



LECo

Local Energy Communities



**Northern Periphery and
Arctic Programme**
2014–2020



EUROPEAN UNION

Investing in your future
European Regional Development Fund

Community Energy Planning



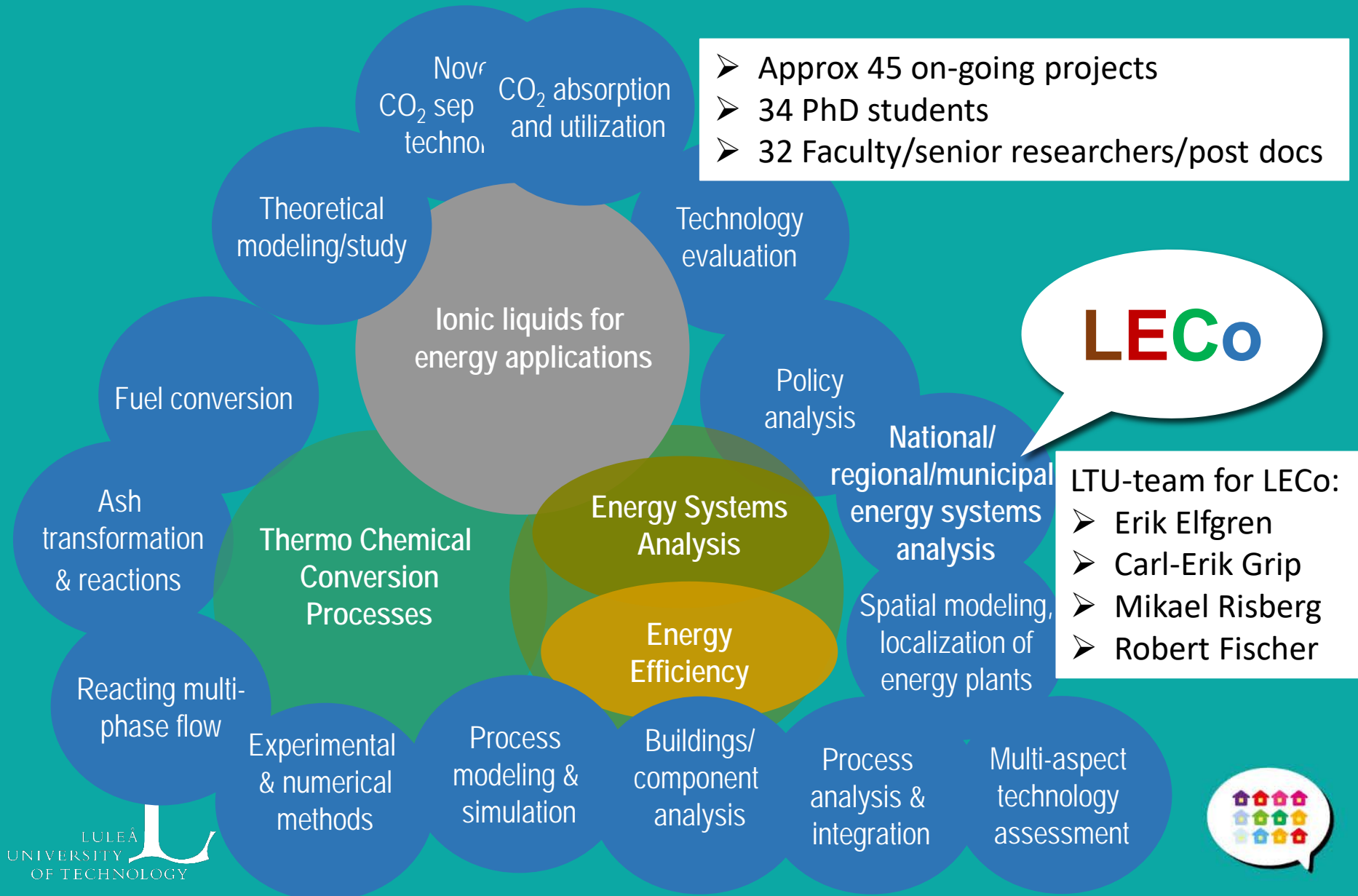
Robert Fischer

Phd-candidate, Luleå university of technology (LTU)

LECo-online conference 11th nov 2020



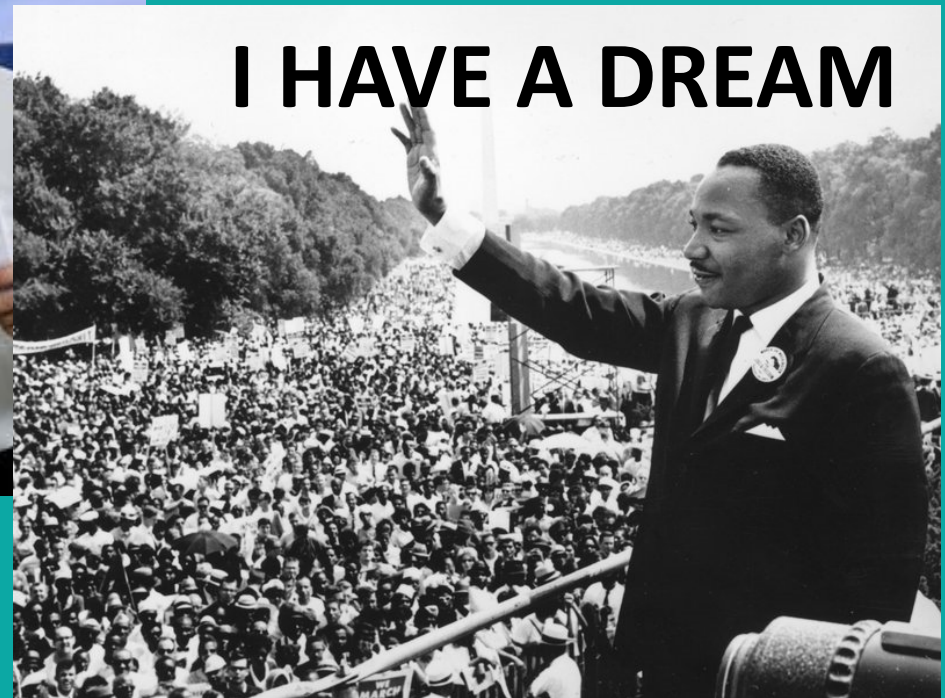
LTU: Competence and research areas



How does a community energy project start?



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Outline

- A typical LECo community
- **Which energy projects** found its way into Action Plans of LECo communities?
- **Which tools** are available for energy planning and how do they support the planning process?
- **Which outcomes** do we get with energy planning?



A typical LECo "community" (Finland, Sweden, Ireland, Germany)

Small towns (urban):

- groups representing a suburb or a distinct part of a suburb (neighborhood), one street, a community building.

Rural:

- a farm or a group of farmers, a community building, a village with a few 100 households or smaller.



Which energy projects found its way into Action Plans of LECo communities?

- **Behavior change:** Information campaigns, capacity building, gamification (competition in energy saving)
- **Energy efficiency:** Lighting (LEDs), building envelope (insulation), appliances (AAA+), heating controls
- **Heating technology:** Heat pumps, solar thermal, renewable fuels (woodchips, pellets)
- **Renewable energy:** Solar PV (rooftop, ground-mounted), biogas, biofuels, wind energy, hydropower
- **(Transport:** car-sharing (behavior), electrification)
- **(District heating** (waste heat, biofuels, heat pumps))



Which factors influenced the choice for a LECo project?

...well, it depends:

- **Experience in the community** with similar projects
- **Socio-economic situation** in the community
- Age, standard of the **building stock**
- The **country's policies**, availability of **funding** for community energy projects and **technical support** from e.g. independent energy agencies.
- **Support from local politicians, authorities?**

AND – NOT TO FORGET:

- **Community energy projects are citizen driven!**



Which tools are available for energy planning and how do they support the planning process?

There are many challenges from the early idea of one individual (“I have a dream”)... to a bankable project... to a finished project... to proper O&M... therefore:

- Buildup of experience and creating a feeling of “Yes, we can!” with successful small projects is crucial.
- When it comes to bigger projects, then a professional approach with **feasibility studies**, project planning, project and financial management, etc. is expedient.



Which tools? A “tool” is not always a difficult to learn and expensive software application:

Looking inside – assessing the “as is”- situation with questionnaires, interviews, at seminars:

- Building stock, standard, heating systems used, ...
- Interest, skills and experience in the community...
- Transport situation for commuting, school busses, etc.
- Results: Data. Visualization of and learning about the “as-is” situation as well as comparing with similar communities

Looking around – key factors influencing a community from the outside: LECo conducted PESTLE analysis:

- Political, Economic, Sociological, Technological, Legal and Environmental key factors.

Find more details e.g. here:

- <https://www.cipd.co.uk/knowledge/strategy/organisational-development/pestle-analysis-factsheet>



Which tools? ...software...

Selection criteria of software for LECo included:

- Free or low cost; easy to learn; support is available
- Low requirements on data input
- Covers electricity, heating and transport sectors
- Provides hourly results, ideally over a one year period.
- Proven and frequently used for similar purposes



Which tool for LECo:

EnergyPLAN

Advanced energy
system analysis
computer model

Fulfills the mentioned criteria and:

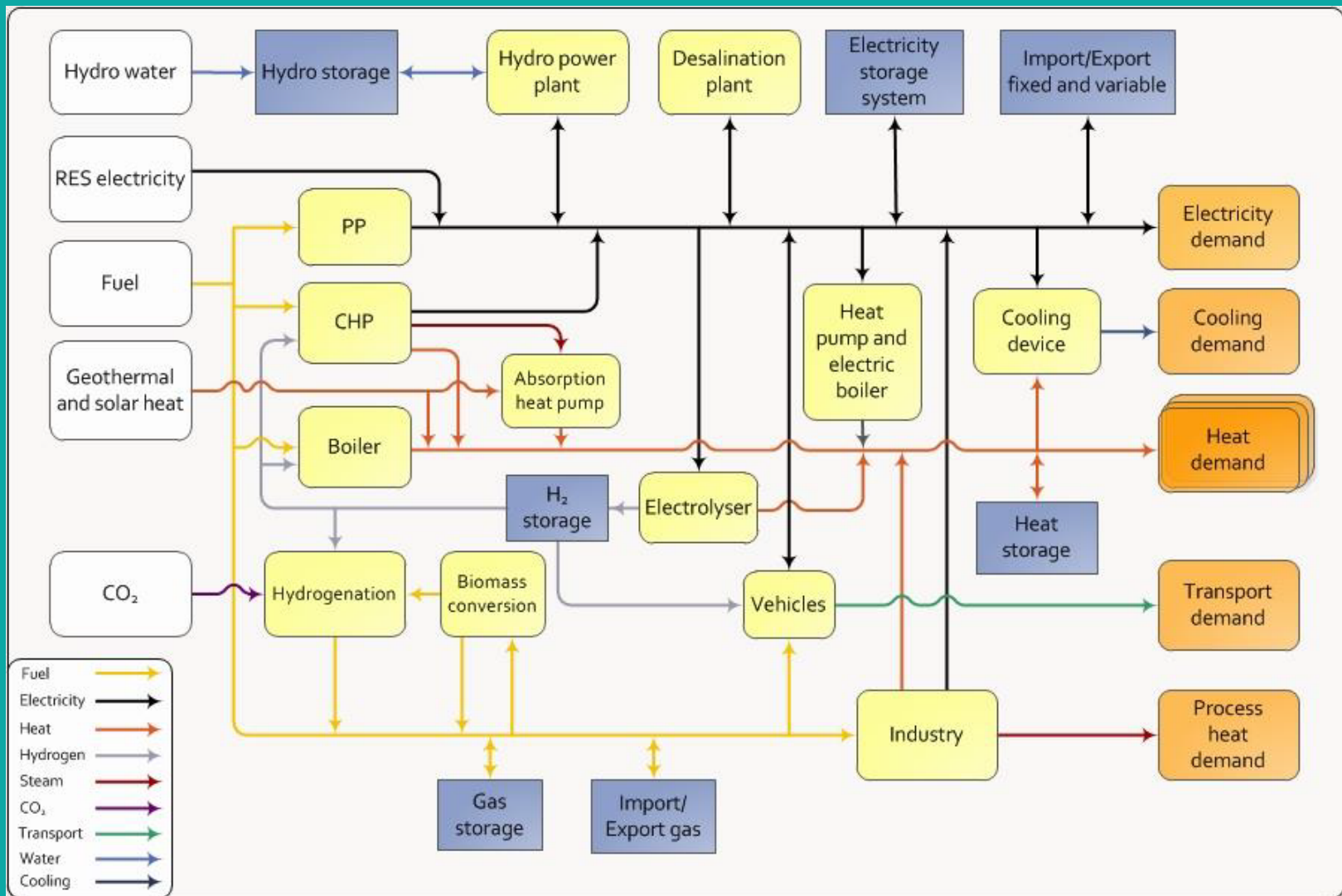
- A reference case is relatively "easy" to model.
- Allows quick simulation of many options.
- Delivers results in graphical and tabular format.
- Calculates energy balances, energy system costs and CO2-emissions, etc.

EnergyPLAN was developed by the Sustainable Energy Planning Research group at Aalborg University, DK.

Download from: <https://www.energyplan.eu/>



EnergyPLAN – Energy system model:



EnergyPLAN user interface: Demand

EnergyPLAN 14.0: Pitea_case01_v1_00_Base2015TRA_cost2015_EUR.txt

EnergyPLAN 13.3: Pitea_case01_v1_00_Base2015TRA_cost2015_EUR.txt

Home Add-On Tools Help

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Warnings Appear Here:

Overview

- Demand
 - Electricity
 - Heating**
 - Cooling
 - Industry and Fuel
 - Transport
 - Desalination
- Supply
 - Heat and Electricity
 - Central Power Production
 - Variable Renewable Ele
 - Heat Only
 - Fuel Distribution
 - Waste
 - Liquid and Gas Fuels
 - Biofuels
 - Biogases
 - Hydrogen
 - Electrofuels
 - Gas to Liquid
 - CO2
- Balancing and Storage
 - Electricity
 - Thermal
 - Liquid and Gas Fuel
- Cost
 - General
 - Investment and Fixed O
 - Heat and Electricity
 - Renewable Energy
 - Liquid and Gas Fuel
 - Heat Infrastructure
 - Road Vehicles
 - Other Vehicles
 - Water
 - Additional
- Fuel
 - Variable DM
 - External Electricity Mark
- Simulation
- Output
 - Overview

Demand

Electricity Heating Cooling Industry and Fuel Transport Desalination

Total Heat Demand* : 488.89 Demand Per Building* : 24000 kWh/year Indv. heated households: 10858 Units

Individual Heating:

GWh/year	Fuel Input	Efficiency Thermal	Heat Demand	Efficiency Electric	Capacity Limit*	Estimated Electricity Production	Solar Thermal		Resulting Fuel Consumption*
							Heat Storage*	Share*	
Distribution: SE_Lulea_hour_2015_HDD17HW_ind_SMHI.txt									
Coal boiler :	0	0.7	0.00				0	1	0.00
Oil boiler :	1.98	0.8	1.58				0	1	1.98
Ngas boiler :	0	0.9	0.00				0	1	0.00
Biomass boiler :	70	0.9	63.00				0	1	70.00
H2 micro CHP :		0.5	0	0.3	1	0.00	0	1	0.00
Ngas micro CHP :		0.5	0	0.3	1	0.00	0	1	0.00
Biomass micro CHP :		0.5	0	0.3	1	0.00	0	1	0.00
Heat Pump :			50	2.5	1	-20.00	0	1	0.00
Electric heating :			146		1	-146.00	0	1	0.00
Total Individual:			260.58			-166.00			71.98

District Heating:

	Group 1:	Group 2:	Group 3:	Total:	Distribution:
Production:	11.3	257.3	0	268.60	Change SE_Lulea_hour_2015_HDD17HW_DH_SMHI.txt
Network Losses:	0.15	0.15	0.1		
Heat Demand:	9.61	218.71	0.00	228.31	

Diagram:

EnergyPLAN user interface: Supply

EnergyPLAN 14.0: Pitea_case01_v1_00_Base2015TRA_cost2015_EUR.txt

EnergyPLAN 13.3: Pitea_case01_v1_00_Base2015TRA_cost2015_EUR.txt

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Demand Supply Balancing and Storage Cost Simulation Output

Heat and Electricity Central Power Production Variable Renewable Electricity Heat Only Fuel Distribution Waste Liquid and Gas Fuels CO2

Variable Renewable Electricity

Renewable Energy Source	Capacity: kW	Stabilisation share	Distribution profile*	Estimated Production GWh/year	Correction factor	Estimated Post Correction production	Estimated capacity factor
River Hydro	40905	0	Change SE_SE1_hour_hj	187.57	0.38	221.63	0.62
Photo Voltaic	256	0	Change SE_Lulea_AE_VI	0.33	-0.6	0.28	0.12
Wind	145000	0	Change SE_SE1_hourly_	450.98	-0.4	385.88	0.30
Offshore Wind	0	0	Change SE_SE1_hourly_	0.00	0.25	0.00	0.00
Offshore Wind	0	0	Change dkvind-offshore.b	0.00	0	0.00	0.00
Wave Power	0	0	Change Hour_wave_200	0.00	0	0.00	0.00
CSP Solar Power	0	0	Change Hour_solar_prod1	0.00	0	0.00	0.00

Concentrated Solar Power

Annual solar input	0	GWh/year	Change	hour_solar_prod1.txt
Storage capacity	0	MWh		
Storage efficiency (losses)	0.5	Percent pr. hour		
Power capacity	0	kW-e	Estimated Production GWh/year	Estimated Storage loss GWh/year
Power efficiency	0.3		0.00	0.00
Stabilisation Share	0			



EnergyPLAN user interface: Cost

EnergyPLAN 14.0: Pitea_case01_v1_00_Base2015TRA_cost2015_EUR.txt

EnergyPLAN 13.3: Pitea_case01_v1_00_Base2015TRA_cost2015_EUR.txt

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Balancing and Storage

- Electricity
- Thermal
- Liquid and Gas Fuel

Cost

- General
- Investment and Fixed OM
 - Heat and Electricity
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- Variable OM
- External Electricity Market

Cost

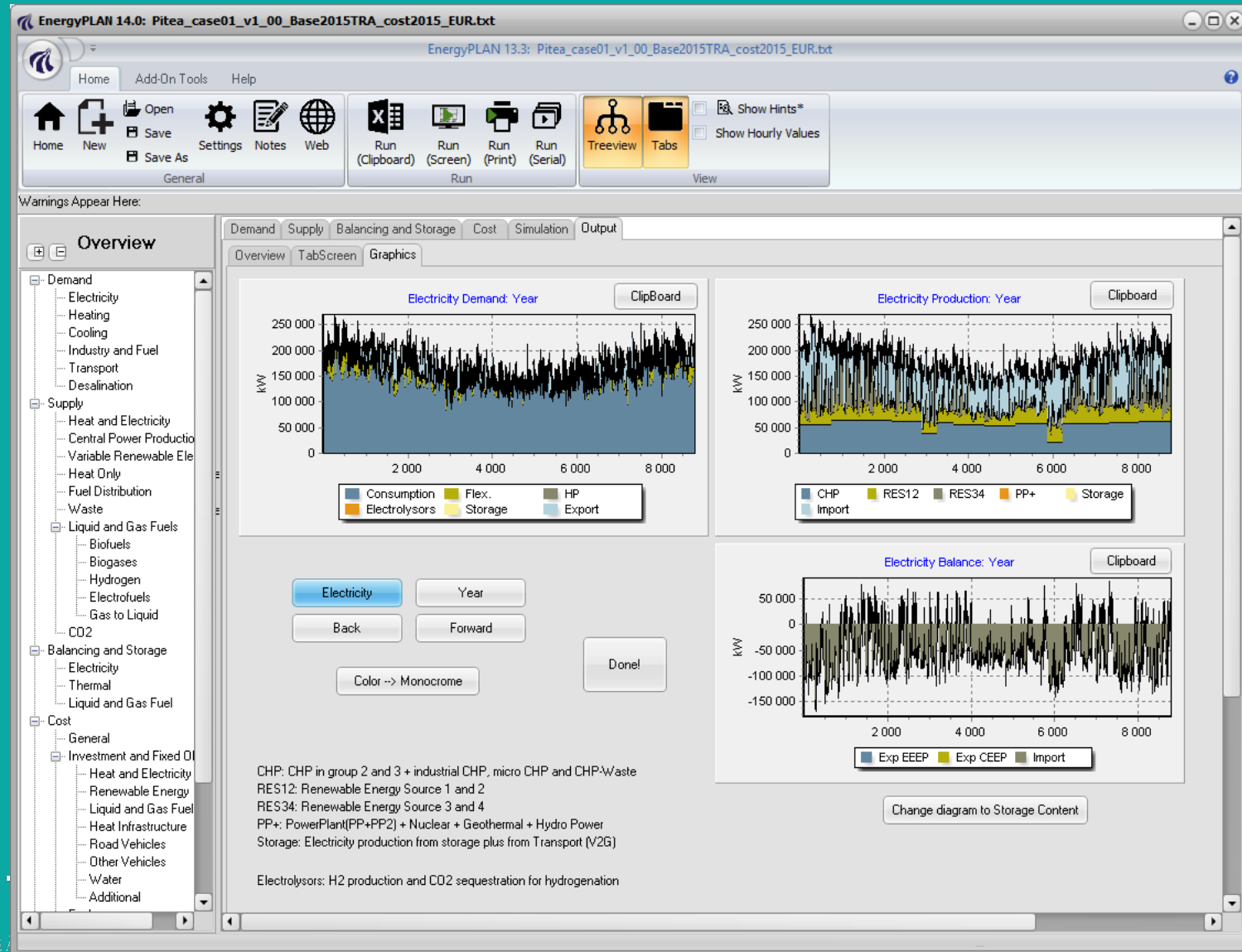
General Investment and Fixed OM Fuel Variable OM External Electricity Market

Heat and Electricity Renewable Energy Liquid and Gas Fuels Heat Infrastructure Road Vehicles Other Vehicles Water Additional

Prod. type	Unit	Investment	Period	O. and M.	Total Inv. Costs	Annual Costs (kEUR/year)	
		kEUR pr. Unit				Years	% of Inv.
Wind	145000 kW-e	1.07	25	3.21	155150	15795	4980
Wind offshore	0 kW-e	2.49	25	2.07	0	0	0
Photo Voltaic	256 kW-e	1.25	30	1	320	31	3
Wave power	0 kW-e	6.4	20	4.1	0	0	0
Tidal Power	0 kW	6.5	20	3.6	0	0	0
CSP Solar Power	0 kW	5.6	30	4	0	0	0
River of hydro	40905 kW-e	5.5	60	1.5	224978	20364	3375
Hydro Power	0 kW-e	2.45	60	1.25	0	0	0
Hydro Storage	0 MWh	7.5	60	1.5	0	0	0
Hydro Pump	0 kW-e	0.6	50	1.5	0	0	0
Geothermal Electr.	0 kW-e	5.53	30	1.4	0	0	0
Geothermal Heat	0 GWh/year	250	25	2.45	0	0	0
Solar thermal	0 GWh/year	425	30	0.13	0	0	0
Heat Storage Solar	0 MWh	0.5	30	0.7	0	0	0
Indust. Excess Heat	257 GWh/year	30	30	1	7719	751	77



EnergyPLAN user interface: Outputs



EnergyPLAN user interface: Outputs

Results

EnergyPLAN model 14.2
 Technical regulation no. 2
 Critical Excess Regulation Strategy: 000000000

Total Calculation Time: 12:00:00
 Loading of Data: 12:00:00
 Calculating Strategy 1: 12:00:00
 Calculating Strategy 2: 12:00:00
 Calculating HeatStorage: 12:00:00
 Calc. economy and Fuel: 12:00:00

ANNUAL CO2 EMISSIONS (kt): 93 729
 CO2-emission (total): 128 561
 CO2-emission (corrected): 128 561

SHARE OF RES (incl. Biomass):
 RES share of elec. prod: 49.6 percent
 RES share of elec. prod: 47.2 percent
 RES electricity prod: 607.79 GWh/year

ANNUAL FUEL CONSUMPTIONS (GWh/year):
 Total: 110580.00
 Coal: 999.46
 Gas: 0.00
 Fuel (incl. Biomass excl. RES): 999.46
 Fuel Consumption (incl. RES): 999.46
 Fuel Consumption (corrected): 1791.04
 Coal Consumption: 0.00
 Oil Consumption: 258.86
 Gas Consumption: 45.30
 Biomass Consumption: 87.52
 Nuclear Fuel Consumption: 0.00
 Waste Input: 0.00
 725 Pre Load Hours: 1.00

ANNUAL COSTS (k EUR):
 Fuel ex. Res exchange: 18970
 Coal: 13
 Gas/Diesel: 1597
 Petrol/JR: 276
 Gas handling: 276
 Biomass: 276
 Food income: 276
 Waste: 276

NGas Exchange costs: 2479
 Marginal operation costs: 34
 Electricity exchange: 14539
 Import: 14539
 Export: -14539
 Net income: 14539
 Fixed exp/imp: -14539

CO2 emission costs: 0

Variable costs: 35941
 Fixed operation costs: 71411
 Annual investment costs: 153020
 TOTAL ANNUAL COSTS: 260372

MONTHLY AVERAGE VALUES (kW):
 January: 166759
 February: 166929
 March: 151878

Electr. Elec. dem. Fixed Demand Cooling Exp/Imp DW River
 Demand Cooling Exp/Imp Demand Electr. Ele

TOTAL FOR ONE YEAR (GWh/year):
 Annual: 1287.00
 Electr. Elec. dem. Fixed Demand Cooling Exp/Imp DW River
 Demand Cooling Exp/Imp Demand Electr. Ele

MONTHLY AVERAGE VALUES (kW):
 January: 166759
 February: 166929
 March: 151878

OVERVIEW OF INVESTMENT COSTS Interest Rate: 9.0%

Costs (k EUR)	Total Inv Costs	Annual Inv Costs	Fixed O&M
Solar thermal	0	0	0
Small CHP units	0	0	0
Heat Pump gr. 1	0	0	0
Heat Storage CHP	0	0	0
Large CHP units	0	0	0
Heat Pump gr. 2	0	0	0
Heat Storage Solar	0	0	0
Boiler gr. 2, and 3	72450	7992	3998

FUEL BALANCE

Primary Energy	DHP	CHP2	CHP3	Boiler2	Boiler3
Coal	0.00	0.00	0.00	0.00	0.00
Oil	0.13	0.00	0.00	0.00	0.00
Gas	0.00	0.00	0.00	0.00	0.00
Biomass	12.43	0.00	0.00	0.00	0.00
Renewable	0.00	0.00	0.00	0.00	0.00
H2 etc.	0.00	0.00	0.00	0.00	0.00
Biofuel	0.00	0.00	0.00	0.00	0.00
Nuclear/CCS	0.00	0.00	0.00	0.00	0.00

Input Pitea_case01_v1_00_Base2015TRA_cost2015_EUR.txt The EnergyPLAN model 14.1

Electricity demand (GWh/year): Flexible demand 0.00
 Fixed demand: 1287.00
 Electric heating + H166.00
 Electric cooling: 0.00

Capacities kW-e kJ/s elec. Ther COP
 Group 2: CHP 0 0 0.40 0.50
 Heat Pump 0 0 0.40 0.50
 Boiler 103500 0.90
 Group 3: CHP 0 0 0.40 0.50
 Heat Pump 0 0 0.40 0.50
 Boiler 0 0 0.90
 Condensing 0 hour_nordpool_elspot-price

Regulation Strategy/Technical regulation no. 2
 CEEP regulation: 000000000
 Minimum Stabilisation share: 0.00
 Stabilisation share of CHP: 0.00
 Minimum CHP gr 3 load: 0 kW
 Minimum PP: 0 kW
 Heat Pump maximum share: 0.00
 Maximum import/export: 99999999 kW

Fuel Price level:
 Capacities Storage Efficiency
 kW-e MWh elec. Ther.
 Hydro Pump: 0 0 0.80
 Hydro Turbine: 0 0.90
 Electrol. Gr.2: 0 0 0.80 0.10
 Electrol. Gr.3: 0 0 0.80 0.10
 Electrol. trans.: 0 0 0.80
 Ely. MicroCHP: 0 0 0.80
 CAES fuel ratio: 0.000

River Hydro: 40995 kW 221.63 GWh/year 0.00 Grid
 Photo Voltaic: 256 kW 0.28 GWh/year 0.00 Stabli-
 Wind: 145000 kW 385.88 GWh/year
 Offshore Wind: 0 kW 0 GWh/year
 Hydro Power: 0 kW 0 GWh/year
 Geothermal/Nuclear: 0 kW 0 GWh/year

Heat storage: gr.2: 0 MWh gr.3: 0 MWh
 Fixed Boiler: gr.2: 0.0 Per cent gr.0: 0.0 Per cent

Output specifications Pitea_case01_v1_00_Base2015TRA_cost2015_EUR.txt The EnergyPLAN model 14.1

Output

District Heating Production

District	Gr. 1				Gr. 2				Gr. 3				RES specification						
	heating	Solar	CHSP	DHP	heating	Solar	CHSP	CHP	HP	ELT	Boiler	EH	Storage	Balance	RES1	RES2	RES3	RES4	Total
	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	MW	MW	MW	MW	MW
January	2153	0	0	2153	49033	0	49951	0	0	0	0	0	0	-918	0	0	0	0	24
February	1753	0	0	1753	39915	0	40663	0	0	0	0	0	0	-748	0	0	0	0	25
March	1585	0	0	1585	36091	0	36767	0	0	0	0	0	0	-676	0	0	0	0	26
April	1377	0	0	1377	31360	0	31947	0	0	0	0	0	0	-587	0	0	0	0	23
May	1117	0	0	1117	25445	0	23253	0	0	0	0	0	0	-368	0	0	0	0	23
June	774	0	0	774	17628	0	17969	0	0	0	0	0	0	-330	0	0	0	0	20
July	612	0	0	612	13938	0	14199	0	0	0	0	0	0	-261	0	0	0	0	18
August	592	0	0	592	13470	0	13722	0	0	0	0	0	0	-252	0	0	0	0	20
September	821	0	0	821	18896	0	15109	0	0	0	0	0	0	-193	0	0	0	0	27
October	1352	0	0	1352	30787	0	31363	0	0	0	0	0	0	-577	0	0	0	0	32
November	1517	0	0	1517	34536	0	35183	0	0	0	0	0	0	-647	0	0	0	0	30
December	1792	0	0	1792	40808	0	41573	0	0	0	0	0	0	-764	0	0	0	0	26
Average	1206	0	0	1206	29292	0	29292	0	0	0	0	0	0	-527	0	0	0	0	25
Maximum	3254	0	0	3254	74089	0	75477	0	0	0	0	0	0	0	0	0	0	0	41
Minimum	429	0	0	429	9763	0	9946	0	0	0	0	0	0	-4541	0	0	0	0	3
Total for the whole year	GWh/year 11.30	0.00	0.00	11.30	257.30	0.00	0.0025730	0.00	0.00	0.00	4.63	0.00	-4.63	0.00	0.00	0.00	0.00	0.00	0.00

Own use of heat from industrial: 4491.00 GWh/year

FUEL BALANCE (GWh/year):
 DHP CHP2 CHP3 Boiler2 Boiler3 F

	Coal	Oil	Gas	Biomass	Renewable	H2 etc.	Biofuel	Nuclear/CCS
Total	12.56	-	-	5.14	-	-	-	-

ANNUAL COSTS (1000 EUR)
 Total Fuel ex Ngas exchange = 18890
 Uranium = 0
 Coal = 0
 Fuel/Oil = 9
 Gas/Diesel = 123
 Petrol/JP = 15972
 Gas handling = 0
 Biomass = 2785
 Food income = 0
 Waste = 0

Total Ngas Exchange costs = 2479
 Marginal operation costs = 34
 Total Electricity exchange = 14539
 Import = 14539
 Export = -14539
 Bottleneck = 0
 Fixed imp/exp = 0

Total CO2 emission costs = 0
 Total variable costs = 35941
 Fixed operation costs = 71411
 Annual investment costs = 153020
 TOTAL ANNUAL COSTS = 260372

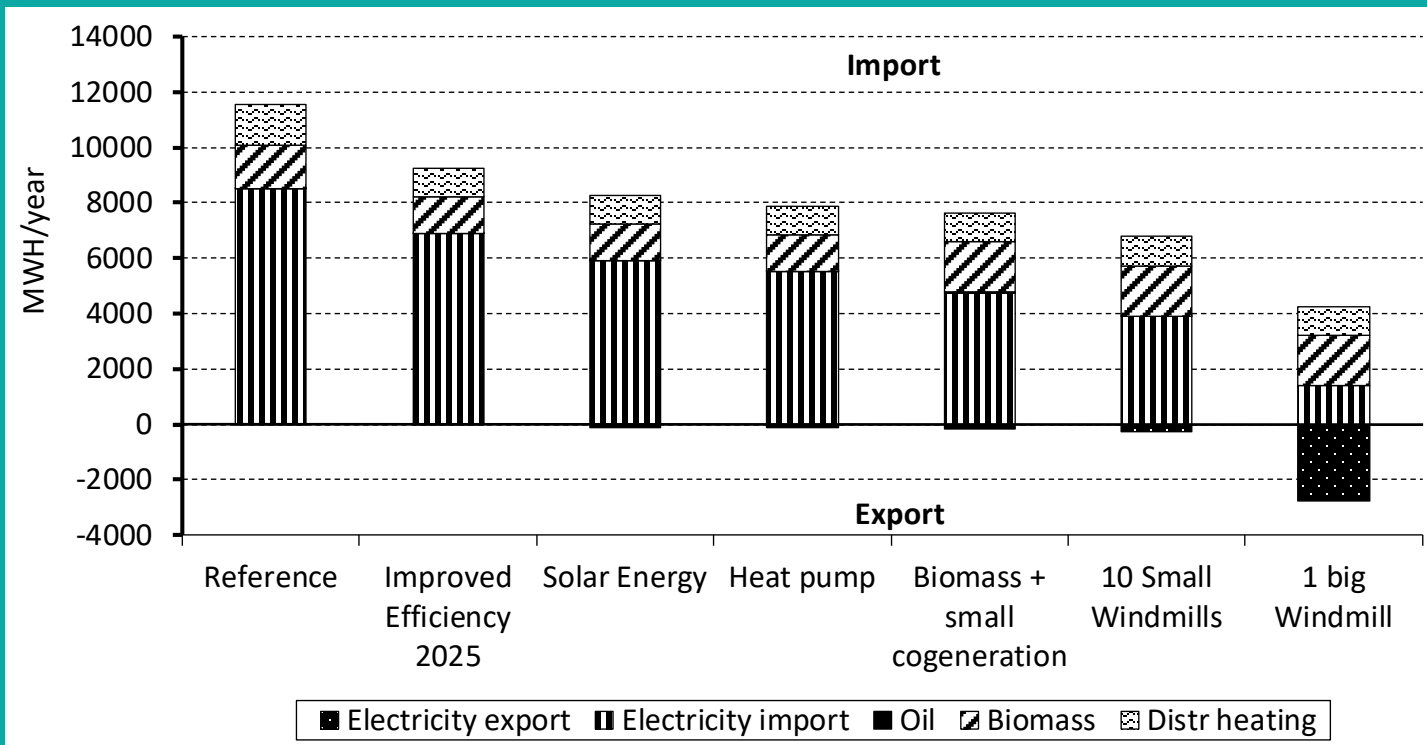
RES Share: -69.6-Percent of Primary Energy/47.2-Percent of Electricity -607.8-GWh electricity from RES

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10-november-2020 [14:57]

EnergyPLAN: Studying scenarios

Process: Stepwise implementation: Reference case → Improved Efficiency → Solar Energy → Heat pump → Biomass + small cogeneration → Wind power with 10 small wind mills → 1 big wind mill.



EnergyPLAN model and scenarios for Vuollerim, Jokkmokk.

Report in LECO deliverable T2.5.3.

By Carl-Erik Grip and Silva Hermann



Which outcomes did we get with energy planning for LECo-WPT2.

13 community Sustainable Energy Action Plans (cSEAPs) 3 for Finland, 5 for Ireland, 5 for Sweden. **Content:**

- Policy and regulatory framework
- Funding sources
- RE supply potentials
- Energy system and scenarios:
 - Input data
 - Reference energy system
 - Scenario assumptions
 - Scenario results
- Action Plan

WP T2.6. cSEAP – Eskola, Kannus

1 Introduction

Eskola is a village which is a part of the city of Kannus situated in the Central Ostrobothnia region in Western Finland. Eskola has a population of 500. There are three major industrial workplaces in Eskola: a window and door factory, a sawmill and a concrete foundry. Although Eskola is it is a rural village, there is very little agriculture in the village (Figure 1).



Figure 1: Village of Eskola

2 Policy framework

Finlands National Energy and Climate Strategy for 2030 targets an 80–95% reduction in greenhouse gas emissions by 2050 (tem.fi 2017). The Strategy promotes decentralised electricity and heat production based on renewable energy. Wood heating in rural areas and urban centres are supported, replacing fossil-based heating and reducing electricity demand for heating.

Municipal councils prepare local master plans, which adhere to regional plans and direct the preparation of local detailed land use plans.

The regional plan for Central Ostrobothnia 2018–2021 proposes the increased production of renewable energy, especially wind power and the usage of wood fuel.

3 Funding sources

Most central support instruments for energy investments in Finland are feed-in tariffs, emission trading, energy taxation, and investment grants (“energy aid”). Small-scale production of electricity has been promoted and barriers for it removed (Table 1).

Table 1: Support mechanisms improve the economic profitability of small-scale energy production

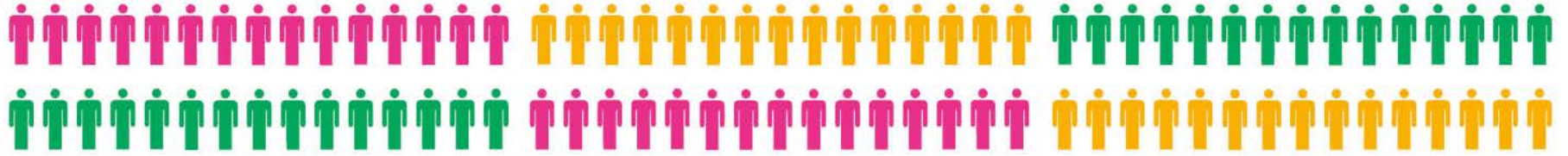
The aid beneficiary	Publicly financed economic incentive for small-scale production (2014)	
Household	Tax credit for domestic projects, 45% of labor costs under certain conditions	Exemption for duty on electricity for systems <50 kW, share ca. 20% of the total price of used electricity (energy, transmission and taxes)

In conclusion:

Which outcomes can we expect from community energy planning?

- **Inside:** Detailed understanding of energy use, behaviour, potentials for energy saving.
- **Outside:** Key factors influencing a community from the outside (PESTLE).
- **Learning** takes place during the entire process.
- A **reference case** of the community energy system
- **Scenario results**, including technical and financial parameters.
- **Energy Action Plan**





Thank you for your interest!

Kiitos! Danke! Tack!

Your questions?





The Project Partners

Centria University of Applied Sciences (Lead Partner) (FIN), Western Development Commission (IRL),
The Gaeltacht Authorigy (IRL), Luleå University of Technology (SWE),
Jokkmokk Community (SWE), Arctic University of Norway (NOR), Renewable Energies Agency (GER)

