AIR POLLUTION EMISSION AND POPULATION EXPOSURE ASSESSMENT OF THE UPDATE OF THE FINNISH ENERGY AND CLIMATE STRATEGY

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Contents of the presentation

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• Environmental Impact Assessment of the Strategy
  – Background
  – Air pollution emissions
  – Population exposure to primary PM2.5
• Conclusions
Update of the Finnish Energy and Climate Strategy

• Update of the 2008 Climate Strategy to integrate the impacts of
  – Economic recession
  – Industrial factory closings in Finland
  – Latest outlook on bioenergy potential in Finland
  – Extension to 2030 (However, the EIA at the moment only for 2020)

• Two scenarios
  – Baseline to fulfill agreed EU targets:
    • Generally 20/20/20
    • More specifically for Finland: renewables target 38 %, non-ETS emissions -16%
  – With-Additional-Measures (WAM) to additionally include measures to reach the non-ETS sector goal (-16%) and better anticipate 80% reduction by 2050 (differs very little from Baseline in 2020)
    • Traffic mode changes and "eco-driving"
    • Stricter building energy regulation
Update of the Finnish Energy and Climate Strategy

CO₂-eq

Total emissions
- Baseline
- WAM

ETS sector emissions
- Baseline
- WAM

Non-ETS sector emissions
- Baseline
- WAM

Non-ETS target

Update of the Finnish Energy and Climate Strategy

Total primary energy

Traffic primary energy

Residential heating primary energy
EIA of the Energy and Climate Strategy

• Impacts of the Strategy on
  – Human health and welfare
  – Environment: soil, waters, air, flora, fauna, biodiversity
  – Urban structure, built environment, cultural heritage
  – Use of natural resources
  – Interactions between the above-mentioned

• Quantitative and qualitative assessments

• Most emphasis on:
  – Impacts on carbon sinks, e.g. carbon budgets of forest soils
  – Impacts on biodiversity
  – Life-cycle Impact Assessment (LCIA)
  – Air pollution emissions and population exposure
Finnish Regional Emission Scenario (FRES) model
Integrating policy analysis tool in the core of the Finnish Integrated Assessment Modeling (IAM) framework

EMEP / IIASA:
- European/global emissions
- Long-range transport (LRT)

Finnish Meteorol. Inst. (FMI):
- Dispersion modelling FIN (e.g. SILAM, UDM-FMI)
- Climate modelling (ECHAM-HAM, REMO)

Finnish Nat. Institute for Health and Welfare (THL):
- Health risk assessment PM

Technical Research Center of Finland (VTT)
- FIN activity projections (e.g. TIMES model)

Kuopio university, VTT etc.
- Emission measurements

FRES-model, SYKE

Emission module
- Emission factors, emission control technologies and costs
- Emission scenarios
- Activity pathways

Dispersion module
- Source-receptor matrices (FIN and LRT)
- Air pollution concentrations and depositions

Effect module
- Critical load exceedances
- PM and ozone exposure and health effects

SLCF module
- Radiative forcing (atmosphere, ice and snow) of Finnish emissions in the Arctic and other areas of interest (?)
- Under development!!
  First results expected during 2013

Finnish Nat. Institute for Health and Welfare (THL):
- Health risk assessment PM
Finnish Regional Emission Scenario (FRES) model

www.environment.fi/syke/pm-modeling


- Comprehensive and congruent calculation for primary PM and gases
  - primary PM (TSP, PM$_{10}$ - 2.5 - 1 - 0.1, chemical composition, incl. BC/OC/sulfates)
  - SO$_2$, NO$_x$, NH$_3$, NMVOCs
  - GHGs

- Abatement technologies and costs

- Aggregation: 154 sectors, 15 fuels (GAINS compatible)

- Large point sources (>200), small point sources (> 200), area emissions (1 × 1km$^2$)

- Several emission heights

- Dispersion with s-r matrices (10 × 10km$^2$ and 1 × 1km$^2$)

- LRT from EMEP

- Databases of population and critical loads
Air pollution emissions and pop. exposure

Emissions of
- SO\textsubscript{2}
- NO\textsubscript{x}
- Black carbon (BC)
- Primary PM2.5

Population exposure of primary PM2.5
Air pollution emissions, SO2 (ktons/a)

Emissions decrease from 2010 due to
- Lesser use of peat, oil and coal
- IE directive

Very little difference between Baseline and WAM
Air pollution emissions, NOx (ktons/a)

Emissions decrease from 2010 due to
- Traffic car fleet renewal
- Lesser use of peat, oil and coal
- IE directive

Very little difference between Baseline and WAM
Emissions decrease from 2010 due to
- Traffic car fleet renewal
- Wood stove stock renewal
- IE directive (+ national legislation) to energy plants < 50 MW

Slight decrease from Baseline to WAM
- Less traffic fuel consumption due to measures on traffic mode changes and "eco-driving"
- Less house heating need due to stricter building regulation

Primary energy use of fuels (PJ/a)
Air pollution emissions, BC (ktons/a)

Emissions decrease from 2010 due to
• Traffic car fleet renewal
• Wood stove stock renewal

Slight decrease from Baseline to WAM
• Less traffic fuel consumption due to measures on traffic mode changes and "eco-driving"
• Less house heating need due to stricter building regulation
Primary PM dispersion in FRES

1. Long-range transport impacts with EMEP 50 km resolution – Not used in this
2. Finnish high-stack PM emissions with 10 km resolution
3. Finnish near-ground PM emissions with 1 km resolution

1. EMEP source-receptor matrices (SRM) 50 x 50 km
2. Lagrangian SILAM based SRM 10 x 10 km
3. Gaussian UDM-FMI based SRM 1 x 1 km
Primary PM2.5 concentrations

Primary PM2.5 SRMs at 1 x 1 km resolution were applied to Finnish near ground emissions

Modelled primary PM2.5 concentrations in 2020 Baseline (ng/m3)

Road traffic

Machinery

Residential wood combustion
Primary PM2.5 concentrations

Primary PM2.5 SRMs at 10 x 10 km resolution were applied to Finnish high stack emissions

Modelled primary PM2.5 concentrations in 2020 Baseline (ng/m3)

Energy production, industry and processes
Population exposure to primary PM2.5 ($\mu g/m^3$)

Population exposure decrease from 2010 due to
- Traffic car fleet renewal
- Wood stove stock renewal

Slight decrease from Baseline to WAM
- Less traffic fuel consumption due to measures on traffic mode changes and "eco-driving"
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Primary energy use of fuels (PJ/a)
Conclusions

- The strategy scenarios are rather conservative and industry-driven. Challenging to get to an 80% pathway by 2050.

- Air pollution study demonstrates a decrease in emissions and population exposure from 2010 to 2020 thanks to emission legislation and cleaner fuels.

- Baseline - WAM scenario comparison demonstrates positive impacts of traffic- and residential-related NTMs (e.g. traffic mode changes, "eco-driving", stricter building efficiency regulations) on the emissions and population exposure to PM2.5 and BC.

- Potential trade-offs from residential wood heating:
  - Increased population exposure and negative health impacts from urban emissions.
  - Increased climate impacts from winter-time BC emissions (especially through snow albedo effects).
Thank You

www.environment.fi/syke/pm-modeling

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