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University of Applied Sciences

Energie Kenniscentrum

The project Flexi-Grow

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Background

Study Groningen 2035

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In 2035, the city of Groningen wants to be fully renewable, on any moment on the year.

1. **Reality check – can it happen?**
2. **Inspiration for further research**
3. **Focus on energy Infrastructure**

"No shale gas, no wind turbines, just solar PV on our roofs will solve our energy challenges"

Energy in city of Groningen

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Three scenario's, existing technology

Electricity and Heat (= Gas)

Actual data from 2012 – translated towards 2035

Annually: 1% energy saving for heat, 1% increase for power

	Solar-PV	Wind	Biogas
All-electric	X	X	
All-gas			X

All-electric electric heat pumps
All-gas (micro-) cogeneration

Gas (heat) and electricity demand in 2012

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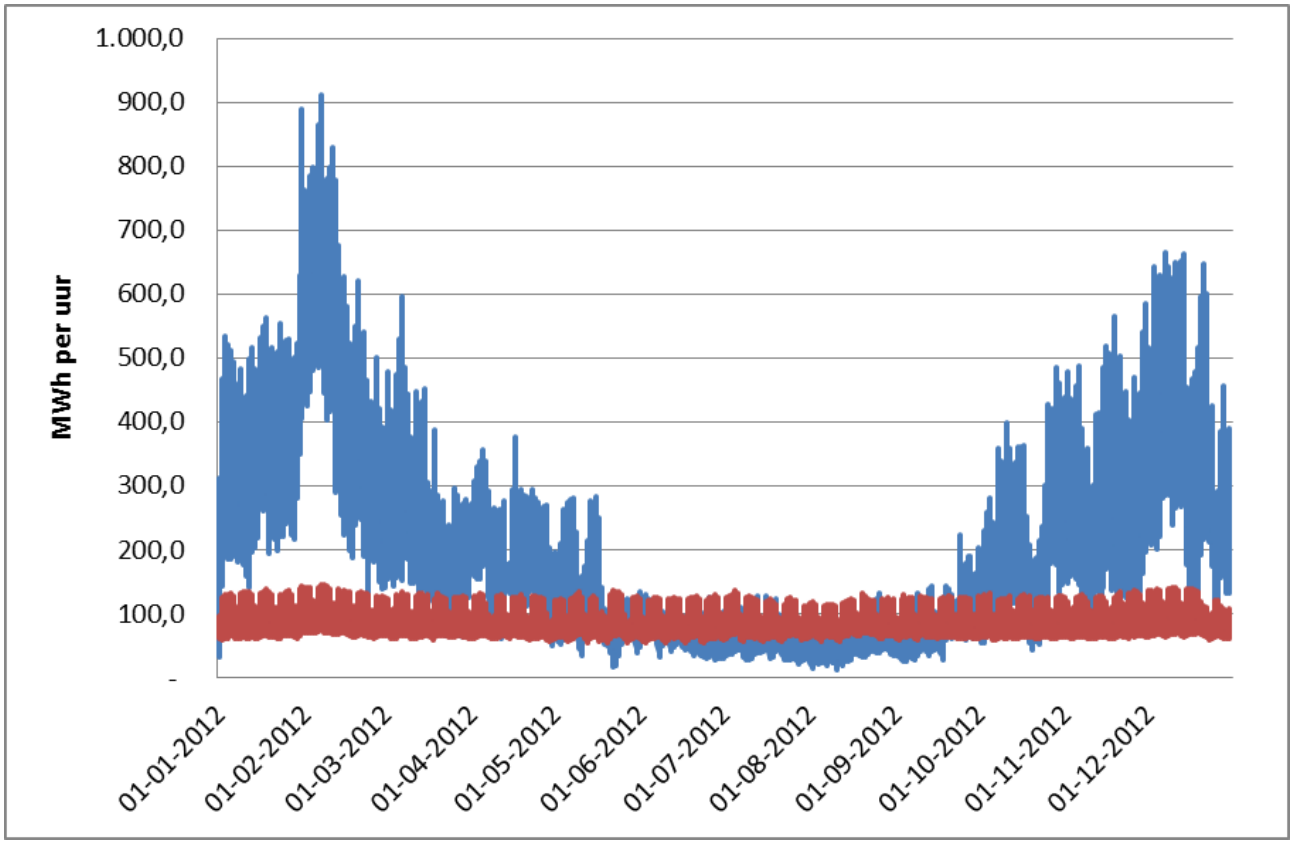
Hourly data for the city of Groningen



Gas demand scales with effective ambient temperature

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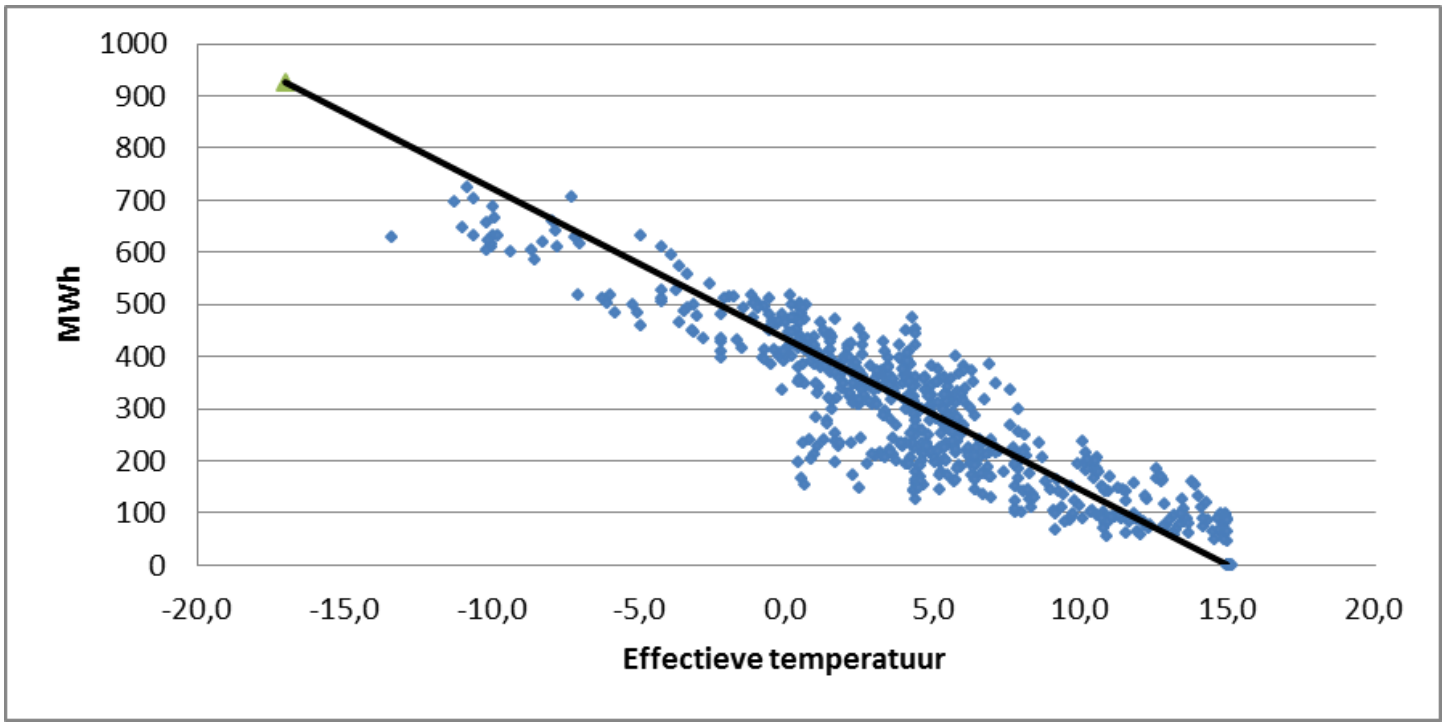
Gas demand = heat demand

Data city of Groningen 2012



Charateristics of Sun and Wind

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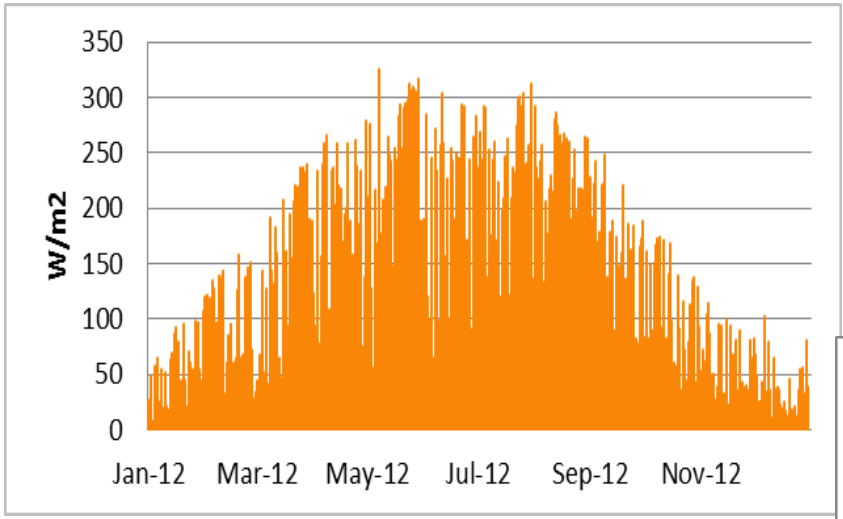
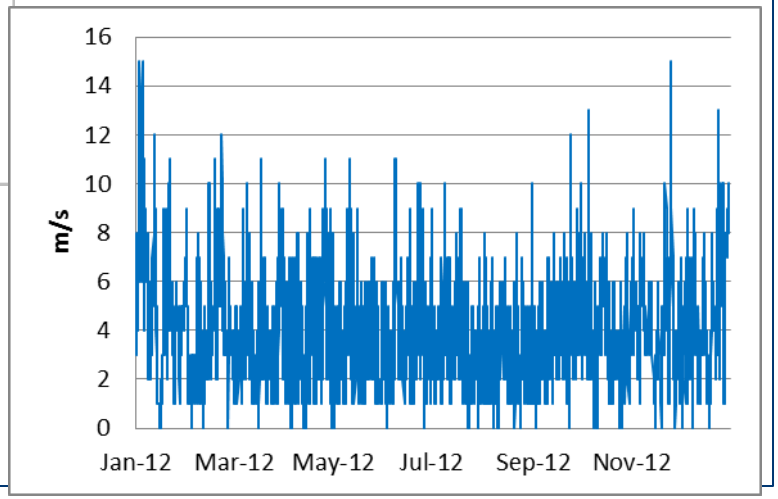
Measurements in 2012 @ Groningen airport



Production by Solar: summer is 10 times winter



Production by wind: winter is 1.5 times summer

Annual quantities

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Year 2035

		Required surface in km2	Percentage off the local community of Groningen
All-electric wind	205 wind turbines (x3 MW)	67	**80%**
All-electric sun-PV	24% eff.	30	**36%**
All-gas biomassa	n.a.	300	**360%**

Excluding mobility

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Required amount of energy storage

Energy demand peaks in a cold winter

2035	Commodity	Percentage of the annual demand for energy
		-
Biomass	Gas	20%
Solar PV	Electricity	44%
Wind	Electricity	10%

Including the effect of a severe winter

E-opslag is extreem duur !

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Factor 1000 !

Car Battery: 1 kWh

Norg Storage: 5 BCM (= 50 bln kWh)

Investments

- Costs of E-storage: car battery : € 100,- per kWh
- Costs of Gas-storage: “Norg” : € 0,10 per kWh
- A gas storage has a life time of 50-100 years ...

100% sustainable Groningen 2035

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The household bill

Excluding taxes

		Annual costs (ex tax)
Current costs	Gas & electricity	€ 1100
Biomass	100% Gas	€ 2500
Wind	100% Electricity	€24000
Zon	100% Electricity	€75000

Costs are mainly due to infrastructure (storage and networks)

A combination of gas and electricity makes sense

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Questions from the Groningen Study 1

- What is the future energy demand pattern in cities
  - Houses will have much better isolation
  - Current knowledge is based on single houses with motivated people
- What is the performance of a modern all electric neighborhoods with well isolated houses, solar panels and heat pumps as a function of weather circumstances
  - How to scale? Having in mind that any neighborhood has its own specific characteristics
  - This requires a systematic, academic sound approach
  - This type of data is lacking in the Netherlands

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Questions from the Groningen Study 2

- What is the performance under severe winter conditions
  - Most houses of heat pumps using ambient air
  - Often heat pumps have not sufficient capacity and electric heating is added
  - The peak situation determines the network capacity.
  - In the Netherlands, all electric neighborhoods have an electric capacity 3 to 7 times larger than in conventional gas/electricity neighborhoods
  - Hoping for a severe winter, at least three years of measurements
  - Is there a natural development in the energy usage of a neighborhood?
  - What about energy storage requirements?
- The all electric neighborhood generates a base case for further research

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Questions from the Groningen Study 3

- How to combine gas with electricity to achieve better results
  - Use of cogeneration based on engines (10-15% power) and or fuel cells (50-60% power)
  - Combining CHP with heat pumps – searching for the optimal scale
  - Houses, blocks, neighborhoods, etc..
  - Targets are CO2, Economics, Reliability and flexibility (e.g. avoiding lock-in)
  - Analyses on system level, not only on the level of the neighborhood

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The main products

- Design criteria to determine the optimal fuel mix in modern neighborhoods and to design the required network configuration
- A model to simulate energy demand patterns in modern neighborhoods, which is dependent of the characteristics of that neighborhood
- A scientific solid data set to optimize and calibrate energy demand models that can be used for a variety of reasons.
- Arguments to be used in the (Dutch) societal discussion about the future of gas in neighborhoods

Project Flexi-Grow

Foreseen Expansions

- Adding other neighborhoods
  - Both in the Netherlands and abroad
  - Expanding the scientific data base
- Including the energy demand by mobility
- Expanding the time series to study the evolution of the energy demand in time
  - Young families get children which become teenagers
- Expanding the project by adding other (renewable) energy sources and technologies
  - The area of Groningen is well suited for geothermic
  - Hybrid heat pumps could be an alternative
- Maybe: study the effect of customer behavior