DEVELOPMENT OF A USER-FRIENDLY MOBILE APP FOR THE 4TH GENERATION DISTRICT HEATING PROMOTION AT THE NATIONAL LEVEL

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MOBILE APP FOR DISTRICT HEATING CONSUMER

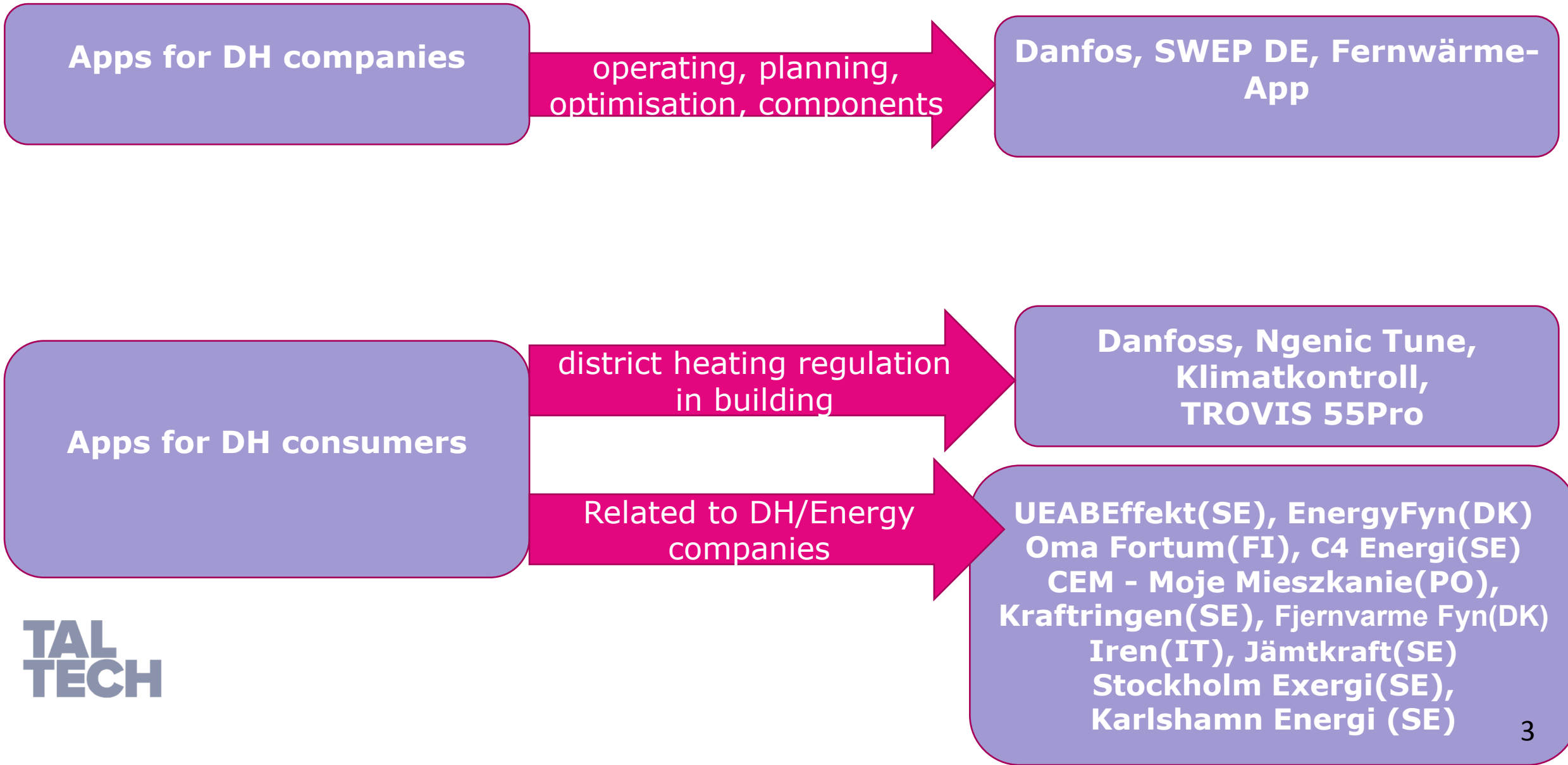
Consumer is important factor in district heating transition process towards 4th generation:

- Educating and informing district heating consumers
- Trust and cooperation
- Positive image of district heating
- Promoting the 4th generation district heating

TAL TECH

DH consumers are the heroes of our time

EXISTING MOBILE APP RELATED TO DISTRICT HEATING



APPS FOR DISTRICT HEATING CONSUMERS

1st level:

1. Information about consumption
2. Warnings, announcements
3. Invoices/bills
4. DH operator contact information

2nd level

1. Comparing consumption with previous years (UEABEffect)
2. Extra content with information about energy saving measures (Iren, Fjernvarme Fyn)

3rd level

1. Informing about heat use above or below a certain threshold (Fjernvarme Fyn, Energy Fyn)
2. Fuel share by type for annual consumption (UEABEffect)
3. Consumption related to temperature (Stockholm Exergy)

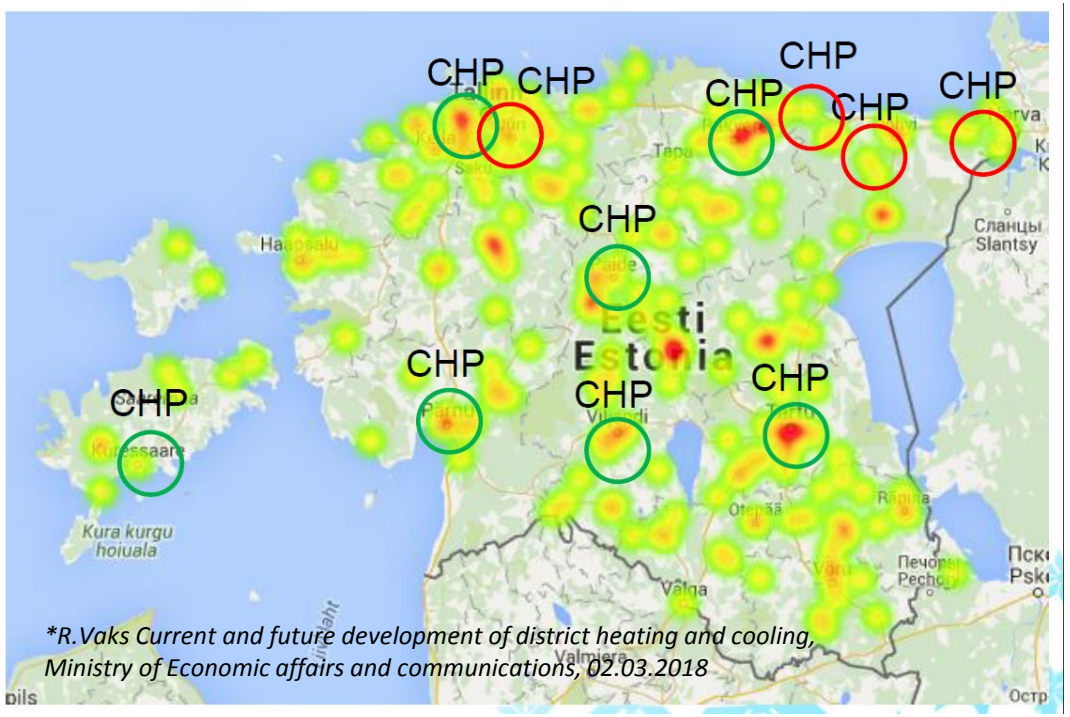
TAL TECH

NEED FOR DISTRICT HEATING PROMOTING APP IN ESTONIA

Support from Estonian government:

District heating regions

are areas within which consumer installations are provided with heat by way of district heating in order to ensure a secure, reliable and effective heat supply. When a district heating region is established, connection to the network shall be mandatory for all persons located within the district heating region



R.Vaks Current and future development of district heating and cooling, Ministry of Economic affairs and communications, 02.03.2018

Currently:

- Approximately **230** DH regions varying from 0.25GWh to 1 585 GWh, Medium sales 225 GWh, price ~53 €/MWh
- Production and end-user prices need to be approved by the Estonian Competition Authority
- Majority of DH areas owned by private companies

APP DEVELOPMENT PROCESS

- Concept development
- Data collection (for 3 district heating regions)
- Calculation, modelling
- Technical task preparation for Software development company
- Software company selection (prices were very varying)
- Prototype development by Software company (for 3 district heating regions)
- APP testing, approbation
- Data collection for 230 DH regions (Estonia)
- APP development for 230 regions
- APP implementation
- New features (return temperature, new possibilities for consumption determining, monthly consumption)

TAL TECH

CONCEPT DEVELOPMENT

Working title: NutiKK=Nuti KaugKüte=Smart District Heating

Tasks: Informing-educating-promoting-cooperation

- to show, that **particular building/apartment/consumer** is the part of the system
- to show how many fuel/energy is consumed to produce heat for **particular apartment**
- to compare current situation with other heating solutions
- to show how district heating system development(in context of 4th generation district heating) would effect the primary energy consumption required for **particular apartment**

3 modules:

1st MODULE
District Heating

2nd MODULE
Individual Heating
(NG, electricity)

3rd MODULE
4th Generation
District Heating

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CONCEPT DEVELOPMENT INPUT DATA

Input data from User side

- **Annual heat consumption, MWh**
  - *Manualy:* Sum of monthly consumption, (from bills)
  - *Calculated*: Area &energy efficiency class of building
- **Location** (will define DH region):
  - *Manualy*
  - *by geolocation*
- **Outdoor today average temperature**
  - *Manualy*
  - *From meteorological service*

APP input data before

- District heating region information:
  - Annual heat losses
  - Energy efficiencies of heating plants
  - Annual fuel consumption by type
  - Heat losses dependent on outside temperature
  - Heat load dependent on outside temperature
  - Share of fuel consumption dependent on outside temperature
  - CO2 emission factor for each primary energy source
- Information about alternatives
  - Natural gas heating or electrical heating (national primary energy factor for electricity production)
  - 4th generation district heating possible scenarios for regions

CONCEPT DEVELOPMENT OUTPUT DATA

For 3 MODULES (DH, IH 4GDH)

- Annual and today heat production for apartment/building heating
- Annual and today total primary energy consumption for heat production, required for apartment/building heating
- Annual and today fuel (by fuel type) for heating the exact apartment in MWh and in natural units *(District heating is not abstract concept for consumer anymore)*
- Annual and today CO_2 emissions, caused by heat production required for apartment/building heating

In future: impact of return temperature on district heating system, impact on parallel consumption on district heating,…

TAL TECH

DATA COLLECTION

Data sources:

- Cooperation with District heating companies
- District heating region development plans (mandatory in Estonia)
- Meteorological data
- Emission factors, primary energy factors (National level)

Parameters we needed to get from DH operators

- Annual fuel consumption (usually is available and opened)
- Annual heat losses (available)
- Heat losses dependent on outdoor temperature (better to receive from company real data, but can be calculated)
- Fuel shares for different outdoor temperatures

TAL TECH

Annual parameters:

For Module 1 District heating

- Data about annual heat losses for annual heat production calculation are available
- Data about annual fuel share are available

For Module 2 Individual heating:

- Fuel share is no needed
- No heat losses
- Primary energy factors and CO2 emission factors (National energy sector development scenarios)

For Module 3 4GDH:

- Annual heat losses in future should be modelled/assumed
- Fuel share in future for this exact district heating region should be modelled/assumed

TAL TECH

CALCULATION OF "TODAY" PARAMETERS

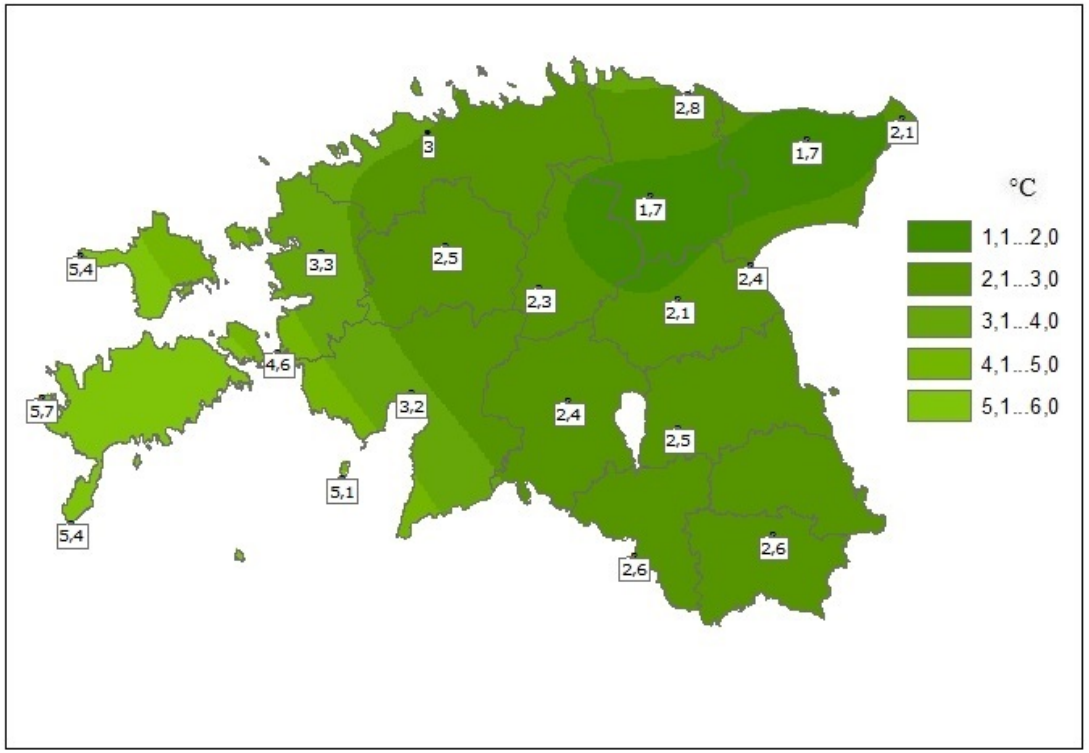
- Required for 3 modules

- To show information about today parameters, not only annual parameters, that may be considered as too abstract concept=> district heating closer to consumer

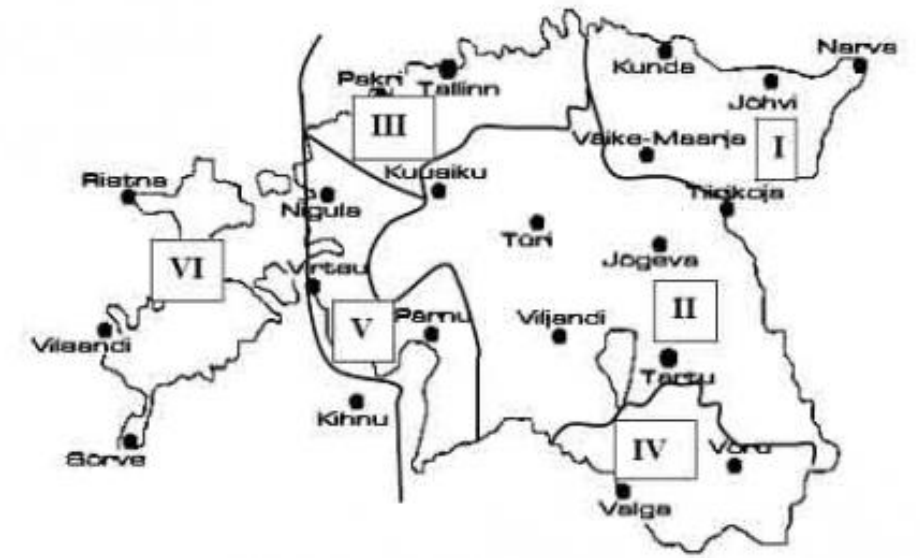
- Not possible to use data from remote metering (sensitive data, not always available)

- Today consumption can be calculated using degreedays approach.

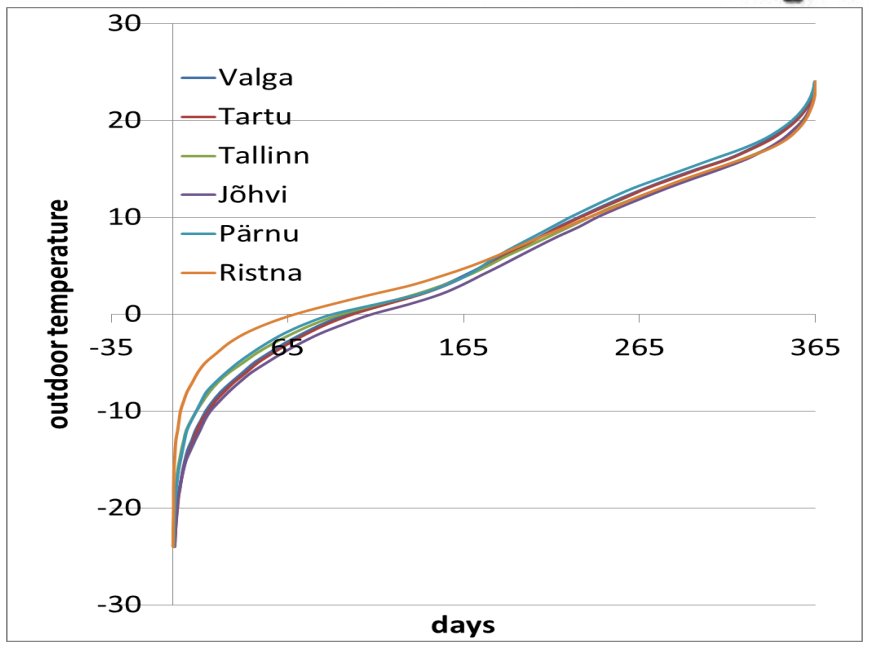
- Available parameter is *today outside average temperature*, that can be automatically online received from national meteorological service. Temperature can be received for all regions from 20 points in Estonia

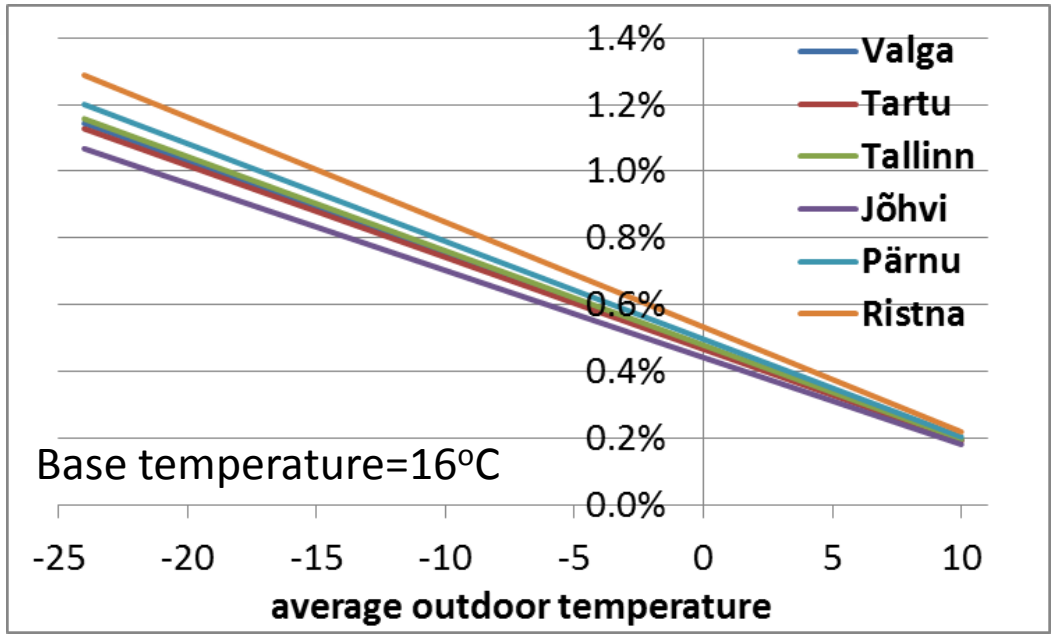


DEGREEDAYS METHOD FOR TODAY CONSUMPTION



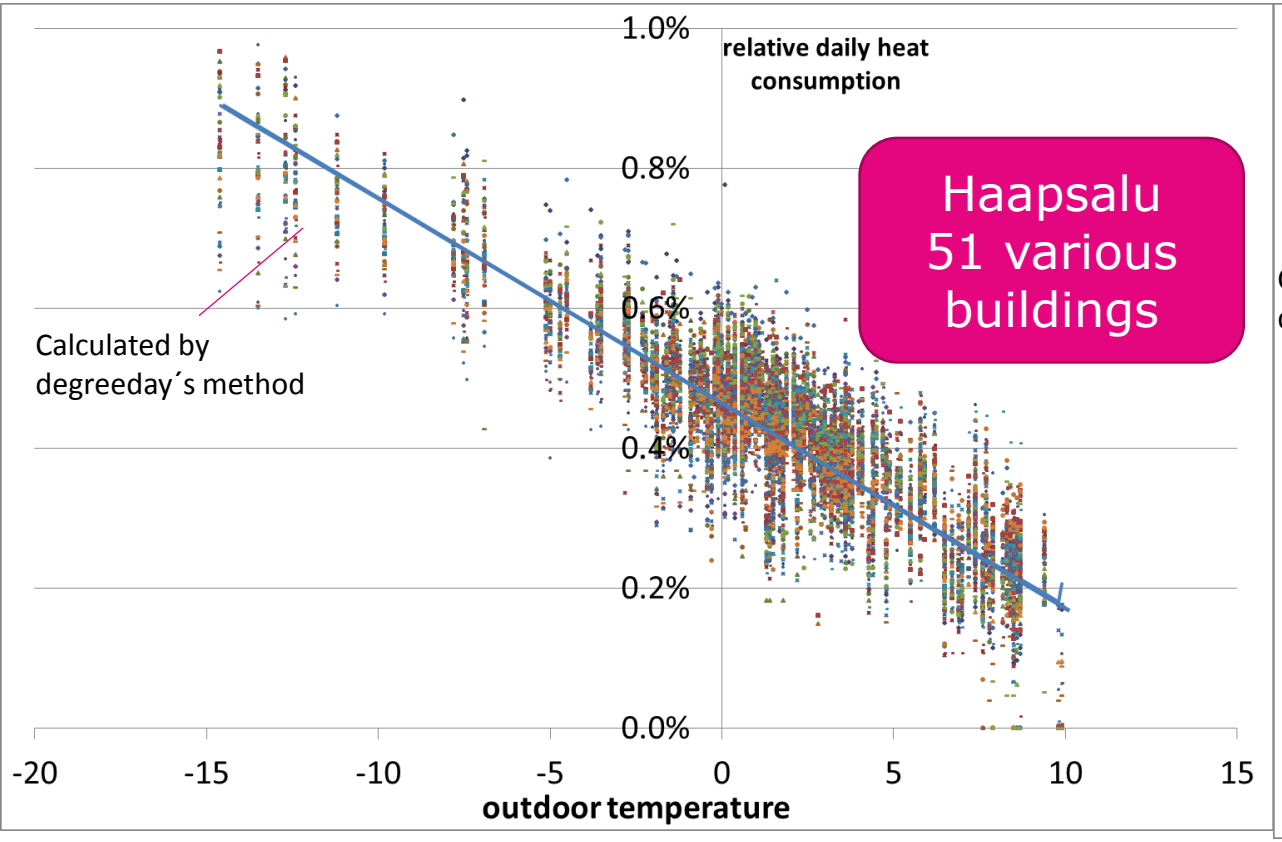
Calculate: how many percent of *annual heat consumption* will be consumed today, if today outside average temperature is *X*°C

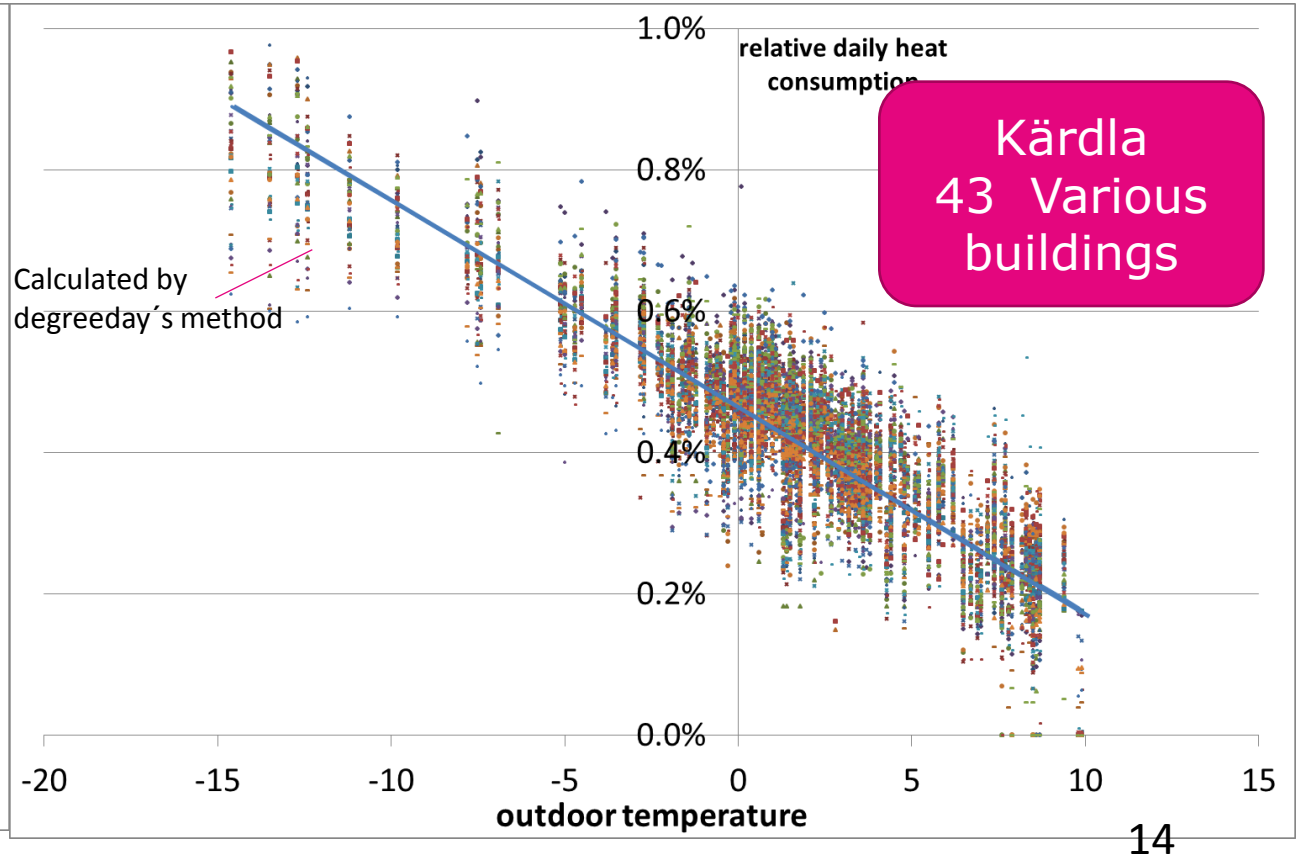


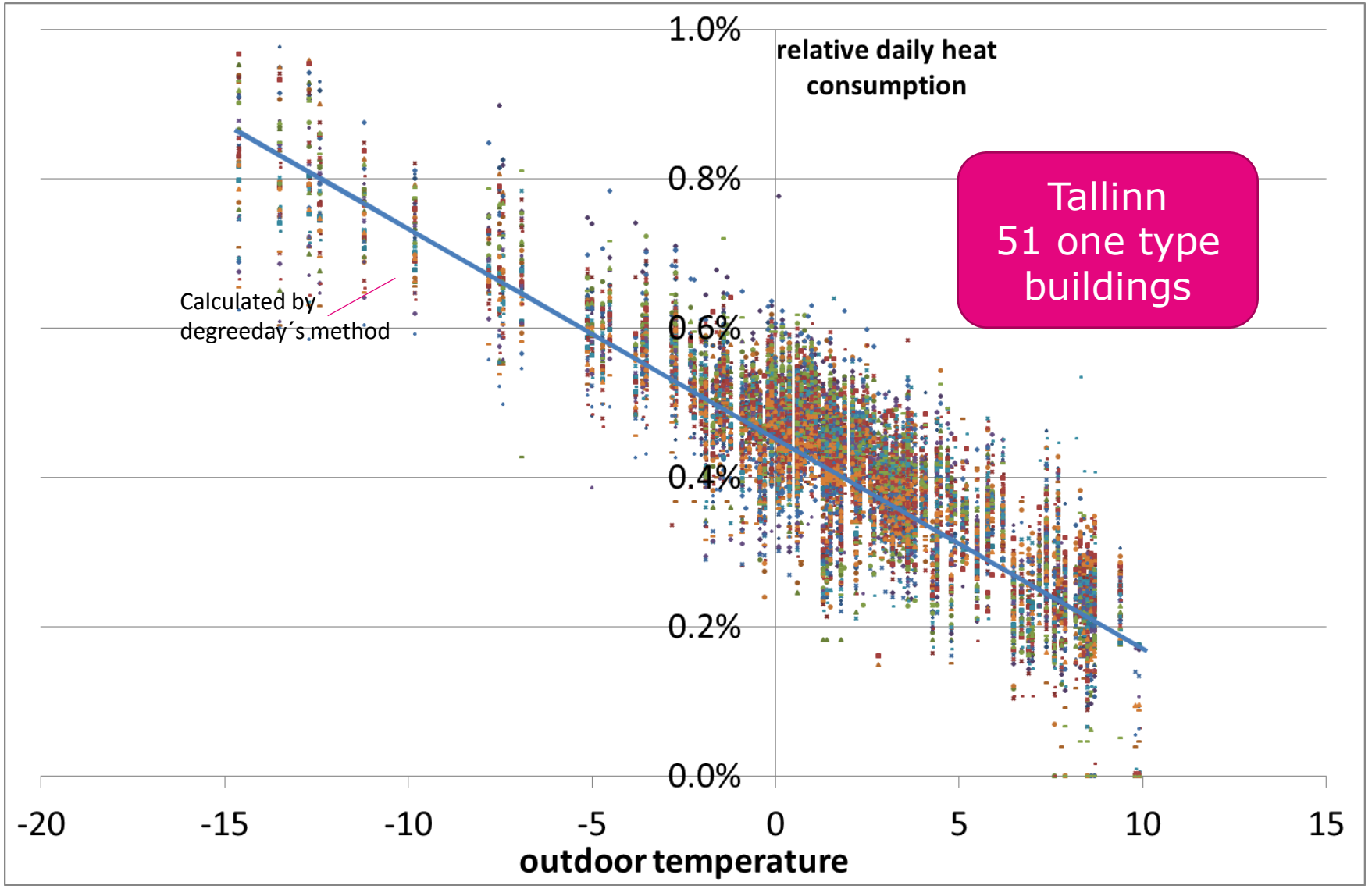


CALCULATED DATA COMPARING WITH REAL DATA

- Daily data for heat consumption and average outdoor temperature, remote metering, 2017
- Buildings without hot water supply (for analysis of outdoor temperature dependent)
- Multifamily houses, different type: renovated/not renovated
- Tallinn (Tallinn region)51 , Kärdla (Ristna region)-43 buildings, Haapsalu (Pärnu region)-48 buildings






1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
relative daily heat consumption
Tallinn
51 one type buildings
Calculated by degreeday´s method
-20
-15
-10
-5
0
5
10
15
outdoor temperature

MODEL ADEQUACY CONTROL

This simple regression model can be used for building today heat consumption for space heating calculation in different regions.

Correlation coefficient for each building, to show, how heat consumption correlates with outdoor temperature

$$r = \frac{\Sigma(x-\bar{x})(y-\bar{y})}{\sqrt{[\Sigma(x-\bar{x})^2(y-\bar{y})^2]}}$$

Fisher criterion to control, if model is adequate and can be used for analyses, if $F<F_{tab}$

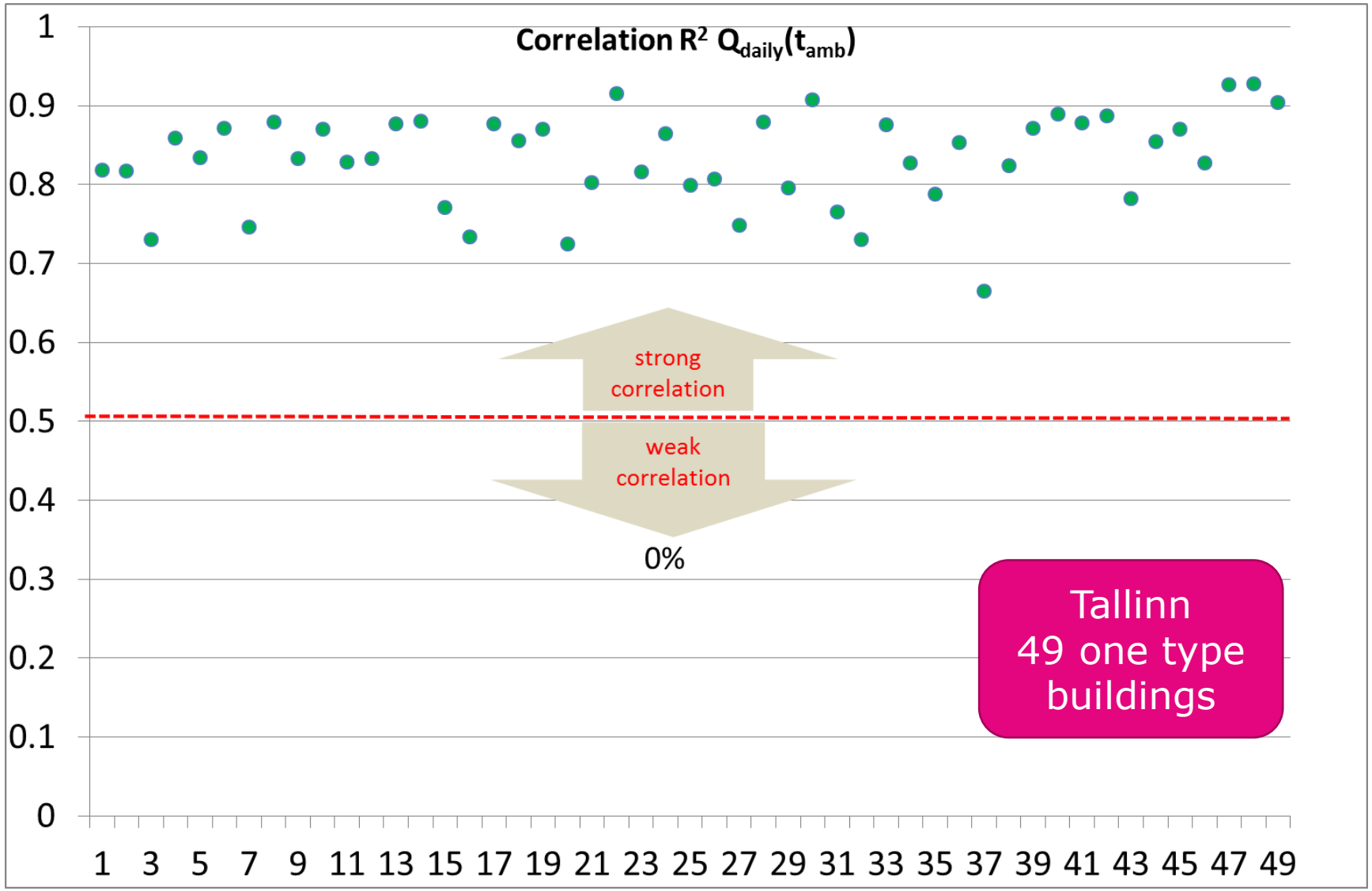
$$F = \frac{(n-k)\sum(\hat{y}_t-\bar{y})^2}{(k-1)\sum(\hat{y}_t-y)^2}$$

Coefficient of determination- to show, how calculated values are close to the metered values

$$R^2 = 1 - \frac{\sum_i(y_i-\hat{y}_i)^2}{\sum_i(y_i-\bar{y})^2}$$

TAL TECH

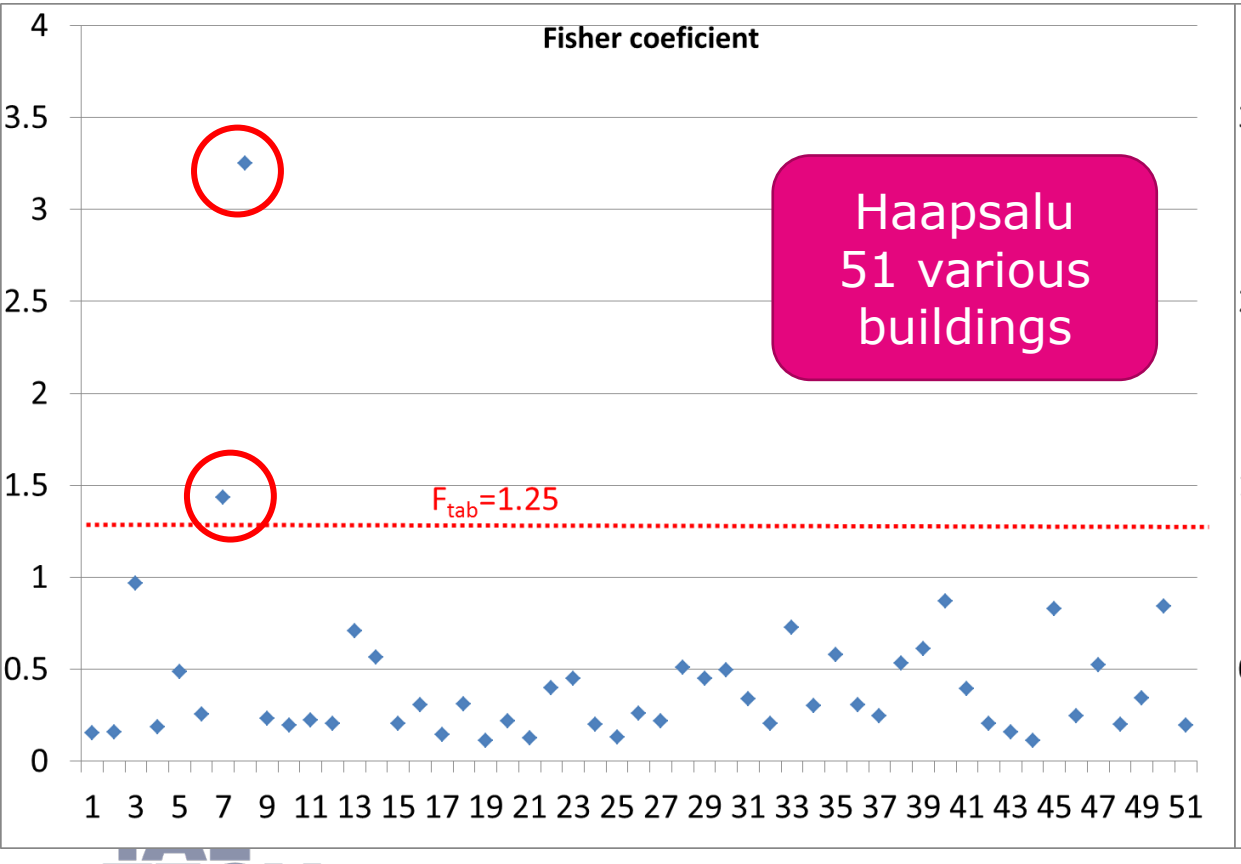
CORRELATION: HEAT LOAD VS OUTDOOR TEMPERATURE

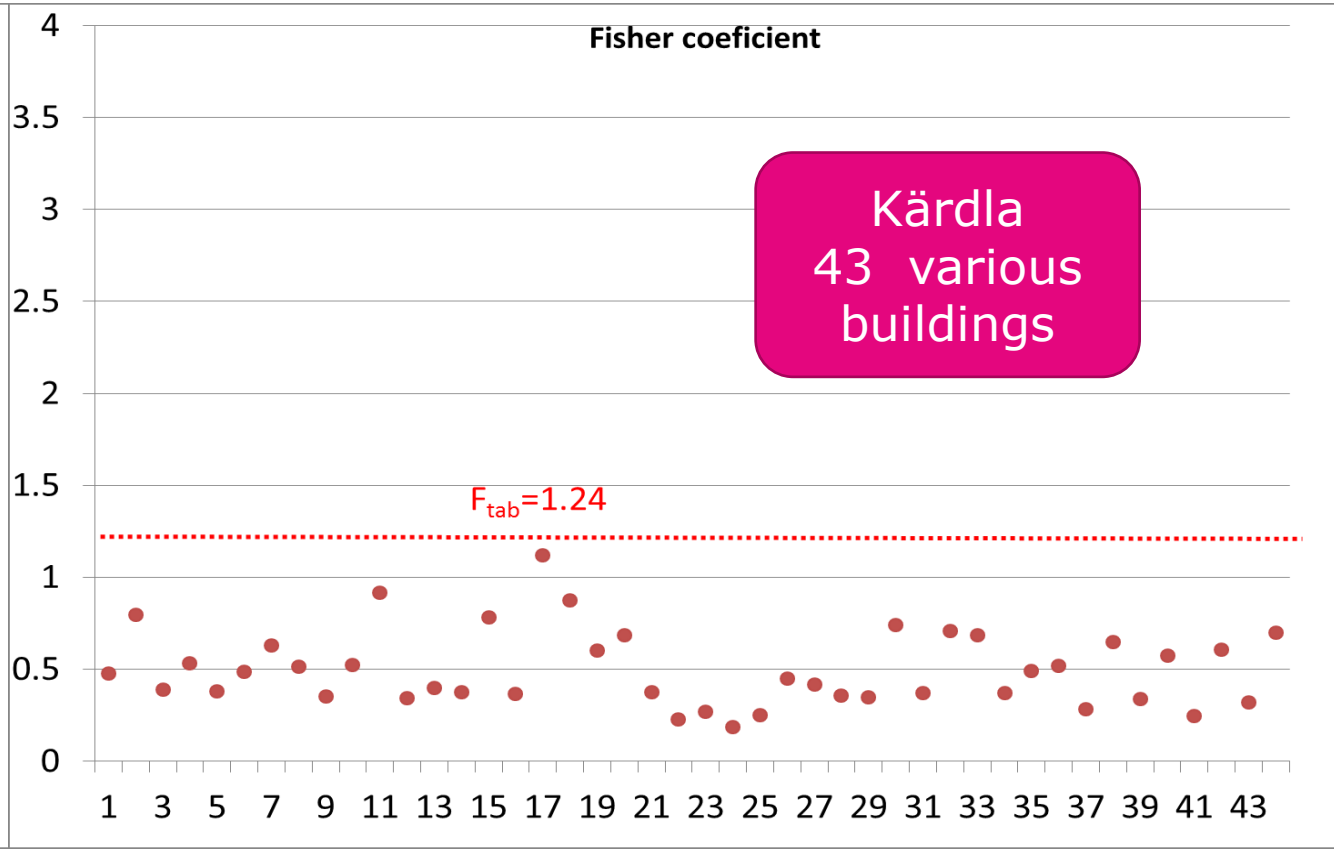


Tallinn
49 one type buildings

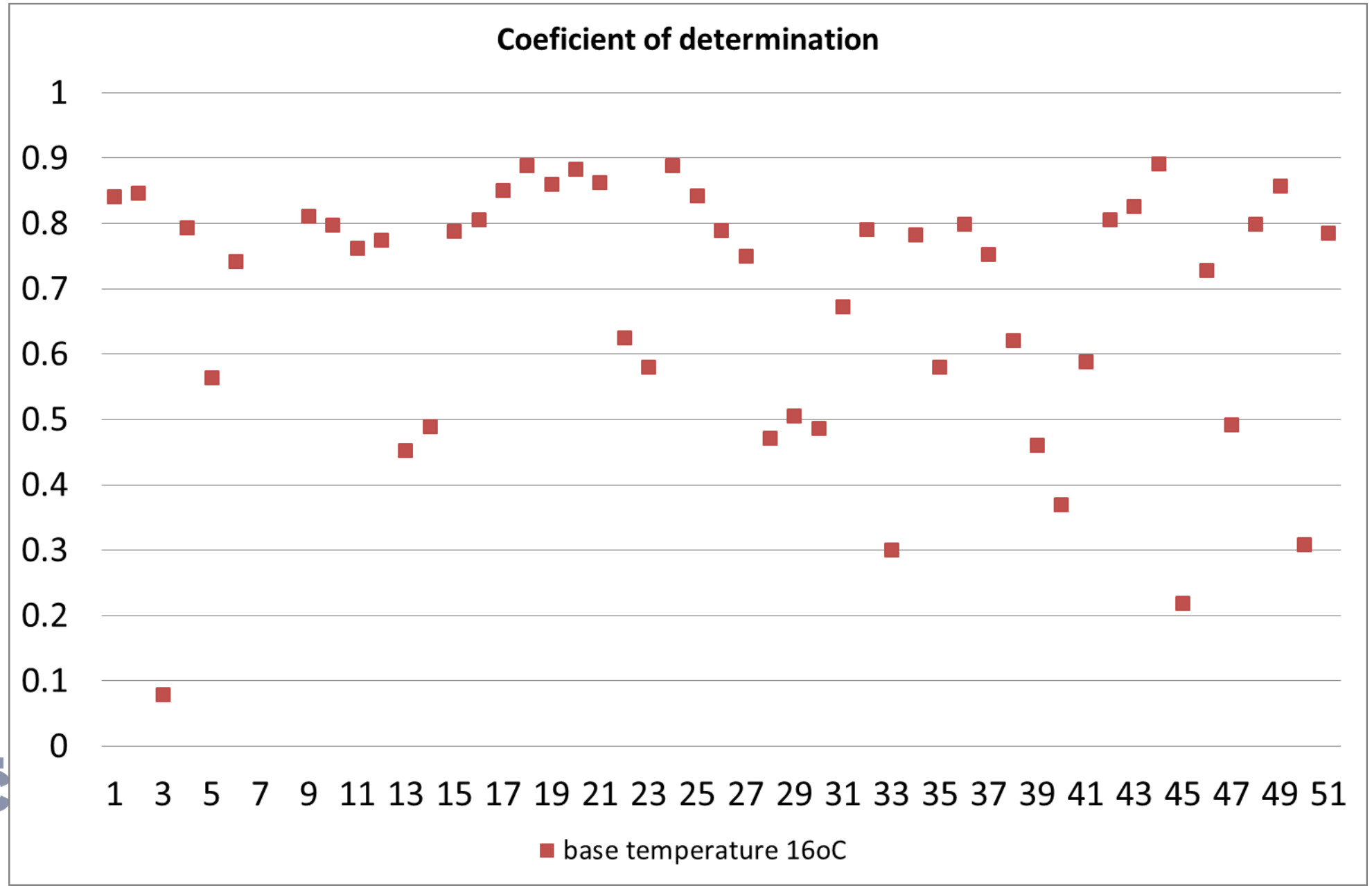
One type buildings
One city district
Close heat demand

FISHER CRITERION



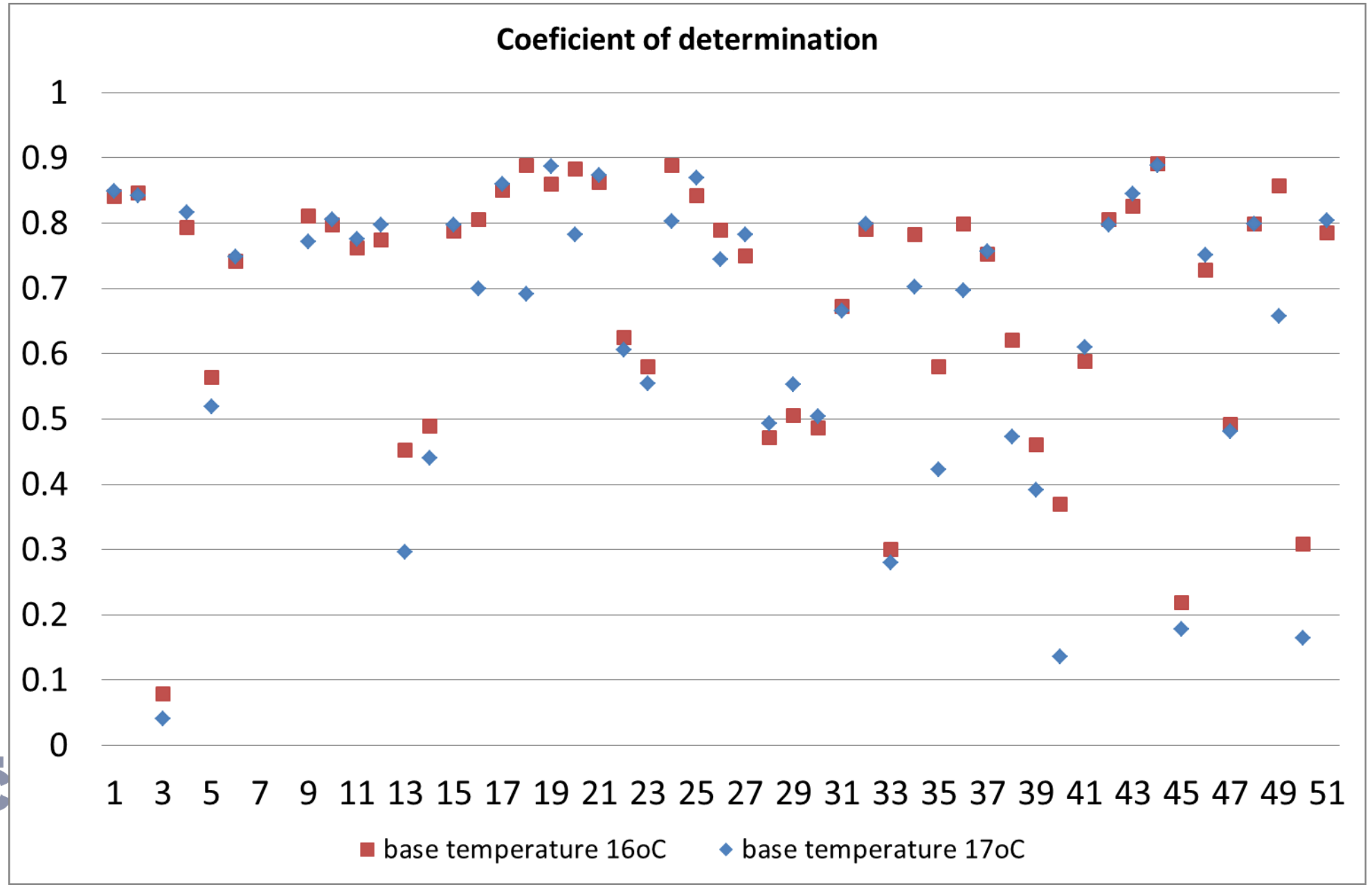


COEFFICIENT OF DETERMINATION (HAAPSALU)



TAL TEC

COEFFICIENT OF DETERMINATION (HAAPSALU)



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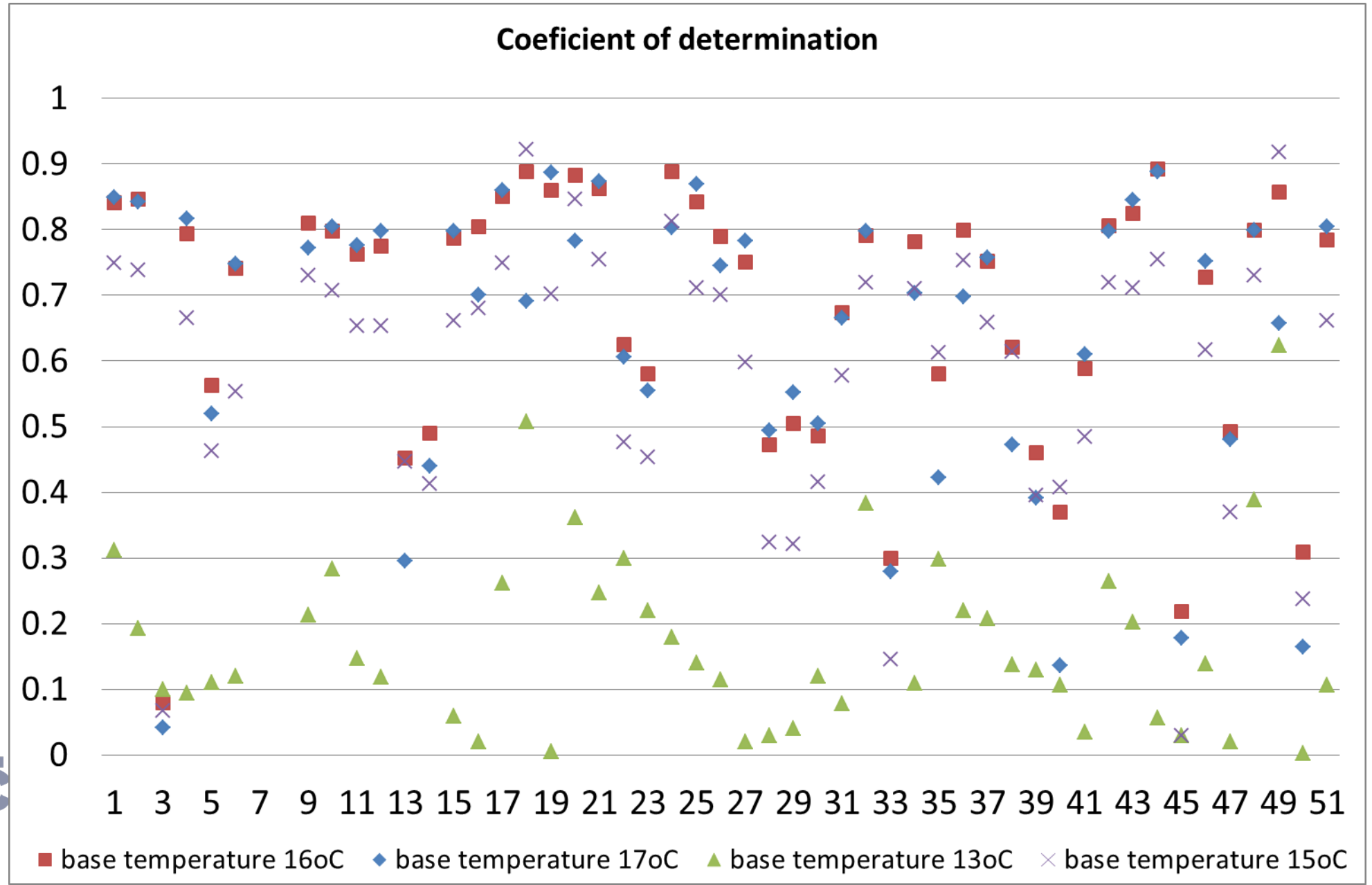
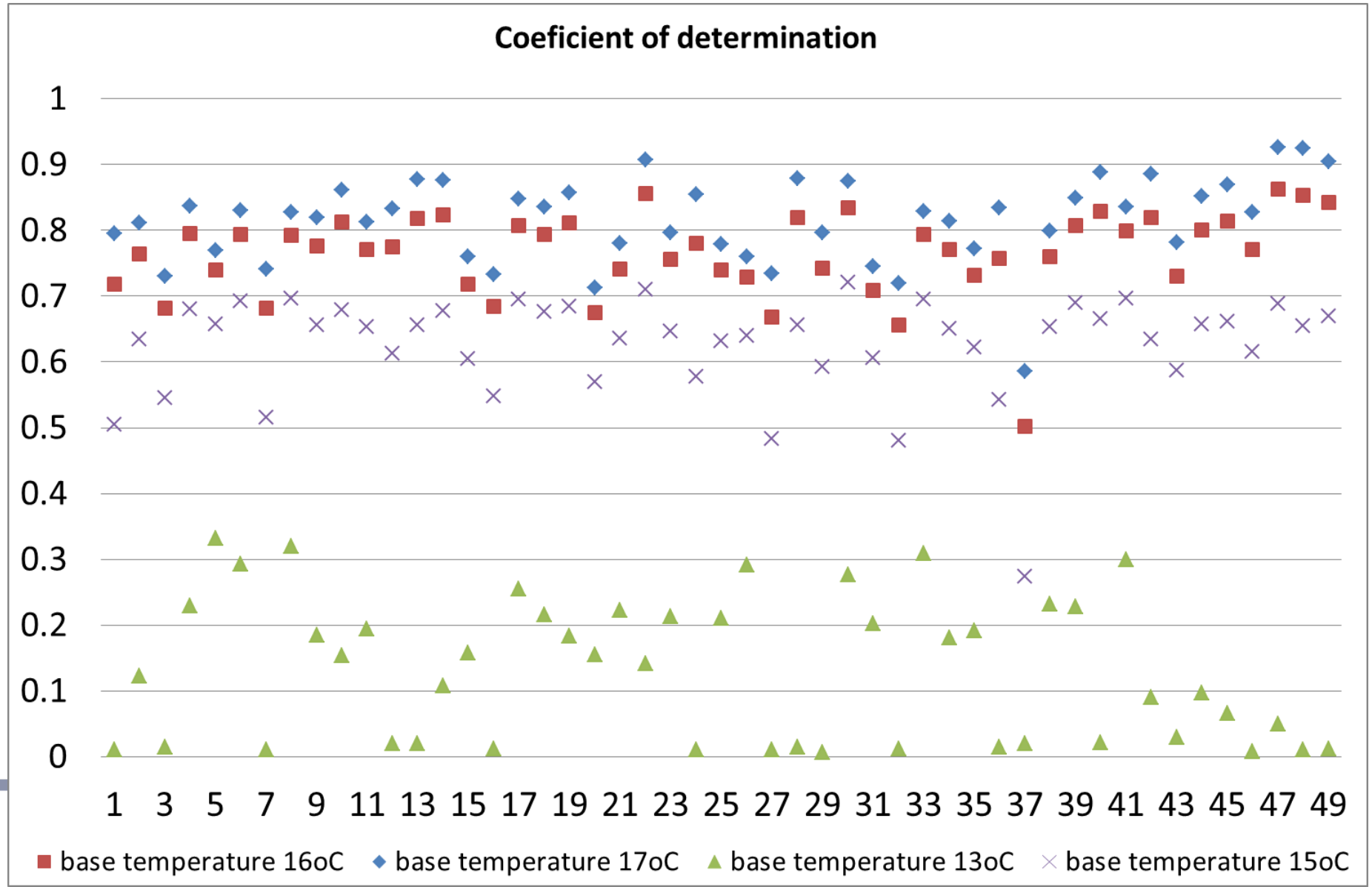
COEFFICIENT OF DETERMINATION (HAAPSALU)

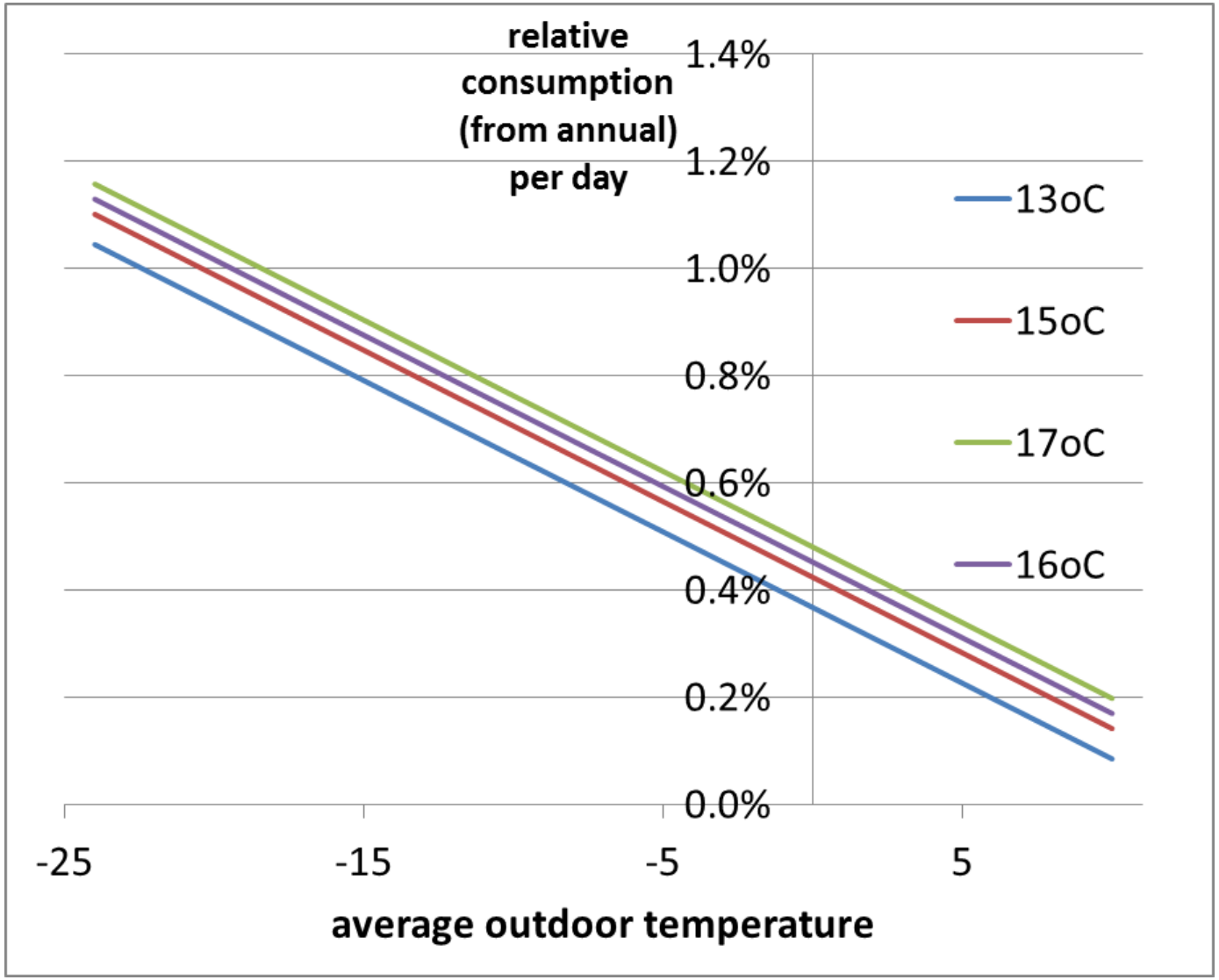


TAL TEC

COEFFICIENT OF DETERMINATION (TALLINN)



DIFFERENT MODELS FOR DIFFERENT BASE TEMPERATURES -- -TYPES OF BUILDING (TALLINN EXAMPLE)



- Easy to define
- Will be possible to define without detailed information
- Closer to reality

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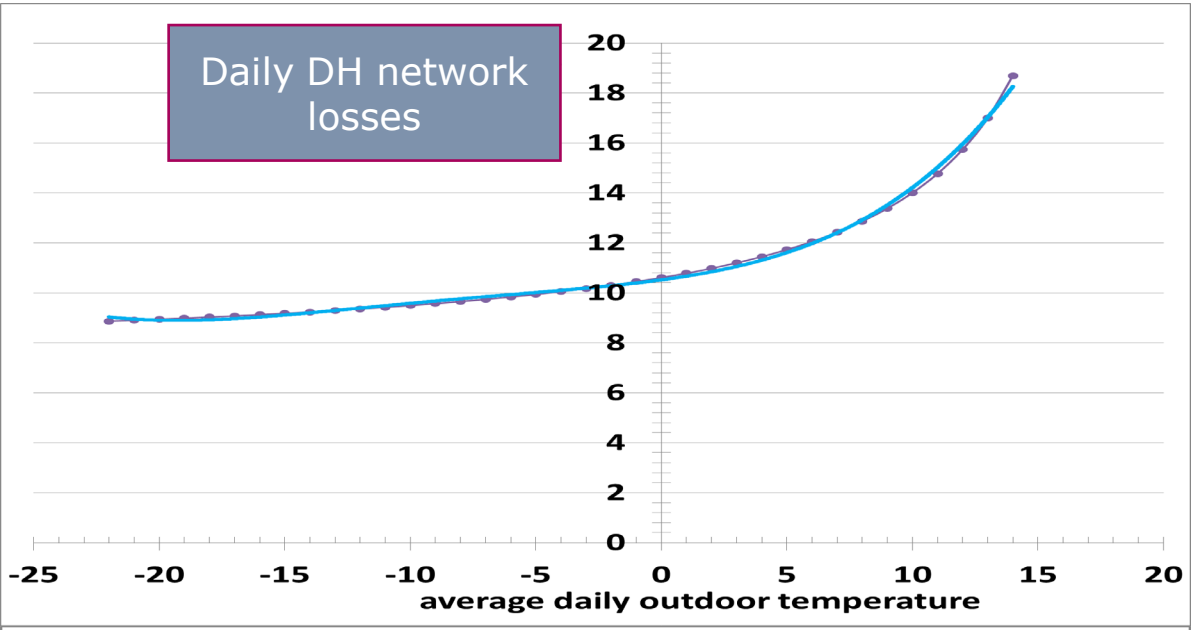
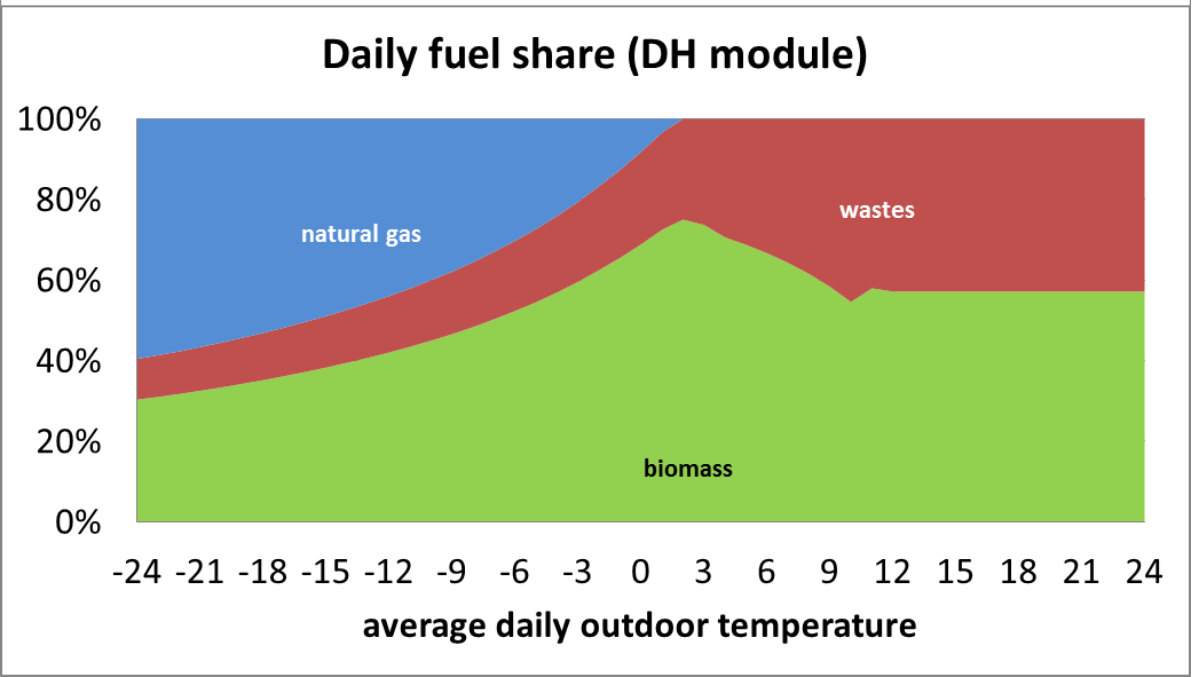
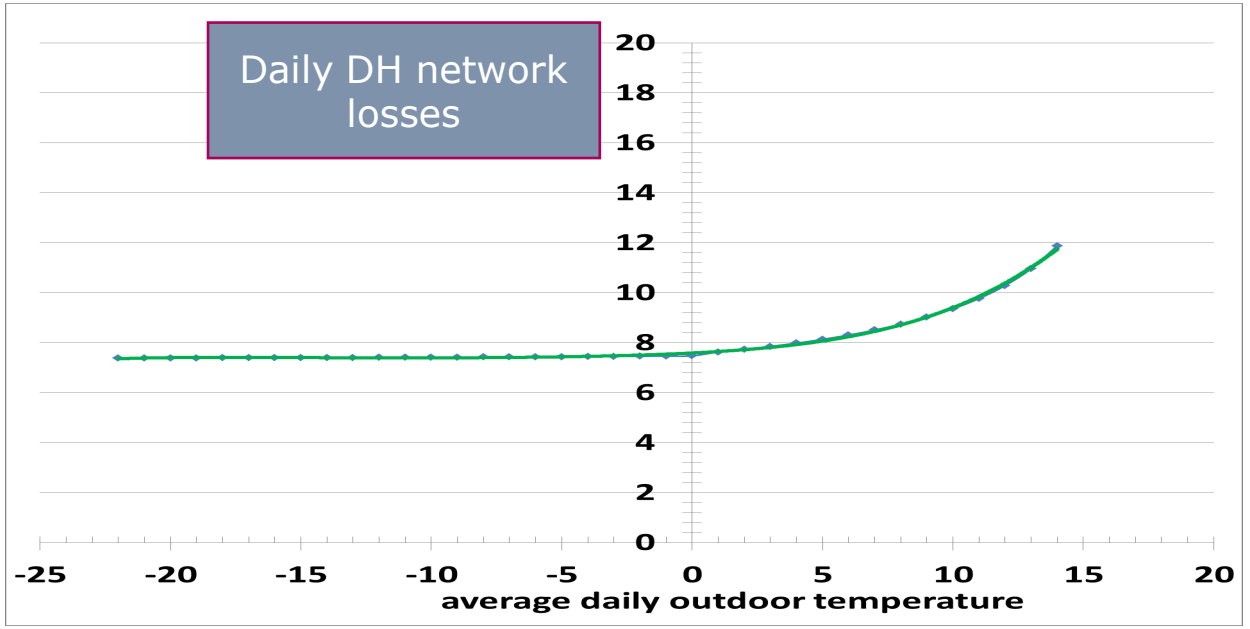
CALCULATION OF DAILY PARAMETERS

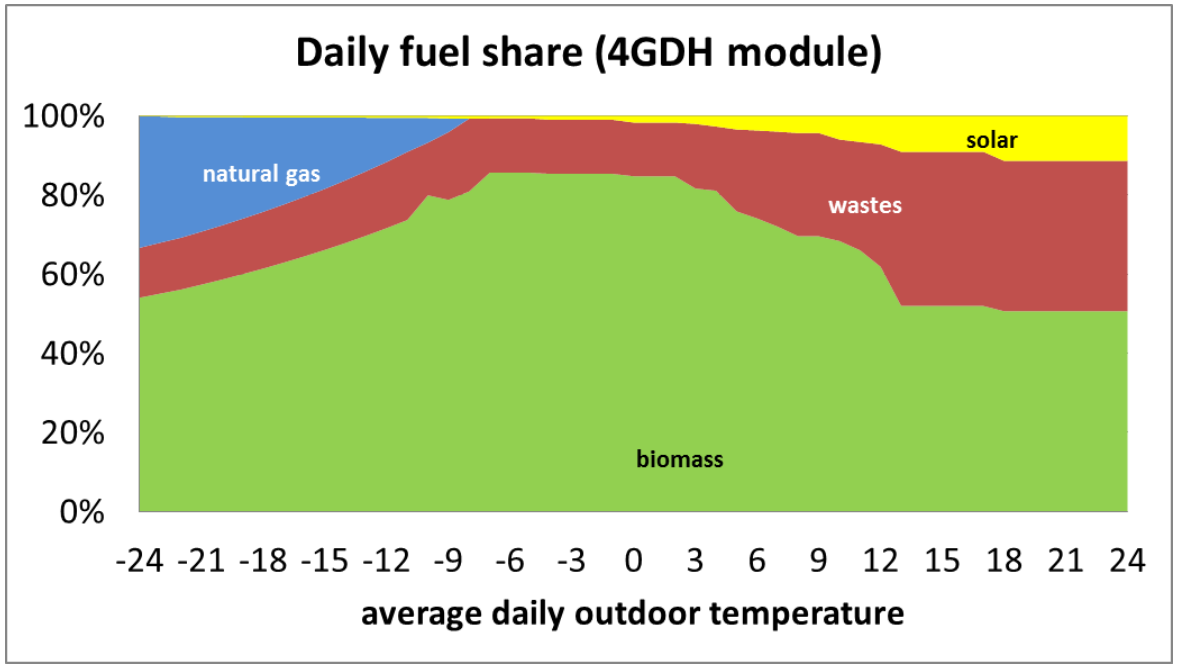
MODULE 1 DISTRICT HEATING





MODULE 3 4G DISTRICT HEATING





EXAMPLE: 65 M2 APARTMENT IN NON RENOVATED MULTIFAMILY BUILDING (TALLINN)

INPUT

Building type: non renovated

Annual consumption: **8500 kWh/y**

Location : **Tallinn**

Today average temperature **6°C**

Today consumption:
26.44 KWh

1st MODULE DH:
Annual:
1.56 t wood chips
534 m3 natural gas
438 kg of wastes
CO2=**1.19 t**

Today:
5.12 kg wood chips
1.11 m3 natural gas
1.96 kg wastes
CO2=**2.92 kg**

2nd MODULE IH

Annual:
1015 m3 natural gas

CO2=1.88 t

Today:

3.15 m3 natural gas

CO2=**5.87 kg**

3rd MODULE 4G District Heating
Annual:
2.62 t wood chips
113 m3 natural gas
420 kg of wastes
477 MWh solar
CO2=**0.40 t**

Today:
8.95 kg wood chips
0 m3 natural gas
1.07 kg wastes
1.43 MWh solar
CO2=**0.47 kg**

CONCLUSION

- There is need for district heating promoting mobile app in Estonia
- Proposed degreeday method can be used for approximate today heat consumption calculation
- With limited data available, it is possible to provide consumer with useful information
- Additional parameter, as a building type(easy defined by user) should be added to input form
- First app prototype will be ready in the end of November
- App NutiKK first version available for 80% of Estonian DH regions will be presented till the end of 2019

TAL TECH

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