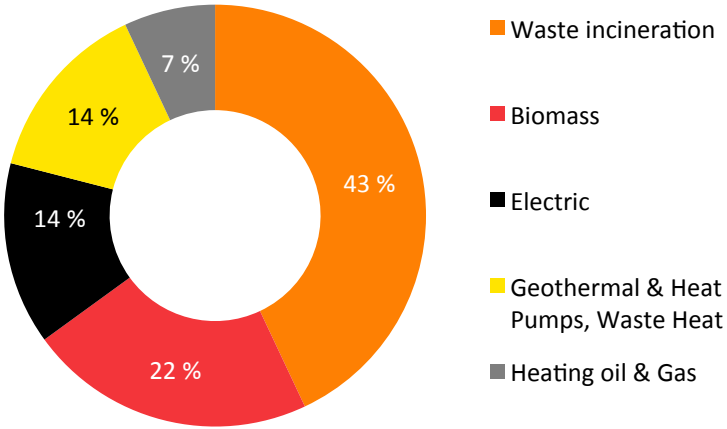
Heating in Norway is mainly produced from electricity



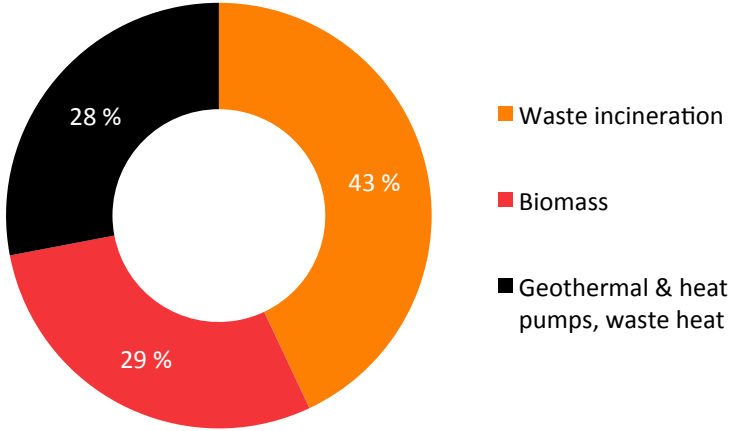
THE NORWEGIAN HEATING MARKET EXPECTED TO FACE ONLY MINOR CHANGES

In Norway fossil energy will disappear and electricity use will decline in district heating

2014: 5,2 TWh



2030 Vision: 7 TWh



TRANSITION FROM FOSSIL ENERGY AND DIRECT ELECTRIC HEATING TO HEAT PUMPS WILL BE THE DOMINANT TRENDS BY 2030.

Heating market in Norway will remain electricity driven

- Relatively slow growth in district heating will continue in Norway as the main population centers are already realized, and new buildings coming onto the grid are very energy efficient
- Fossil fuels will disappear as an energy source in household heating
- Electricity will remain the dominant energy carrier and the attractiveness of alternatives will be limited by electricity surplus up to 2030
  - Separate incentives to increase the energy efficiency of direct electric heating will be required
- District heating has historically been driven by municipal waste management
  - The value and smarter use of waste could significantly decrease its use in heating, which will require new renewable sources

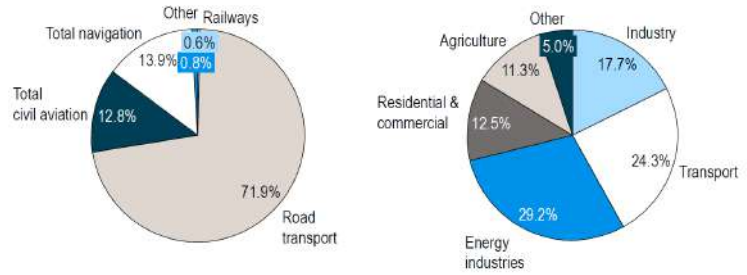
IMPROVED ENERGY EFFICIENCY REQUIREMENTS WILL LEAD TO INCREASED USE OF HEAT PUMP SOLUTIONS

Nordic Energy Outlook 2030: Road Transport

Transport is responsible for almost 25% of GHG emissions in the EU

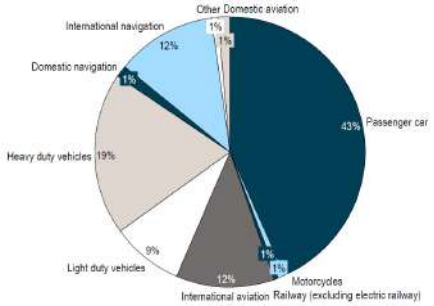
- Road transport corresponds appr. 70% of the total transport GHG emission in the EU
- Due to the difficulty, cost and urgency of decarbonization measures, it should not be left to be handled by market-based mechanisms such as Emission Trading System (ETS)
  - ETS will contribute to sectors with lowest costs to decarbonize first, thus it would easily delay transport decarbonizing measures by 15–25 years
- Urgent transport decarbonization measures are imperative, which require the use of existing infrastructure to begin with the existing vehicle fleet

Road transport GHG in the EU by vehicle segment, 2012 [%]



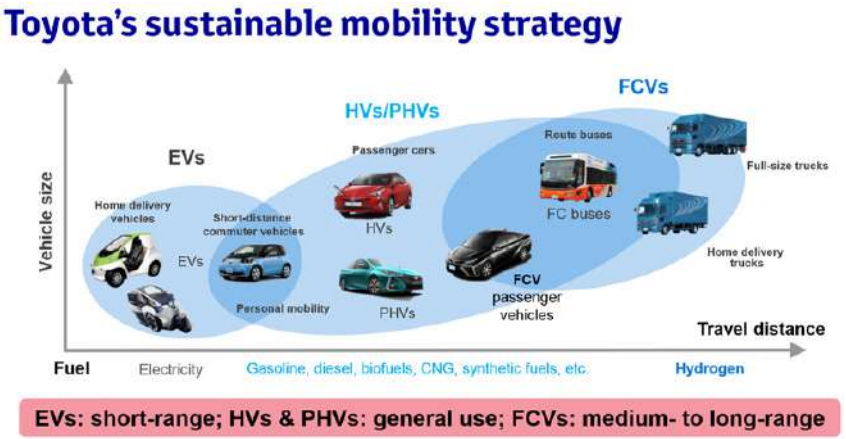
Source: European Commission

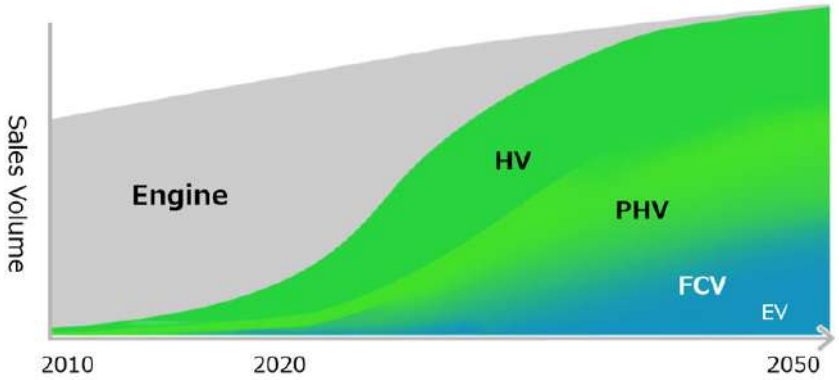
GHG emissions by transportation mode in EU28 by sector in 2013 (%)



Source: Transport emissions rising (EEA, 2015b)

Different powertrains serve different transportation needs

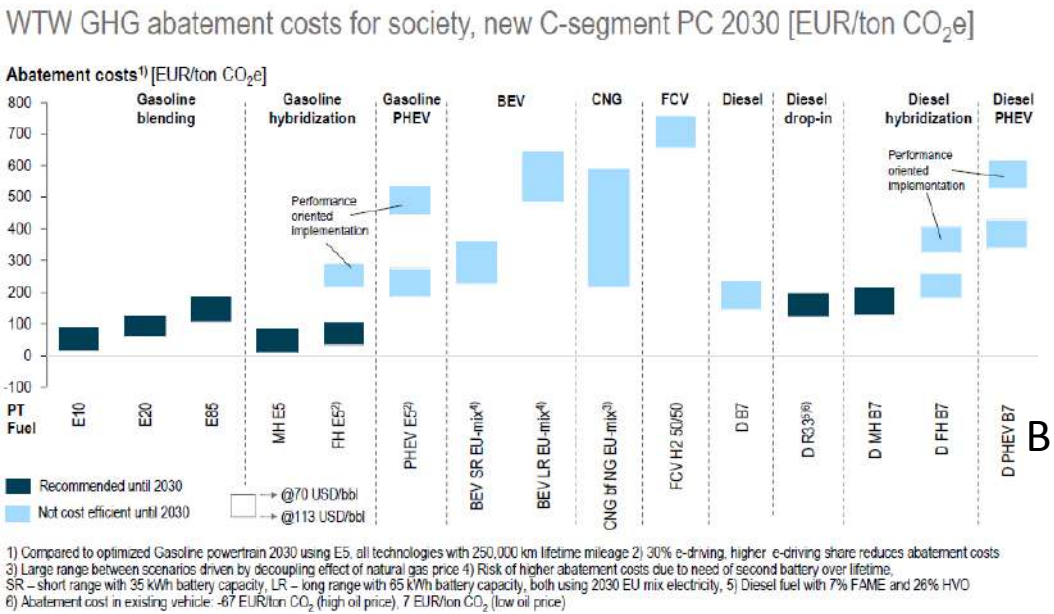




AND MARKET PENETRATION OF ALTERNATIVE POWERTRAINS IS LIKELY TO BE RELATIVELY SLOW

SOURCE: Toyota

Advanced biofuels decarbonize cost-effectively

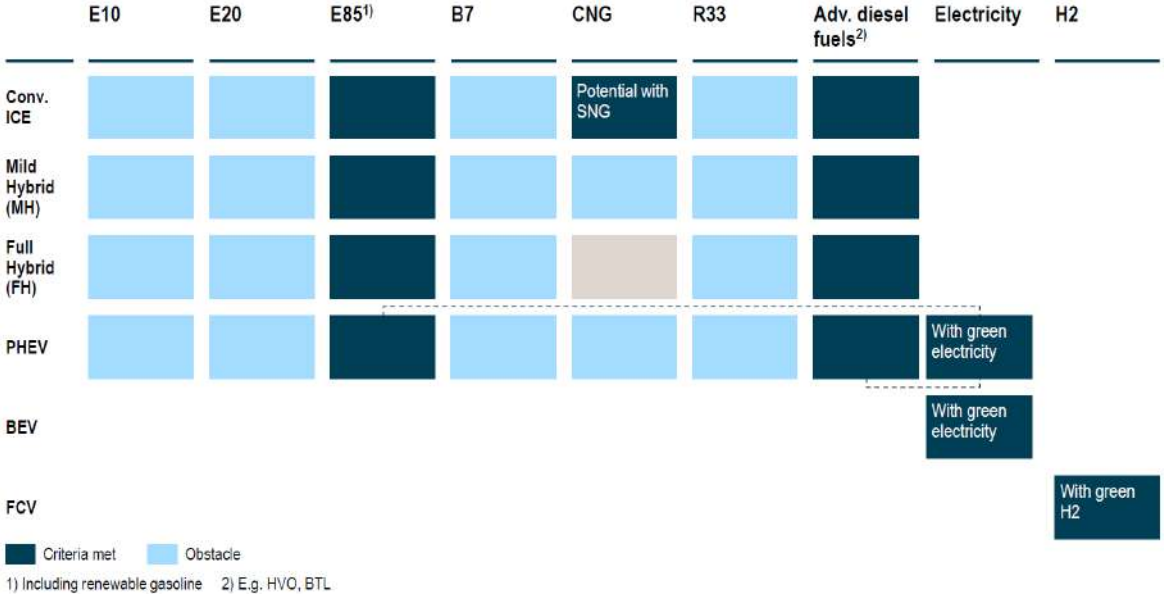


1) Compared to optimized Gasoline powertrain 2030 using E5, all technologies with 250,000 km lifetime mileage 2) 30% e-driving, higher e-driving share reduces abatement costs
3) Large range between scenarios driven by decoupling effect of natural gas price 4) Risk of higher abatement costs due to need of second battery over lifetime.
SR – short range with 35 kWh battery capacity, LR – long range with 65 kWh battery capacity, both using 2030 EU mix electricity, 5) Diesel fuel with 7% FAME and 26% HVO
6) Abatement cost in existing vehicle: -67 EUR/ton CO_2 (high oil price), 7 EUR/ton CO_2 (low oil price)

IMPROVED ENERGY EFFICIENCY, HYBRIDIZATION AND ADVANCED BIOFUELS HAS THE MOST REALISTIC CO_2 ABATEMENT POTENTIAL BY 2030

SOURCE: Integrated Fuels and Vehicles Roadmap to 2030+, Roland Berger

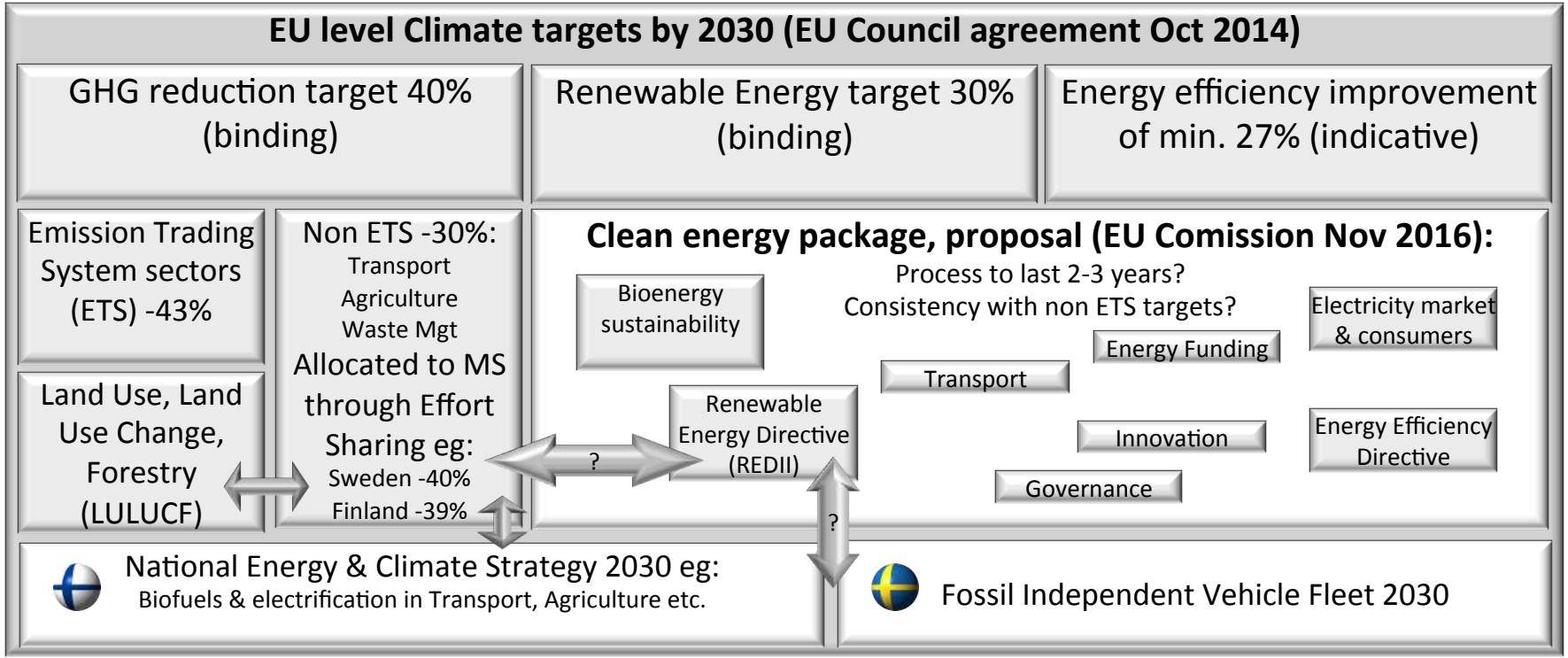
An integrated approach of technologies and fuel types will allow for ultra low carbon emissions in road transport sector



HIGH BLENDS OF ADVANCED BIOFUELS WITH HYBRIDIZATION COULD PLAY MAJOR ROLE IN ULTRA LOW CARBON SOLUTIONS ALSO BEYOND 2030

SOURCE: Integrated Fuels and Vehicles Roadmap to 2030+, Roland Berger

Legislation under construction and unclear interdepence slows down decarbonisation efforts in the EU



Overall Climate targets of EU are pretty clear as such

- European Council agreed in Oct 2014 on the EUs 2030 climate and energy:
  - a binding EU target of at least 40% less greenhouse gas emissions by 2030, compared to 1990
  - a target, binding at EU level, of at least 27% renewable energy consumption in 2030
  - an indicative target at EU level of at least 27% improvement in energy efficiency in 2030
- Based on Council's agreement of the minimum of 40% GHG reduction target is split into:
  - Emission trading system (ETS) sectors to cut -43% (vs. -05)
  - non-ETS sectors to cut -30% (vs. -05), of which a great share is from transport => translated into binding targets for MS (effort sharing):

- For Finland and Sweden the non-ETS burden will be -39% and -40% GHG reductions respectively by 2030, of which the transport needs to carry a lion share.

HOWEVER, BINDING EFFORT SHARING TARGETS WILL BE EXTREMLY CHALLENGING FOR THE NORDIC COUNTRIES TO REACH

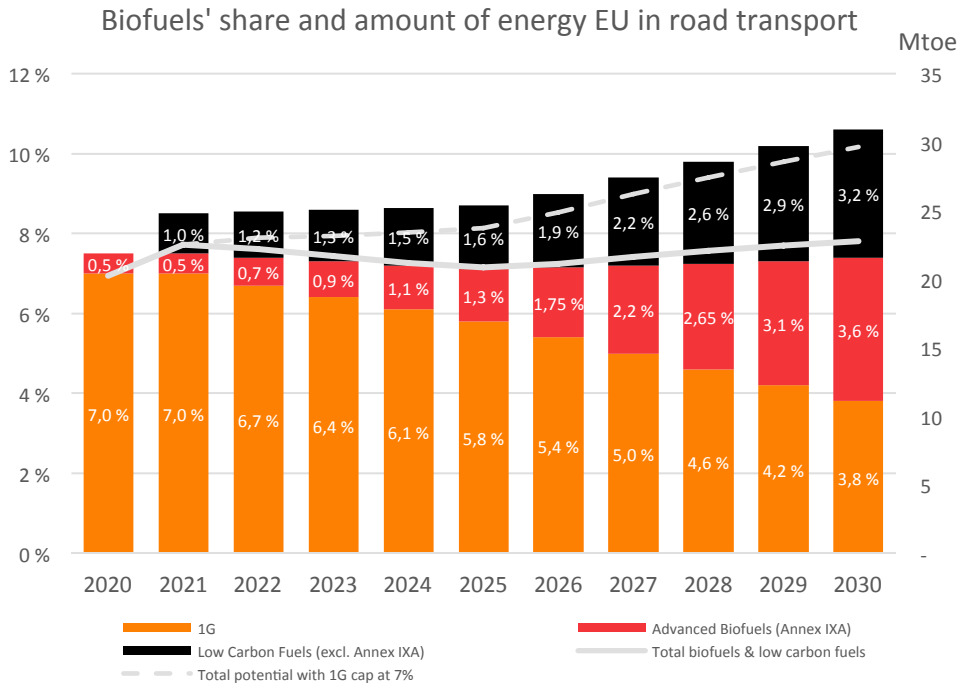
Consistency of different EU legislation is unclear

- As part of the "Winter Package" in November 2016 the EU Commission proposed a Renewable Energy Directive for 2030 (REDII) as a tool to achieve the 27% renewable energy target set by the Council.
- As a positive element fuel suppliers would have to put a minimum of 6,8% different waste based biofuels into the market in 2030, of which 3,6% has to be advanced biofuels in 2030 (Annex IX, Part A). However, the feedstock base for the 6,8% mandate is a list and a narrow definition. A wider definition should be used instead of a closed list to enable effective implementation.
- REDII would restrict the eligible biofuels' feedstock base significantly from the existing one:
  - Food and feed crop based biofuels would be capped on 3,8% at national level in 2030 (so called 1G biofuels)
  - Waste oil and molasses based biofuels would be capped on 1,7% at national level in 2030 (Annex IX, Part B)
- The feedstock restrictions from REDII would ruin the ability of Finland and Sweden to achieve their 2030 non-ETS sector targets, if they would be applied strictly and consistently both in REDII and in non-ETS sectors. However, to date is not clear if there would be a consistent approach, or if a MS could have more freedom in the non-ETS sector measures
- Uncertainty is likely to remain another 2-3 years before the REDII is final and the consistency issue is solved

Binding target creates the Advanced Biofuels market

- Growing obligation for fuel suppliers to bring advanced biofuels and other low carbon fuels into the market (1,5% to 6,8% by 2030), needs to be kept in the package.
- Specific subtarget (0,5% to 3,6%) for advanced biofuels (Annex IXA) is **imperative** to create the market and to enable investments in new production capacity.
  - 7-8 Mtoe/a corresponding 60-80 new biorefineries is a realistic target for 2030 at the EU level.
- By lowering the cap on 1G biofuels from 7% to 3,8%, EU will throw away ca. 7Mtoe/a biofuels and 15-17 mton/a CO_2 abatement potential.
- REDII should enable fuel suppliers to fulfill their mandate in a Member State of their choice.
- National and international trade of fulfilled obligations between the operators should be enabled (”ticket trading”).

AT THE SAME TIME EU SEEMS TO WASTING 15-17 MTON/A OF CO_2 ABATEMENT POTENTIAL

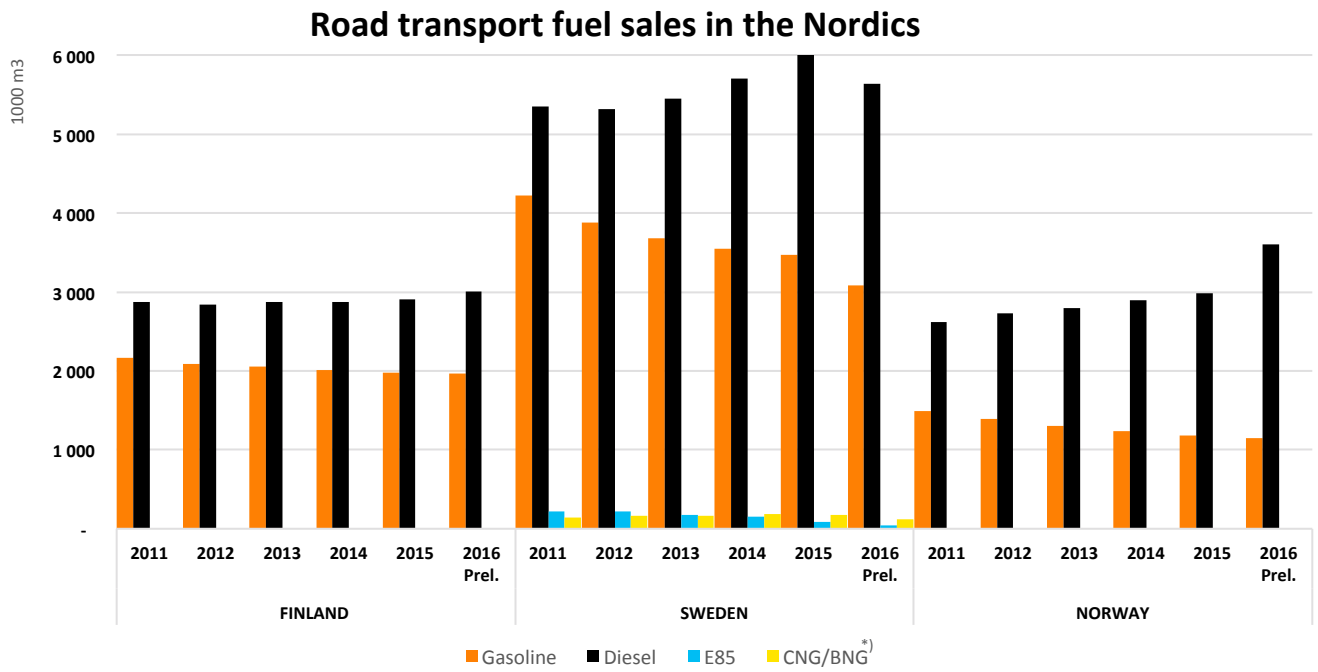


Blending walls limit the intake of advanced biofuels

Biocomponent	Standard or specification	Blend wall	Vehicles	Fuel infrastructure
HVO/BTL low blends	EN 590 Diesel	Drop-in EN 590 up to density hurdle (tens of % points)	Entire diesel fleet	Current diesel infra
FAME	EN 590 Diesel	Max 7% in diesel (B7)	Entire diesel fleet	Current diesel infra
Ethanol low blends (E5, E10)	EN 228 gasoline	Max 10% in gasoline	Entire gasoline fleet	Current gasoline infra
Ethanol mid blend (E20)	Standardization initiated in CEN	Max 20% in gasoline	Only E20 compatible vehicles or FFV	Current gasoline infra, but may require investments (e.g. corrosion)
FAME	prEN 16734 B10 EN 16709 B30	Max 10% or 30% in diesel (winter properties not sufficient)	Only B10 or B30 compatible vehicles	Specific infra required
High Blends				
HVO/BTL 100%	EN 15940 paraffinic diesel	No blend wall: 100% as such	Separately certified diesel vehicles	Specific infra required
ED95	Mothballed in CEN	Ethanol max 95%	Specifically manufactured diesel engines; not compatible with diesel	Specific infra required
Ethanol high blend E85	TS 15293	Ethanol max 85%	FlexiFuel Vehicles (FFV, also compatible with gasoline)	Specific infra required
FAME B100	EN 14214	100% (winter properties not sufficient)	Specifically manufactured diesel engines	Specific infra required
(Bio)methane		Not blended	CNG-vehicles; PC typically bi-fuel system with separate gasoline tank	Specific infra for gaseous fuels required

DESPITE OF THE FACT THAT E.G. PRACTICALLY ALL NEW GASOLINE VEHICLES ARE E20 COMPATIBLE - TODAY

Nordic gasoline volume continues to decline



WHEREAS DIESEL IS STILL GROWING

FAST GROWING e-MOBILITY IN NORWAY HAS NOT DECREASED THE OVERALL DEMAND FOR LIQUID FUELS

*) CNG/BNG in 1000 m^3 gasoline equivalent

Overall Nordic demand for liquid fuels will decrease

- Overall energy efficiency is estimated to cut road transport energy demand by 20–25% by 2030 vs. 2016 level (*
  - Key driver is the 95 g/km target by 2020 which is pushing car manufacturers (OEM) to invest in electrification, hybridization and in even more efficient internal combustion engines (ICE)
  - Battery Electric Vehicles (BEV) remain relatively expensive which will slow down the e-mobility penetration pace
  - Mild hybrid (MH) and full hybrid (FH) vehicles (gasoline and electricity) are cost-effectively abating CO_2 emissions
  - Plug-in hybrid (PHEV) is relatively more expensive than MH and FH, thus will be more appealing with high annual mileage in urban areas (maximizing the share of e-driving)
  - In Norway e-mobility is assumed to grow fastest in the Nordics through widely accepted political targets and aggressive incentive schemes

*) Based partly on Integrated Fuels and Vehicles Roadmap to 2030+, Roland Berger and on own assessment

Gasoline demand is to decrease faster

- Gasoline demand will continue to decrease cumulatively up to 25–35% by 2030 vs. 2016 level
  - Gasoline powertrain remains the most cost effective option offering a good platform for increasing the share of advanced biofuels
  - E20 is not likely to be in place before 2025, despite of the fact that most new gasoline vehicles are technically E20 compatible already today
  - E-mobility is slowly replacing gasoline powertrain especially due to the typically shorter annual mileage of gasoline cars

BUT, THE INTERNAL COMBUSTION ENGINE WILL STILL BE DOMINANT POWERTRAIN IN 2030 AND BEYOND

*) Based partly on Integrated Fuels and Vehicles Roadmap to 2030+, Roland Berger and on own assessment

Diesel demand declines in the passenger car segment

- Demand for diesel is estimated to grow for some years before it starts to decrease, cumulatively the decline is expected to reach 10–15% by 2030 vs. 2016. The entire decline is expected to take place in passenger cars (PC) ~-25%, whereas commercial diesel in heavy duty (HD) and light duty (LD) segments is expected to be flat or to just slightly decline
  - Tightening EURO 6 emission regulation for diesel vehicles results in higher vehicle prices (e.g. installations of urea-SCR i.e. Selective Catalytic Reduction and low and high EGR i.e. Exhaust Gas Recirculation) that will cause a shift to gasoline vehicles from small diesel cars, especially in the A (e.g. VW Up!) and B (e.g. VW Polo) segments
  - Diesel will also lose ground in the C (e.g. VW Golf) and D (VW Passat) segments mainly through hybridization.
- Due to the slow renewal pace of the car fleet, advanced liquid biofuels offer the most viable decarbonization opportunity up to 2030 and even beyond, though highly impacted by political decisions.

WHEREAS, COMMERCIAL TRANSPORT REMAINS DEPENDENT ON DIESEL

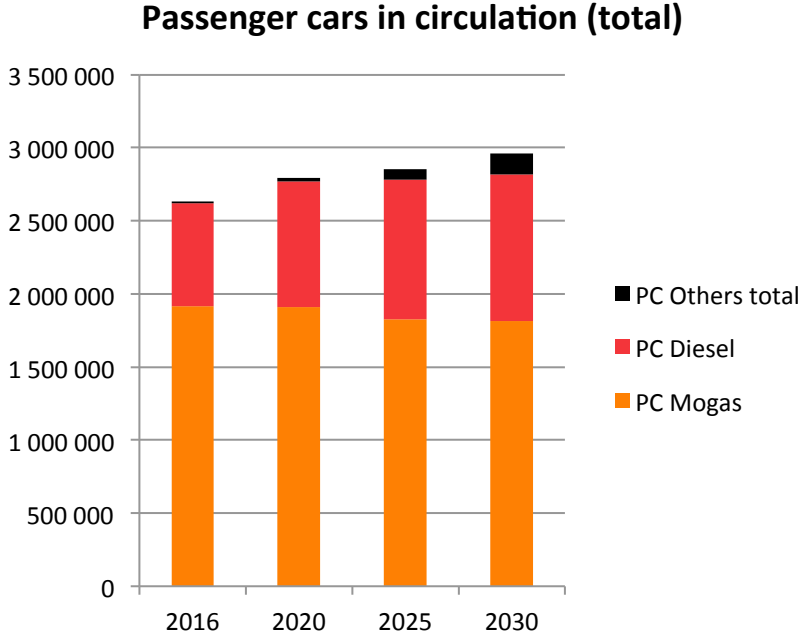
Finland has a good combination of mandate and tax structure

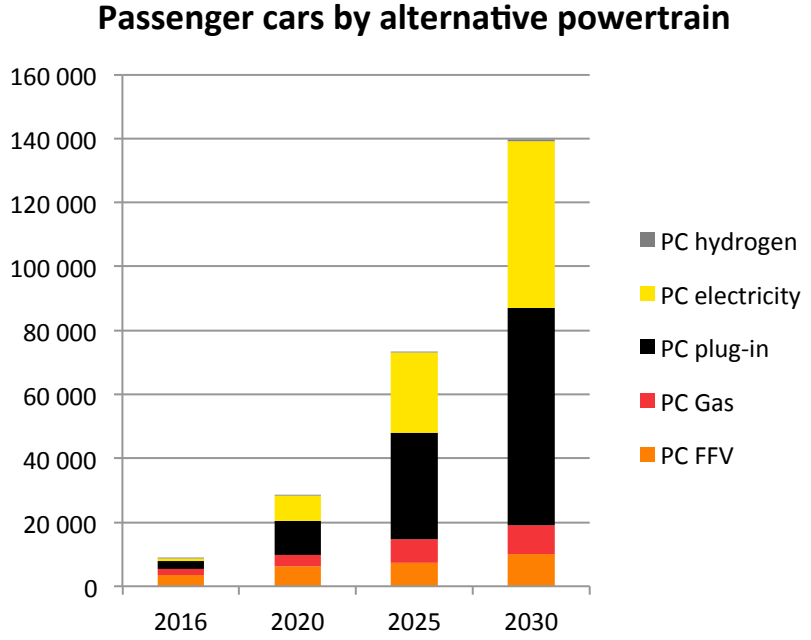
- The biofuels mandate increases up to 20% energy by 2020 with double counting allowed (2017: 12%)
- The technology neutral taxation model includes all liquid fuels with same principles, but giving excessive benefits to CNG and electricity
- Excise tax has two components: Energy component and CO_2 component
  - Secures tax income regardless of changes in the product mix
  - Energy tax for Gasoline 1.631 cent/MJ and Diesel 0.911 cent/MJ
  - CO_2 tax is EUR 62/t CO_2
- As long as the proposed REDII for 2030 is not legally binding, any change in the current mandate or tax structure should not be made

Product	Product category	Energy content tax (c/l)	CO_2 Tax (c/l)	Energy Security Fee (c/l)	Total (c/l)
Motor Gasoline	10	52.19	17.38	0.68	70.25
Bioethanol	20	34.25	11.40	0.68	46.33
Bioethanol R	21	34.25	5.70	0.68	40.63
Bioethanol T	22	34.25	0.00	0.68	34.93
Diesel	50	32.77	19.90	0.35	53.02
Biodiesel Paraffinic	55	25.95	18.79	0.35	45.09
Biodiesel Paraffinic R	56	25.95	9.40	0.35	35.70
Biodiesel Paraffinic T	57	25.95	0.00	0.35	26.30

THE NATIONAL LEGISLATION BEYOND 2020 SHOULD NOT BE DECIDED BEFORE EU's RENEWABLE ENERGY DIRECTIVE FOR 2030 IS FINALIZED

Number of PC's is expected to grow slightly in Finland





EVs GRADUALLY PENETRATING THE MARKET THROUGH INCENTIVES, BUT STILL REMAINING MARGINAL

SOURCE: VTT, Lipasto database, Aliisa model and St1 own analysis

Increased use of domestically produced advanced biofuels has neutral to positive effect on GDP

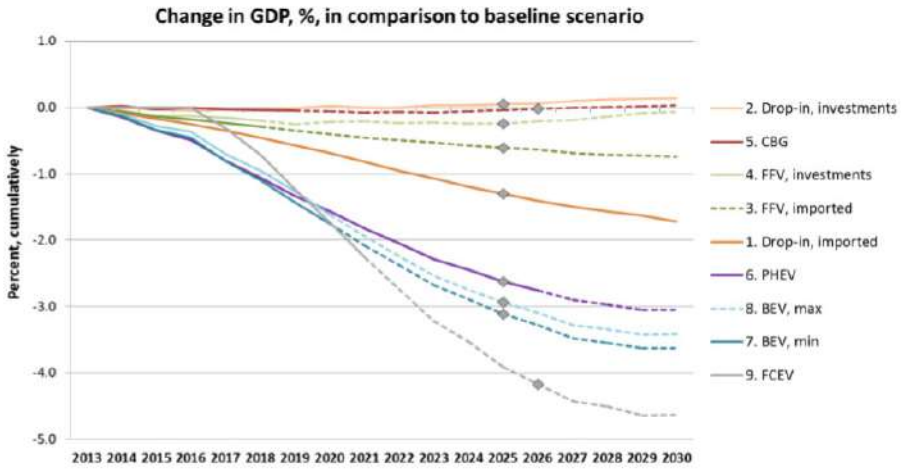


Chart 1: GDP effects of different scenarios[7] (♦ =30 per cent reduction obtained).

ALTERNATIVE POWERTRAIN SCENARIOS AND SIGNIFICANTLY INCREASED BIOFUELS IMPORT WOULD RESULT IN NEGATIVE GDP DEVELOPMENT

VTT Research Report VTT-R-00752-15: http://www.transsmart.fi/files/248/Tutkimusraportti_VTT-R-00752-15_liitteineen.pdf

Finland has today one of the highest renewable energy shares in transport in the EU

- The recent Finnish national energy and climate strategy for 2030 proposes to increase biofuels mandate up to 30%$_{e/e}$ in physical volume (without double counting) by 2030, which means additional 600.000 TOE of biofuels vs. 2015 level
- At the same time EU commission's proposal to Renewable Energy Directive for 2030 (REDII) would restrict the eligible biofuels' feedstock base significantly from the existing one

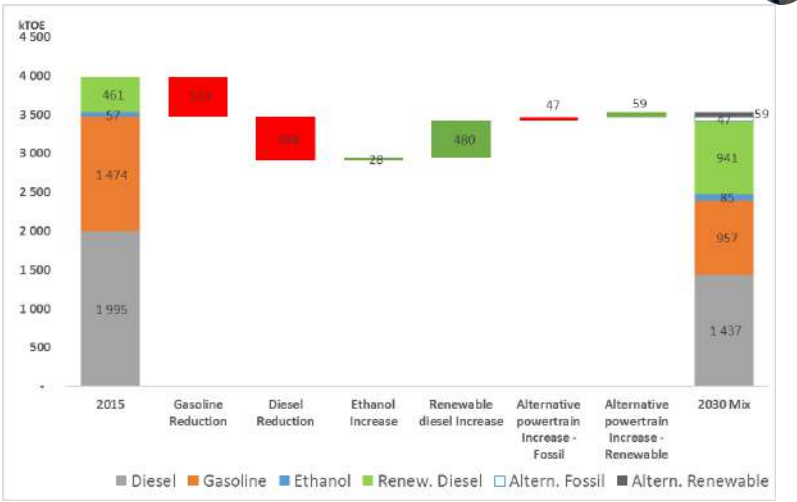
- Based on the experiences from the ILUC process, the political risk for any new investments in advanced biofuels production, before the REDII is legally binding, is too high. The final outcome of the ILUC directive was extremely different from the proposal. In addition to failing to create the market for the Advanced Biofuels, it also destroyed the EU market outlook for 1st generation biofuels.

THUS, THERE IS NO URGENCY IN CREATING ANY NEW NATIONAL LEGISLATION BEYOND 2020

Targeted 30% biofuels share can't be met in 2030 by the REDII proposed feedstock base

- REDII proposal severely limits the potential feedstock base. There would be a need to bring up to 0,8-1 mill. toe of new biofuels into the Finnish market by 2030 in the worst case
- Targeted domestic investment are not likely materialise timely for 2030, thus a 30% national target would have to be met with imported biofuels
  - Target could potentially be met in 2035, but not in 2030
- Simultaneously several other countries are having similar national ambitions, but with the same feedstock restrictions
- Investors and financiers will wait and analyse the final REDII and other relevant EU regulation very carefully, before making any investment decision on new biofuels capacity.

THERE WOULD HAVE TO BE UP TO 0,8-1 MILLION TOE OF NEW BIOFUELS IN THE FINNISH MARKET IN 2030



Fulfilment of 2030 obligation	Energy (kTOE)	*Basis*
Targeted 2030 obligation	1 058	
1G biofuels contribution max.	134	*max. 3,8%*
Waste oil based biofuels contribution max.	60	*max. 1,7%*
Gap vs. 30% obligation	**864**	
Road transport energy demand in 2030	3 526	

Source: St1 own analysis

1) Renewable energy share in alternative powertrain vehicles (e.g. electricity, gas)

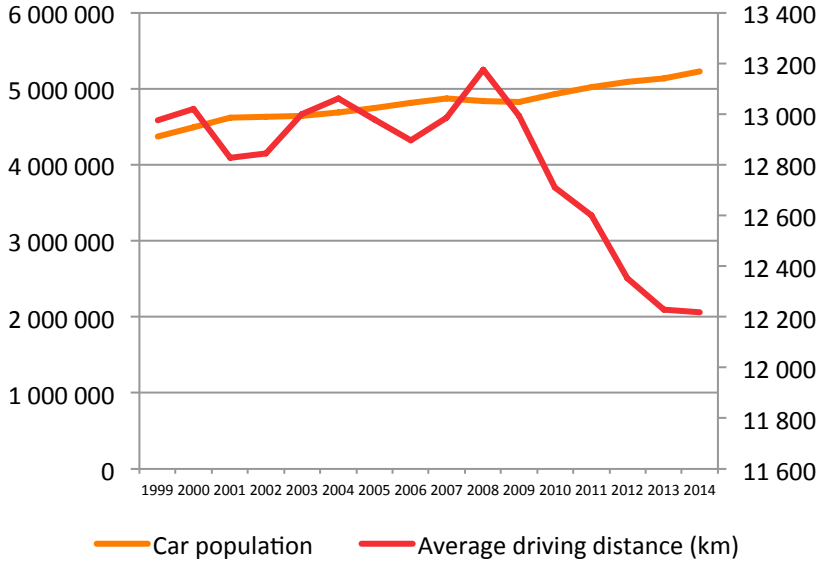
Sweden: Tax exemptions are effective in the short term but do not trigger investments in new capacity

- Tax exemptions for biofuels :
  - Taxation includes energy tax & CO_2 tax
  - No mandate structure introduced so far
- Separate tax incentives for different low blend biofuels
  - Ethanol: reduced energy tax 74%, CO_2 tax 100% exemption, no volume limits
  - ETBE (biopart): both taxes 100% exemption
  - RME/FAME: reduced energy tax 8%, CO_2 tax 100% exemption
- For high-blends:
  - E85: reduced energy tax 73%, CO_2 tax 100% exemption
  - ED95: full tax exemption
  - B100: reduced energy tax 50%, CO_2 tax 100% exemption
  - HVO: 100% full tax exemption
- Sweden is currently drafting a GHG Reduction Obligation ("Reduktionsplikt") to meet the formal EU requirements for 2020. However, it should not be extended to 2030 until the REDII is legally binding, as any new production capacity investments are not likely to take place prior to that.

Product	Energy tax (SEK/m³)	CO_2 tax (SEK/m³)	Total (SEK/m³)
Mogas	3.720	2.590	6.310
Diesel	2.355	3.204	5.559

Car pool in Sweden is estimated to increase but average driving distance continues to decrease

Car population-Average driving distance



Proposed shift to Bonus–Malus earliest in 2017

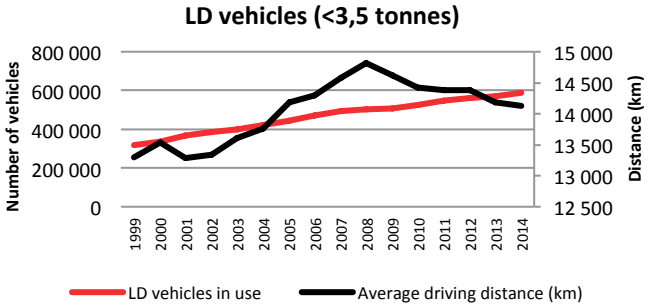
Level	Bonus/malus SEK	2017–2019 g CO_2/km	2020–2022 g CO_2/km	Description
A Bonus	50,000	0–29	0–20	BEV, FCEV
B Bonus	25,000	30–60	21–50	PHEV >50 km cert. range, biogas
C Bonus	10,000	61–80	51–70	FFV and Biogas, PHEV< 50 km
D (Neutral)	+/-0	81–120	71–100	Fuel efficient
E Malus	-10,000	121–160	101–130	Bad fuel efficient
F Malus	-25,000	161–200	131–170	Fuel guzzler
G Malus	-50,000	201–	170–	Fuel guzzler

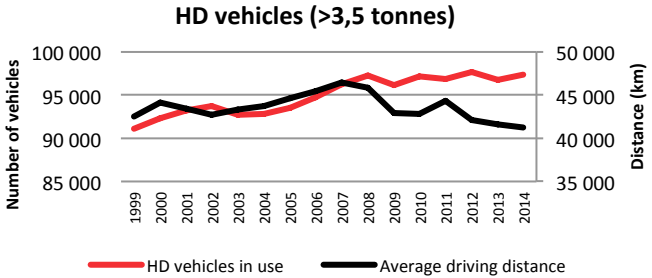
Bonus-Malus to push down average consumption

- The number of passenger cars in traffic is estimated to grow to 5 million by 2030 (4,7 in 2015)
- Expected growth together with company car fleets offers the main channel for increased alternative powertrain penetration
- The proposed Bonus-Malus is likely to push down the average fuel consumption and promote PHEV
- Gasoline is expected to remain strong as main/secondary fuel in PHEV
- Promotes diesel over gasoline vehicles due to its lower GHG intensity per kilometer driven
- Car pooling and congestion fees may result in peak car by 2030

BUT DOES NOT YET INCENTIVISE FOR INCREASED ADVANCED BIOFUELS UPTAKE

High blend solutions imperative in commercial fleets due to lack of feasible alternatives





Light Duty vehicles (<3,5 t):

- Significant increase in the number of vehicles (e.g. due to increase just-in-time deliveries)
- Local transports shifting increasingly to alternatives

Heavy Duty vehicles (>3,5 t):

- Moderate increase in the number of vehicles (e.g. due to increased international competition)
- Limited possibility to shift to alternative power trains
- Drop-in fuels will be key for both short and long haul

GHG Reduction Obligation should include binding sub target for Advanced Biofuels

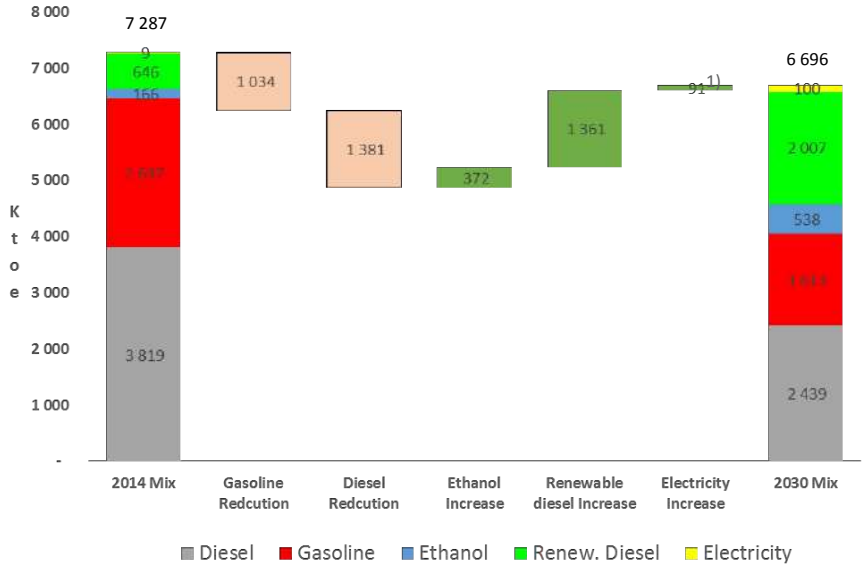
- On a short term, the national GHG Reduction Obligation (Reduktionsplikt or RO2020), to fulfill the current EU requirements for 2020, should extend only until the year end of 2020, and it should contain the existing tax exemption element to the extend possible.
- The long term Reduction Obligation (RO2030) for the period 2021-20320 should not be be finalised and implemeted before the EU REDII is final and legally binding. Domestic investements in new biofuels production capacity is not likely to take place anyway before that.
- In the RO2030 there should be a binding and dedicated subtarget to be reached with Avanced Biofuels in order to create market, with the aim to trigger domestic investements. Without new (domestic) investments, the globally available Advanced Biofuels would just be allocted to the highest paying markets in any given time.
- The RO2030 should have a one fuel pool approach where the obligation can be fulfilled in any transport fuel put into the market. In other words there should not be separate pools for diesel and gasoline or low blends and high blends.

GHG Reduction Obligation should allow for mass balance approach consistently – also in fuel taxation

- RO2030 should enable, in an oil refinery with crude oil, co-processed biocomponents to be included in the obligation. That would be cost effective and to attract investments in R&D aiming to reduce the overall demand for crude oil.
- Mass balance approach would ensure that claimed amount of GHG reducing biofuels is always sold to the market in a given time period. However, there's no need follow (segragated) physical prodcuts from production to the point of sale. Mass balance approach follows the logic of green electricity.
- In the mass balance approach of co-processed biofuels, the obligated party may allocate the biofuels' share to any of the refinery streams, however never exceeding the total amount of biofuels produced.
- The mass balance should be treated consistently in all the related regulation, including the fuel taxation.
- As a result of the upcoming RO2020 and RO2030, the so called "Pumplagen" (requiring to sell a pure biofuel on every retail site) becomes redundant, thus should be annulled.

ALLOWING BOTH CO-PROCESSING AND A MASS BALANCE APPROACH IN THE REDUCTION OBLIGATION FOR 2030 IS COST EFFECTIVE

Long-term policies are required to trigger domestic investments and to reach FFF targets



BINDING BLENDING MANDATE SET ON OIL COMPANIES WITH DOUBLE COUNTING HAS PROVEN TO BE EFFECTIVE TOOLBOX TO TRIGGER INVESTMENTS!

1) Renewable energy share in alternative powertrain vehicles (e.g. electricity, gas)

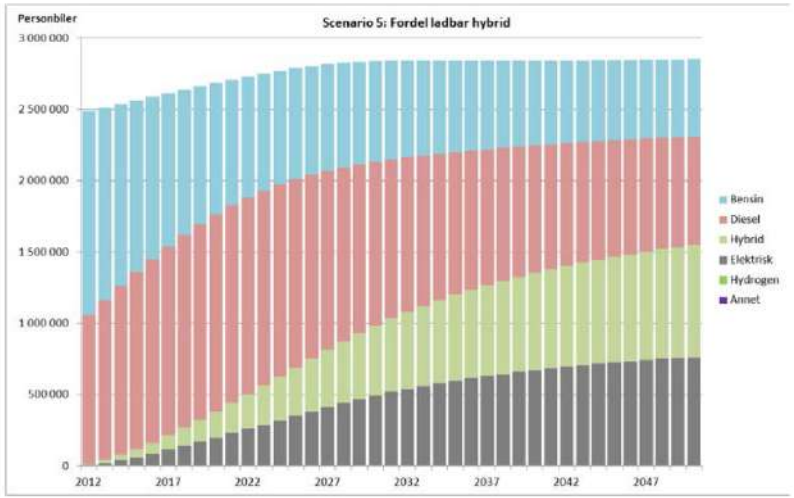
Norway: New hybrid system of tax exemption and mandate cannot be reappraised on effectiveness yet

- The volume mandate will increase during the next 5 years raised from 5,5% up to 20%
  - Tax exemptions for all biofuels volumes beyond the mandated level
  - Sub mandate of advanced biofuels will increase from 1,5% in 2017 to 8% in 2020 (including double counting
- A general tax increase from the beginning of 2017 will leverage the tax emption impact
- The impact on domestic investments still to seen, as the currently outstanding REDII will also affect Norway
- Expected introduction of significant volumes of HVO into Norway
- Potential for higher ethanol contents in gasoline, but the real development require introduction of E10

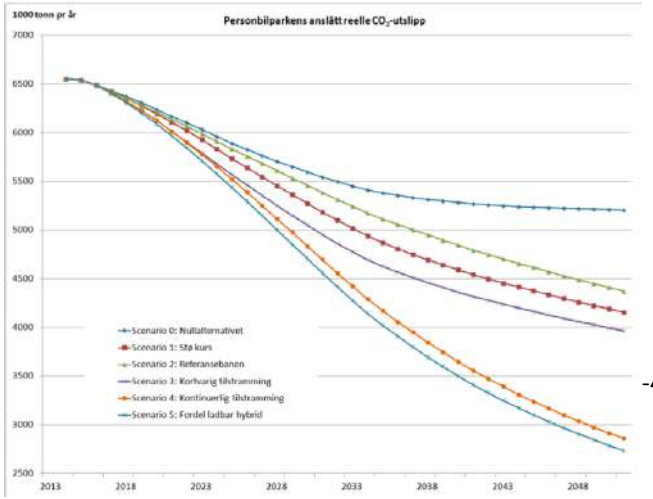
	2016	2017	Oct 2017	2018	2019	2020
Diesel Tax	4,56	5,00	5,00			
Gasoline Tax	5,96	6,23	6,23			
Biofuels – Diesel (within mandate)	3,44	3,82	3,82			
Biofuels – Mogas (within mandate)	2,47	2,80	2,80		?	
Mandate	5,5 %	7 %	8 %	11%	13%	20 %
of which advanced biofuels		1,5 %	2,50 %	3,50 %	4,50 %	8 %

Electric vehicles are estimated to grow significantly in Norway by 2030

Car Fleet Composition 2030



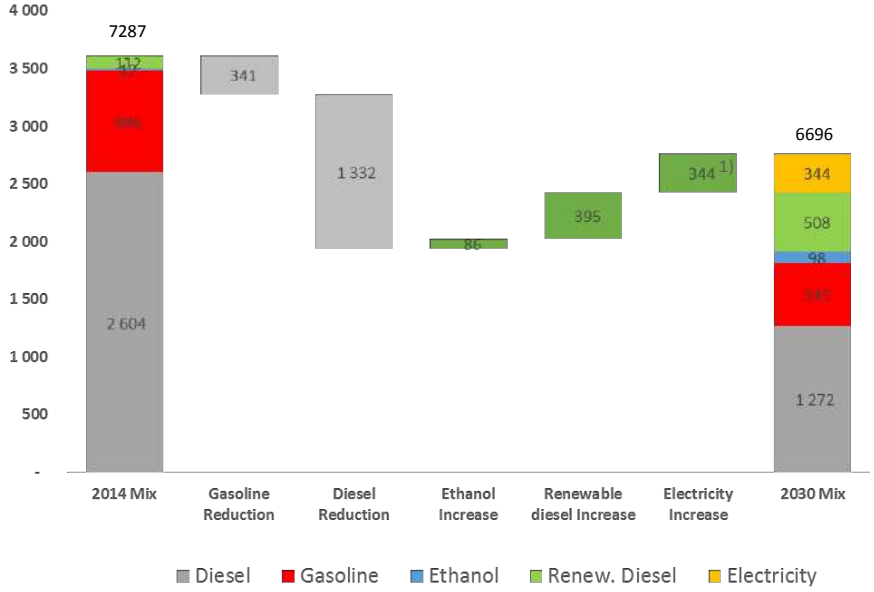
Emissions 2030



-40%

HOWEVER, THE INTERNAL COMBUSTION ENGINE IS STILL EXPECTED TO BE DOMINANT IN 2030

Heavy incentivization of e-mobility is expected to replace 1,100 KTOE of fossil by 2030



BALANCE OF 500 KTOE NEEDS TO BE COVERED BY ADVANCED BIOFUELS

1) Renewable energy share

Advanced biofuels blending mandate of 30% is needed to reach 40% GHG reduction target

A renewable energy mandate of 20% in 2020 is coming too soon, as companies don't have enough time to carry out the desired investments, especially because REDII process is expected to continue another 2-3 year.

- The 20% mandate level would be more realistic to have in place in 2025, and to be increased to 25–30% in 2030
- One pool biofuels mandate is an effective way to serve GHG reduction target
- Local E20 standard to be implemented earliest possible and E30 by 2030
- EU GHG-reduction target and sustainability criteria to be met locally for non-ETS sector

Clear and long term taxation with two components: taxes on energy and CO_2

- Set fossil CO_2 tax to EUR 100/CO_2 ton by 2025

Domestic investment on domestic feed-stocks ensured by carefully designed investment grant program

- Secure Norway's supply of advanced Biofuels. Potential shortage of advanced biofuels is a risk
- Incentivized local production of advanced biofuels, including drop-in variants is cheaper than winning the "regulatory" arbitrage game and better industrial policy
- Incentivized research into ways of leveraging electricity surplus and available feedstock to produce drop-in bio fuels

Blending mandates trigger domestic investments

	Finnish System	Swedish System	Norwegian system
Pros	+ Investment security through clear mandate structure and long term view + Supports increasing low carbon fuel alternatives in fuel blending	+ Ensures a lot of biofuels volume into the system + Market can pay a lot for existing fuels	+ Guaranteed volume of biofuels + Supports going higher blends than mandated volume + Creates investment security in principle, but the time frame is too short
Cons	− Not all transport energies are included in the system e.g. Gaseous fuels	− Not predictable − No Investment security due lack of long term vision − Results in high level of imported biofuels − Cost for society	− Cost for society

AND BALANCED TAX STRUCTURE INCENTIVIZES THE MARKET UPTAKE EVEN FURTHER

Common Nordic approach would speed up the overall decarbonization effort

Long-term view for decarbonization in the policies is imperative – preferably at the Nordic level. However, the overarching EU regulation has to be in place first.

- New investments in sustainable, domestic and competitive production capacity are needed. Just shifting existing production volumes to the highest paying market(s) is both short-sighted and counter productive
- Investments need a 10–15 years market view for them to be made
- Combined Nordic market is big enough to make significant investments for renewable energy (e.g. advanced ethanol and other large biorefineries, such as BtL plants)
- To enable a liquid market for advanced biofuels there is a need for synchronizing cross-border ticket/certificate systems
- Harmonizing the Nordic transport system would enable internal market and investments

A renewable energy mandate of 10-20% in 2020, to be increased to 20-25% in 2030 assuming that the double counting is not in the EU toolbox in the 2020'ies.

- If the 1G cap of 3,8% and a 1,7% cap of Annex IX Part B based biofuels will survive to final REDII, the targeted level needs to be revisited
- Local E20 standard to be implemented earliest possible and E30 by 2030
- Keep double counting in markets where it's used today. Consider introducing it to other markets.

RIGHT SET OF EU AND NATIONAL POLICIES TOGETHER WILL TRIGGER INVESTMENTS IN LOCAL PRODUCTION OF ADVANCED BIOFUELS

Common Nordic CO_2 price of EUR 100/t enables price differentiation

Set a common CO_2 price of 100 €/t CO_2 and seek to harmonize the fuel tax structure to the extend possible

- Create energy and CO_2 -based taxation for all transport fuels (liquid, gaseous, electricity etc.)
- This will ensure the most cost effective choices made for decarbonization of transport

High blend markets should be developed in a coordinated way, e.g.

- Apply well-to-wheel methodology in vehicle CO_2 emissions certification. This offers OEM's incentive to produce and sell FFV's in the Nordics
- ED95 and HVO100 markets through local interpretation of minimum tax regulation
- Accept FFV conversions up to Euro 4/5 cars

PRICE DIFFERENTIATION ENSURES MARKET UPTAKE OF HIGHER LEVELS OF RENEWABLE ENERGY IN TRANSPORT

Nordic Energy Outlook 2030: Aviation

Global nature of Aviation requires impactful international decarbonisation measures

- Aviation Jet fuel demand has increased from 160 mill. ton in 1990 up to 260 in 2013[1)].
- Passenger-km on regular aviation has grown from 1.900 billion km in 1990 up to 6.100 in 2014.
- The number of flight passengers is expected to grow 4% pa during the next 20 years[2)].
- The energy efficiency is expected to improve slower than transportation need. Thus, continuing with the current path the fuel demand is estimated to grow 200% during the next 30 years[2)].

1) IEA 2016
2) IATA 2015
3) ICAO 2013

- International decarbonisation measures are needed, as ca. 65% of aviation fuel is used on international flights
  - International Civil Aviation Organisation (ICOA) has agreed in 2013 on objectives to improve fuel efficiency 2% pa and to achieve carbon neutral aviation transport growth from 2020 onwards. By 2050 the target is to achieve a level of 50% GHG emissions vs. 2005.
  - Aviation was placed under EU Emission Trading Scheme (ETS) in 2012. In principal system covers all flights departing from or landing on airports within European Economic Area (EEA), unless they are specifically excluded from ETS. However, 2013-2016 system applies only to internal flights within the EEA.
  - ICAO agreed in 2016 on a Global Market Based Measures (GMBM). The principal is to offset the growth of CO_2 emissions post-2020 by airlines having to buy "emission units" generated by projects reducing CO_2 emissions in other sectors of the economy (e.g. renewable energies).
  - EU Commission is expected to propose a possible synchronization or replacement of the ETS with GMBM.

- To cut the emissions within the aviation sector itself is a huge challenge which has not been solved yet. In addition, the growing demand of Jet fuel increases the demand for crude oil, which results in increased production of other petroleum products ("the distillation curve problem"). They, in turn, will always be used in some other applications somewhere, resulting in further increased GHG emissions.

1) IEA 2016
2) IATA 2015
3) ICAO 2013

Biojet can only play a marginal role in decarbonising the aviation

- Price of the biojet is not likely to be competitive with conventional Jet A-1 near to medium term.
  - Fossil reference is at the level of 0,25 eur/l, whereas sustainable biojet could be produced at a price of 0,8-2,2 eur/l, thus a factor of 3-9 times higher.
- Not even the expected annual growth of the Jet demand (8-10 mill.tons/a) can be satisfied with the existing (< 1 mill.tons/a) or envisaged new biojet supply.
- Availability of sustainable feedstock is a challenge in quantities needed.

- ICAO's agreement in 2016 on a Global Market Based Measures (GMBM) indicates that the energy efficiency improvements are not expected be enough to reach the goal of carbon neutral aviation transport growth from 2020 onwards. At the same time it's evident that the world does not yet have a solution to reach the aviation 2050 target.

- Behavioural changes in person transport from air to rail (modal shift) is of paramount importance to cut aviation related GHG emissions to the extend needed.

- Efforts in R&D need to be multiplied from the current levels in helping to reach the decarbonisation targets.

EFFORTS TO IMPROVE ENERGY EFFICIENCY AND MODAL SHIFT NEEDS TO BE ACCELARATED

Jet demand in the Nordics is ca. 1,5% of the global

- National or Nordic level measures can only have marginal effect on overall GHG emissions, taking into consideration the global nature of the aviation.
- From purely climate perspective the most impactful measure would be a modal shift to rail on national and regional level. It would reduce both direct emissions and help in solving “the distillation curve problem”.
- A modal shift to rail would be most effective in densely populated regions, e.g. central and western Europe and between major Nordic towns.
- Modal shift would require a clearly increased service level of railroads, especially the speed of trains. Pricing of the externalities of the aviation would also be needed, especially on short flights, e.g. < 1 hr.

Table 3: Aggregated Nordic demand for jet fuel

Million 1	2010	2011	2012	2013	2014
Denmark	1,092	1,139	1,114	1,113	1,196
Sweden	1,050	1,136	1,087	1,118	1,014
Norway	1,014	1,004	1,041	1,159	1,184
Finland	849	957	923	931	906
Iceland	163	184	187	211	243
Total	4,169	4,419	4,353	4,532	4,543

Table 4: Projection of Nordic demand for jet fuel up until 2050

Million 1	2014	2020	2025	2035	2050
Denmark	1,196	1,414	1,1487	1,414	1,414
Sweden	1,014	1,199	1,260	1,199	1,199
Norway	1,184	1,400	1,471	1,339	1,399
Finland	906	1,072	1,126	1,071	1,071
Iceland	243	287	302	287	287
Total	4,543	5,372	5,646	5,369	5,369

Source: Sustainable jet fuel for aviation, Nordic perspectives on the use of advanced sustainable jet fuel for aviation, Wormsley et all.

Nordic Energy Outlook 2030: Maritime transport

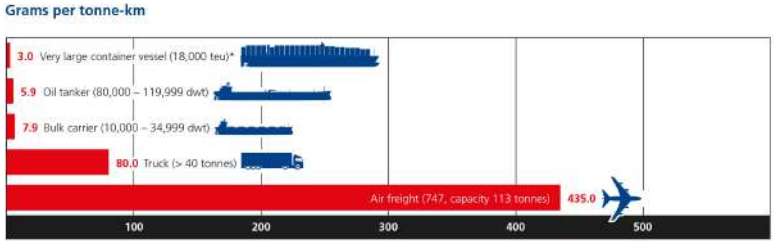
Maritime is an effective transport mode

- The international shipping is responsible for the carriage of ~90% of world trade
- Maritime transport emits ~1.000 mt/a CO_2e[1)] corresponding 2,5% of global GHG emissions in 2012
  - International shipping emissions are >800 mt/a CO_2e
- Total marine fuel consumption globally is estimated be >300 mt/a, of which international shipping ~270 mt/a. An increase to 320 mt is expected in 2020.
- Industry goal is a 50% CO_2 reduction per ton/km by 2050
- However, shipping emissions are predicted to **increase between 50% and 250%** by 2050 – depending on future economic and energy developments[2)]

Third IMO GHG Study 2014 CO_2e

Year	GlobalCO2e[2]	Total shipping	%of global	International shipping	%of global
2007	34,881	1,121	3.2%	903	2.6%
2008	35,677	1,157	3.2%	940	2.6%
2009	35,519	998	2.8%	873	2.5%
2010	37,085	935	2.5%	790	2.1%
2011	38,196	1,045	2.7%	871	2.3%
2012	39,113	961	2.5%	816	2.1%
Average	36,745	1,036	2.8%	866	2.4%

Comparison of typical CO_2 emissions between modes of transport



*Source: IMO GHG Study, 2009 (*AP Møller-Maersk, 2014)*

1) 3rd IMO GHG study 2014
2) EU Commission Climate Action

IMO[1)] is driving global maritime CO_2 reductions through international agreements

- In 2011, the IMO adopted the[2)]
  - Energy Efficiency Design Index (EEDI), which sets compulsory energy efficiency standards for new ships, and
  - Ship Energy Efficiency Management Plan (SEEMP), a management tool for ship owners.
- However, international discussions have yet to bring agreement on global market-based measures or other instruments that would cut emissions from the sector as a whole, including existing ships

The 10 most effective existing technical and operational measures to reduce CO_2 emissions from shipping

Solution	Relative CO_2 savings	Savings/Costs per ton CO_2	Take-up 2007	Take-up 2011
Speed reduction	17-34%	-280 €/t	0%	50%
Propeller & rudder upgrade	3-4%	-150 €/t	0%	0%
Hull coating	2-5%	-280 €/t	0%	50%
Waste heat recovery	2-6%	-60 €/t	0%	0%
Optimization of trim & ballast	1-3%	-200 €/t	0%	50%
Propeller polishing	1-3%	-280 €/t	75%	75%
Hull cleaning	1-5%	-200 €/t	75%	75%
Main engine tuning	1-3%	-250 €/t	75%	75%
Autopilot upgrade	1-1.5%	-280 €/t	75%	75%
Weather routing	1-4%	-280 €/t	75%	75%

CO_2 savings and costs compared to business as usual in2020 (source: Maddox 2012)

1) IMO = International Maritime Organization
2) EU Commission, Climate Action

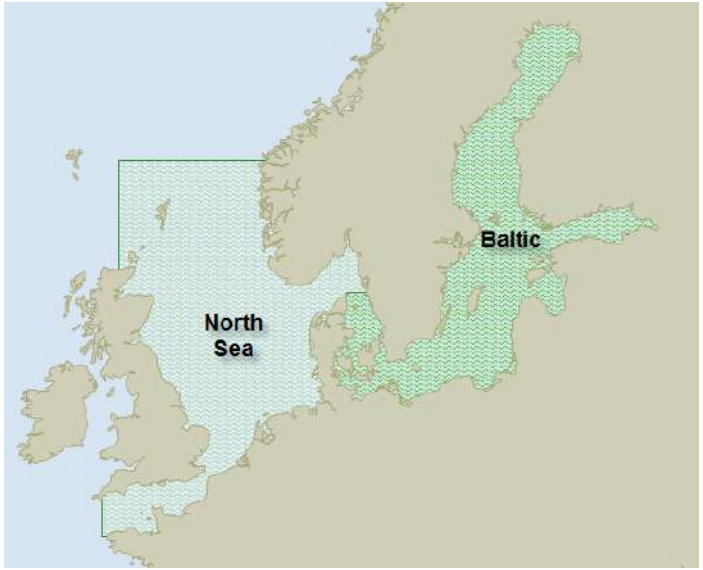
- Considerable GHG reduction potential exists through fuel saving techniques with little to no cost

- The EU strategy consists of 3 consecutive steps:
  - Monitoring, reporting and verification of CO_2 emissions from large ships using EU ports
  - Greenhouse gas reduction targets for the maritime transport sector
  - Further measures, including market-based measures, in the medium to long term

- National or Nordic decarbonisation efforts in maritime sector can only have a marginal impact, thus should not be prioritized by local governments. The focus should be set on such technology development which could offer attractive export possibilities for Nordic countries, e.g. in energy efficiency solutions.

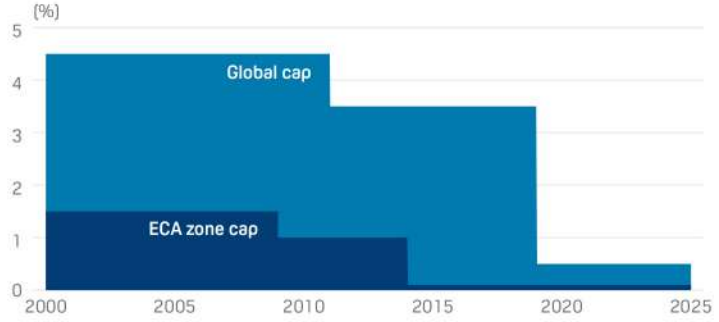
Global sulphur cap is expected to have major impact on fuels market – not only in Marine sector

- Sulphur Emission Control Areas (SECAs) or Emission Control Areas (ECAs) are sea areas in which stricter controls were established to minimize airborne emissions (SOx, NOx, ODS, VOC) from ships as defined by Annex VI of the 1997 MARPOL Protocol which came into effect in May 2005.
- Under the revised MARPOL Annex VI, the global sulphur cap will be reduced from current 3.50% to 0.50%, effective from 1 January 2020, subject to a feasibility review to be completed no later than 2018.
- The resulted cost increase in shipping is unknown, but is expected to be large. That in turn may trigger innovation in more energy efficient solutions.



- There are conflicting views whether the global refining capacity will be sufficient in 2020 to supply enough low sulphur products. Major difference lies in the assumption if the demand would be primarily filled by blends of several refinery streams, or mostly by middle distillates. A part of the market will convert to LNG.
  - IEA is expecting that majority of shippers will revert to marine gasoil (MGO), as happened in 2015 in ECA-areas, as being a less capital intensive option.
  - Another unknown variable is e.g. the amount of exhaust gas cleaning systems ("scrubbers") installed.
- In a constraint supply scenario in 2020 an increased use of naphtha/kerosene may be required
- Even if the capacity constraints could be overcome, the sulphur cap is likely to increase the prices of the road fuels as well.
- This will be an attractive business opportunity for Nordic oil refiners and several other industries offering energy efficiency solutions and scrubber technologies in the Maritime sector.

MARPOL ANNEX VI SULFUR LIMITS



Source: IMO

A KNOCK OUT EFFECT MAY EXPECTED IN THE GLOBAL ENERGY SYSTEM - INCLUDING ROAD FUELS

St1 Energy Outlook – sources of information

2030.se

BP Energy Outlook 2016, 2014

Center for Climate and Energy Solutions

Economic Information Office

Ekonomifakta.se

Energiläget 2014, Statens Energimyndighet

Energiläget 2014, Statens Energimyndighet

Energimyndigheten.se

ExxonMobil: Outlook for energy 2016

Fingrid Oyj

Finnish Energy

Finnish Forest Industries

Fossilfrihet på väg (regeringen.se)

http://www.asrc.albany.edu/people/faculty/perez/Kit/pdf/a-fundamental-look-at%20the-planetary-energy-reserves.pdf

Integrated Fuels and Vehicles Roadmap to 2030+, Roland Berger

Miljömagasinet.se

Ministry of employment and the economy of Finland

Ministry of Transport and Communications

Morgan Stanley Research

Natural Resources Institute Finland

Nord Pool

North European Oil Trade Oy

NVE

Petroleum & Biofuels Association Finland

Pira Energy Group: World Oil Market Forecast

Pöyry Finland Oy

Report: Bærekraftig skogbruk I Norge; Tomter & Dalen; 2014

SCB.se

Scenarier över Sveriges Energisystem, Statens Energimyndighet

Skatteverket.se

SSB: Nettoproduksjon av fjernvarme fordelt på varmesentraler

SSB; Energi balansen

SSB; Husholdninger (prosent), etter oppvarmingsutstyr, tid og statistikkvariabel

SSB; Landskogs takseringen

SSB; Produksjon, import, eksport og forbruk av elektrisk kraft

SSB; Statsregnskapet

Statgraft

Statistics Finland

Svebio.se

Svenska kraftnät

SvenskEnergi.se

Toyota

Trafa.se

Trafikverket.se

Transport emissions rising (EEA, 2015b)

Transport økonomisk institutt

Transportsyrelsen.se

Värmemarknad.se

Vindkraftbranschen.se

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