Investment guide for forest biomass based cogeneration and district heating in Slovenia

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Purpose

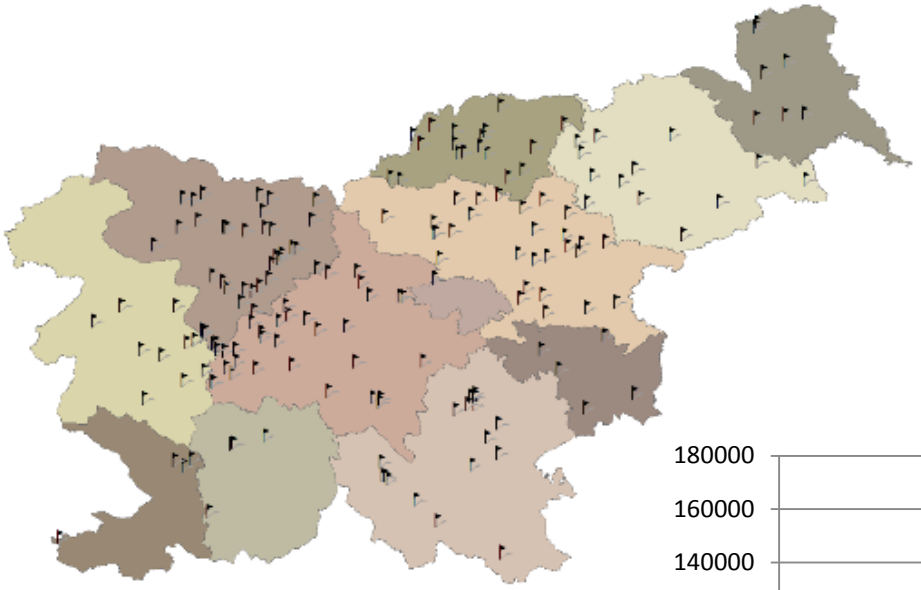
To develop an Investment Guide on biomass in Slovenia with the use of indigenous forest biomass. The guide covers two options:

– biomass cogeneration of heat and power (CHP) plants, and

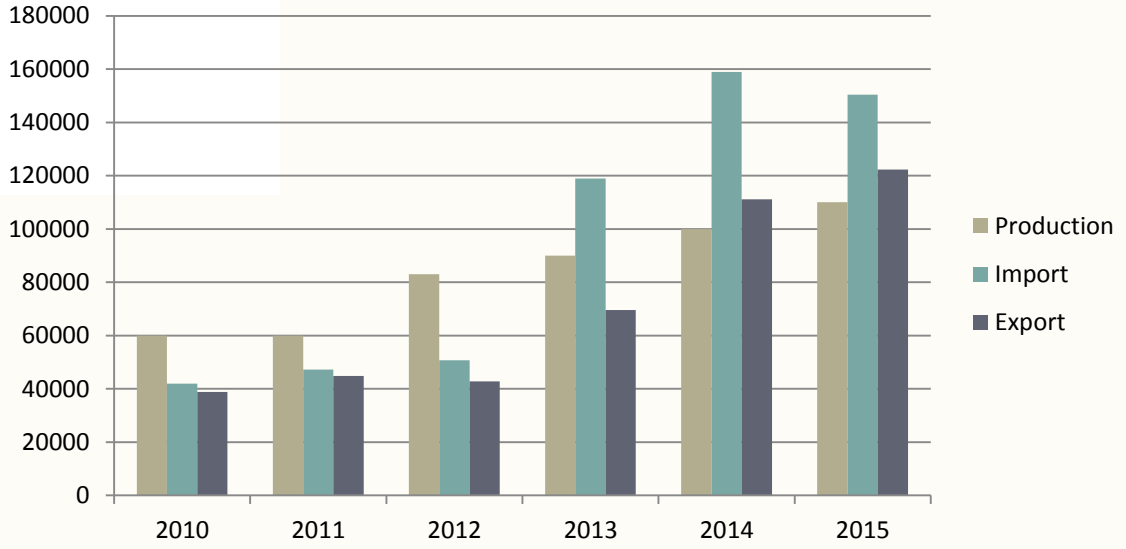
– district heating (DH) systems with biomass for a small town (covering mainly public buildings).

Both options tie well with national action plans, forest biomass availability and supply infrastructures in the country.

Woody biomass resources currently sold in Slovenian market



Wood chips producers in Slovenia (SFI, 2015)



Wood pellet production nad trade in Slovenia (SORS, SFI, 2016)

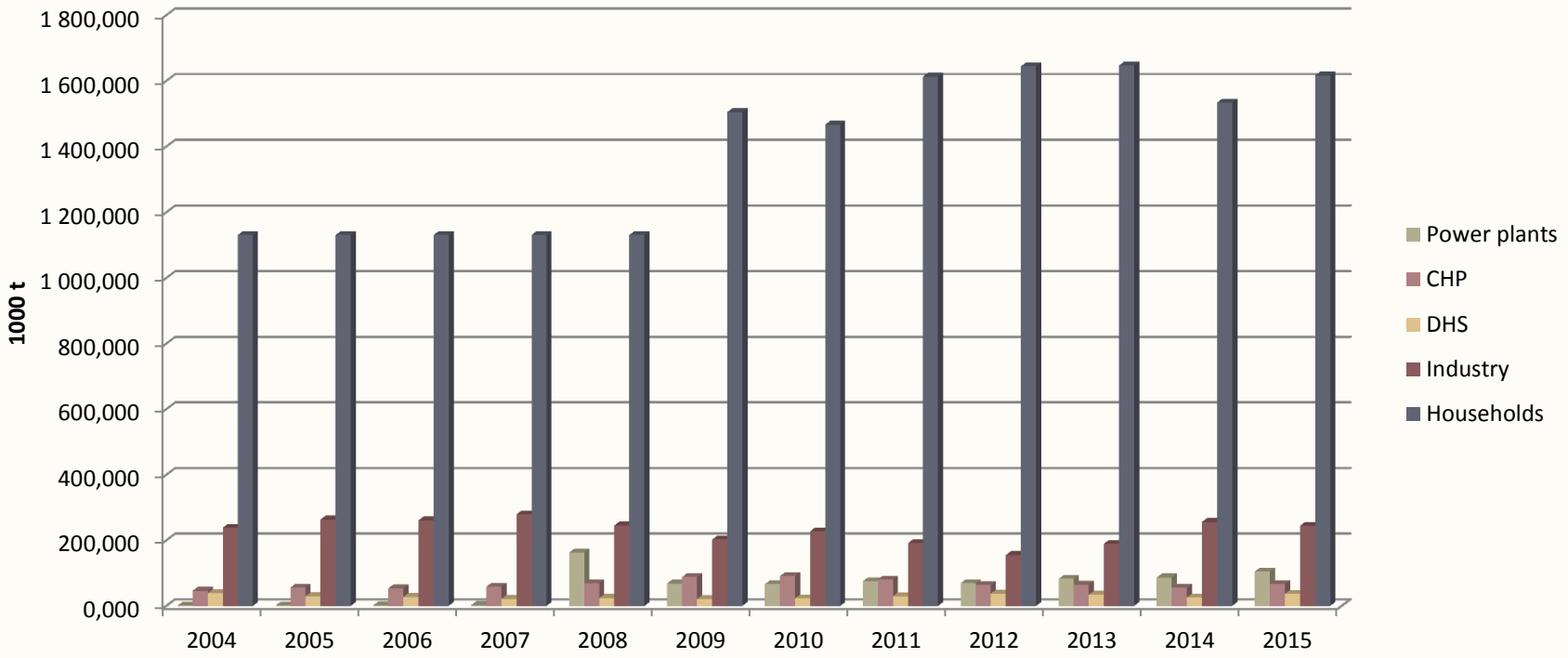
Wood chips

- The production of wood chips in Slovenia has almost tripled during the last ten years with figures rising from 460,000 loose m3 in 2007 to 850,000 loose m3 in 2012 and more than 1.500.000 loose m3 in 2014. The respective numbers of wood chippers increased from 62 (2007) to 122 (2012) and 187 (2015). Data collection for the reported figures has taken place in the form of three surveys combining phone and interview methods. The raw material used for wood chips production is mostly low quality wood not used by the industry, wood removals and wood residues from wood processing industry.
- Detailed information can be found on:
  - www.gozdis.si

Wood pellets

- Based on data from SFI about wood pellet production there are 20 producers with a total annual production of around 120.000 tonnes (the biggest produce 65.000 t per year, all the other are small with the majority producing less than 5.000 t per year).
- Almost 80 % of the indigenous pellets are exported while the country imports large amount of pellets from Romania (amounting almost to 50% share), Croatia, Bosnia and Herzegovina, a result of high demand and cheaper prices from these countries.
- Data about Slovenian pellet producers can be found on: www.s4q.si

Current Use of forest biomass in Slovenia

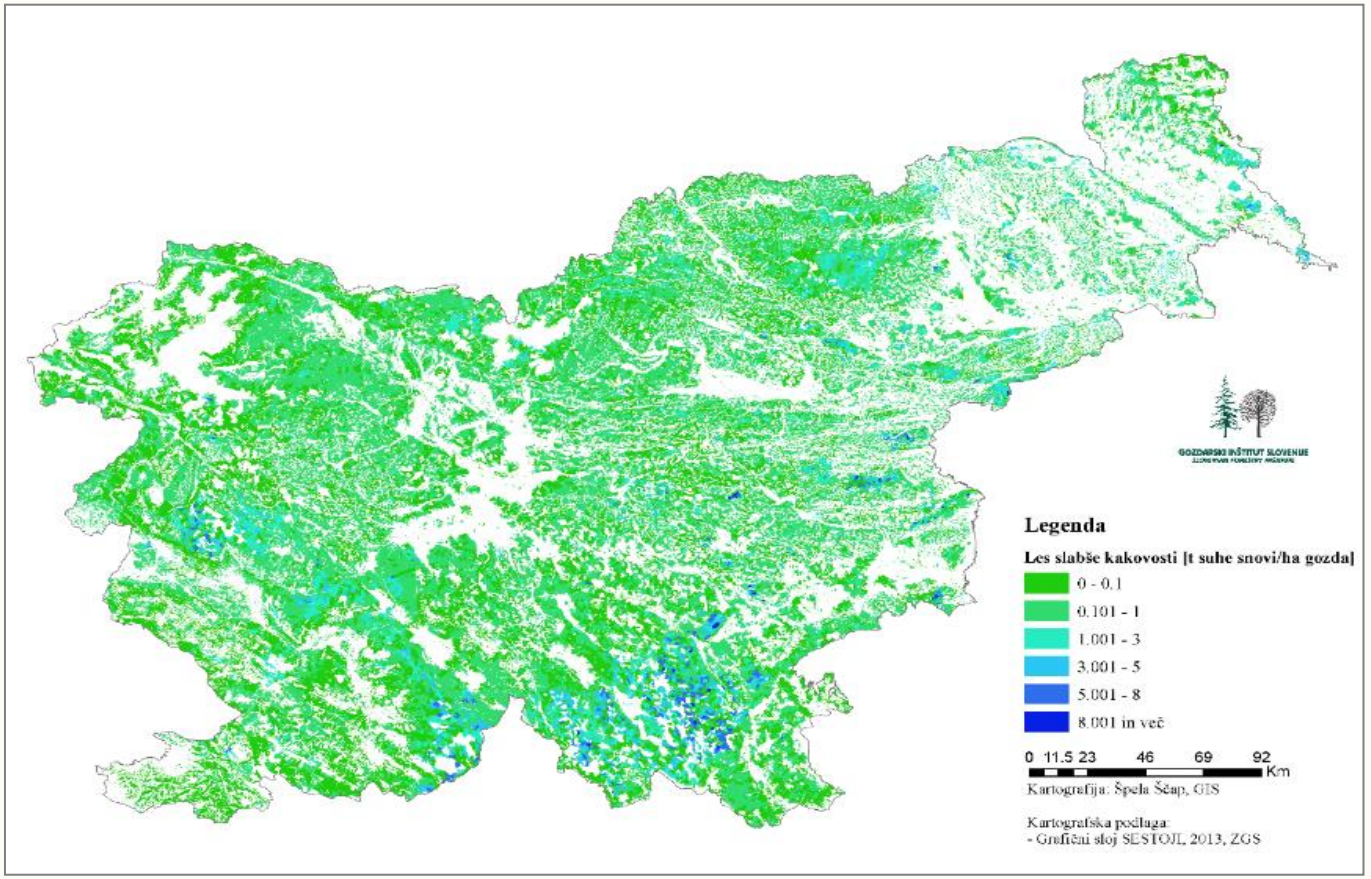


Source: SORS, 2016

Forest biomass types used in Slovenia

- The most commonly used form of wood fuels is firewood, use of wood chips and pellets is increasing in the last decade.
- Recent work from SFI (SORS, 2016) reports that the use of biomass in households is slightly increasing between years with households consumption is 1,137,000 tons of wood fuels, which is dominated by firewood (1.1 million tons). In years 2009 and 2010 Slovenian households used around 1.5 million m3 of roundwood (with bark) for energy production. According to National renewable energy action plan (NREAP) supply with domestic biomass will increase among the years. The amount of wood biomass is set to 1,302,000 tons for year 2015 and to 1,338,00 tons for 2020 (Beurskens and Hekkenberg, 2011).
- In October 2015 study about state of the art of wood chips production was performed. In our database we have data about 195 wood chippers all around Slovenia, mainly middle size chippers (capacity from 5 to 50 loose m3/hour) are used. Their production was estimated to more than 1.500.000 loose m3 of wood chips. It is estimated that in Slovenia the number of wood chippers is higher, but their production is negligible and they are mainly used for production of wood fuel for domestic use.

Availability of forest biomass estimated by S2Biom

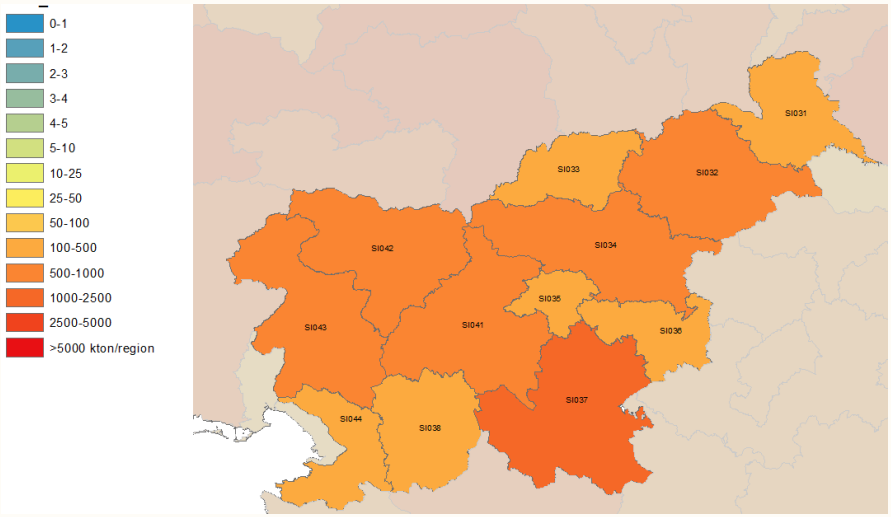


Map of actual market quantities of lower quality wood (in tones of absolute dry matter per hectare of forest per year, SFI, 2016).

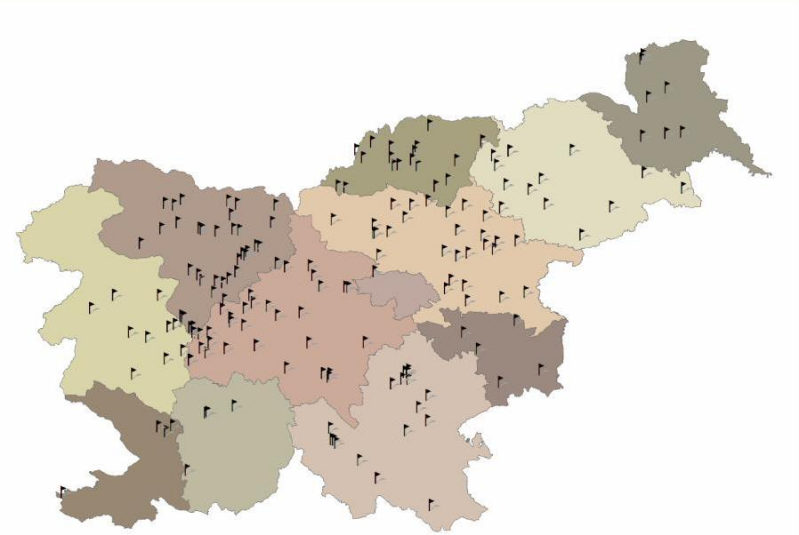
Which forest biomass types are included?

Forest biomass in this guide includes:

- i) primary forestry production from thinnings & final fellings, stem and crown biomass from early thinnings,
- ii) primary forest residues from logging residues and stumps from final fellings,
- iii) secondary forest residues from wood industries (sawmill and other wood processing).



Estimated potential in Slovenian regions

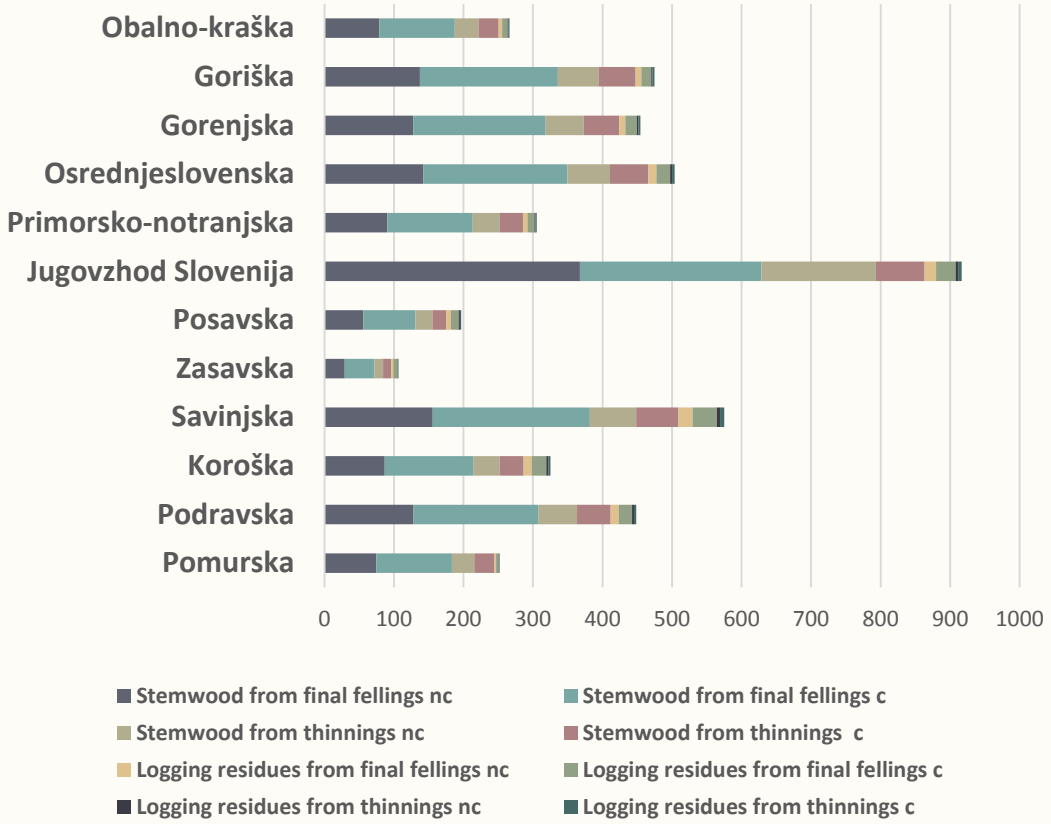


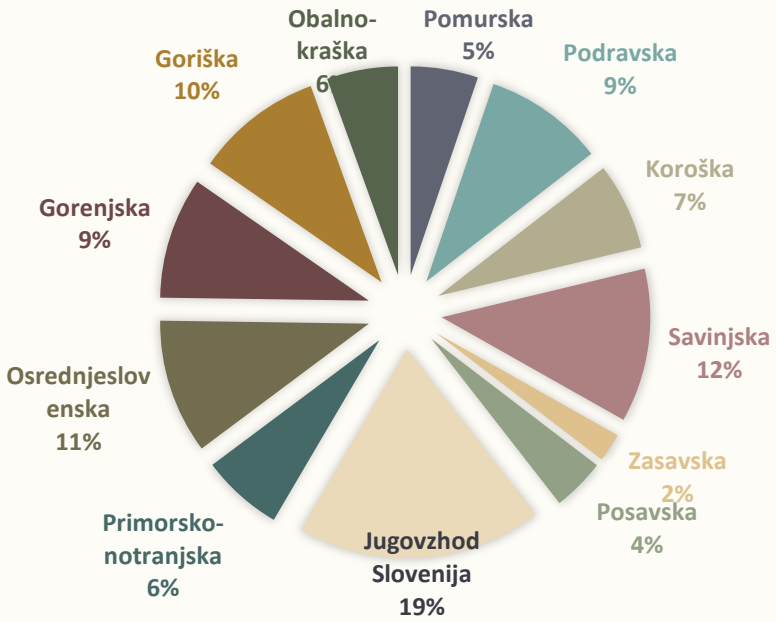
Wood chipper locations; source SFI

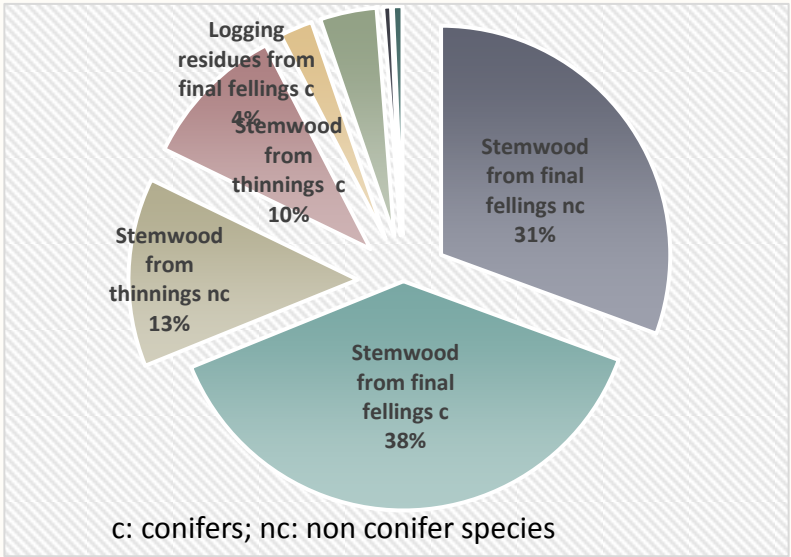
Forest biomass sustainable potentials

- Total estimated sustainable potential can reach up to 5.3m dry tonnes/ year
- Primary forestry production is estimated at 4.23m dry tonnes/ year
- Primary forest residues are estimated at 0.35m dry tonnes/ year
- Secondary forest residues are estimated at 0.73m dry tonnes/ year

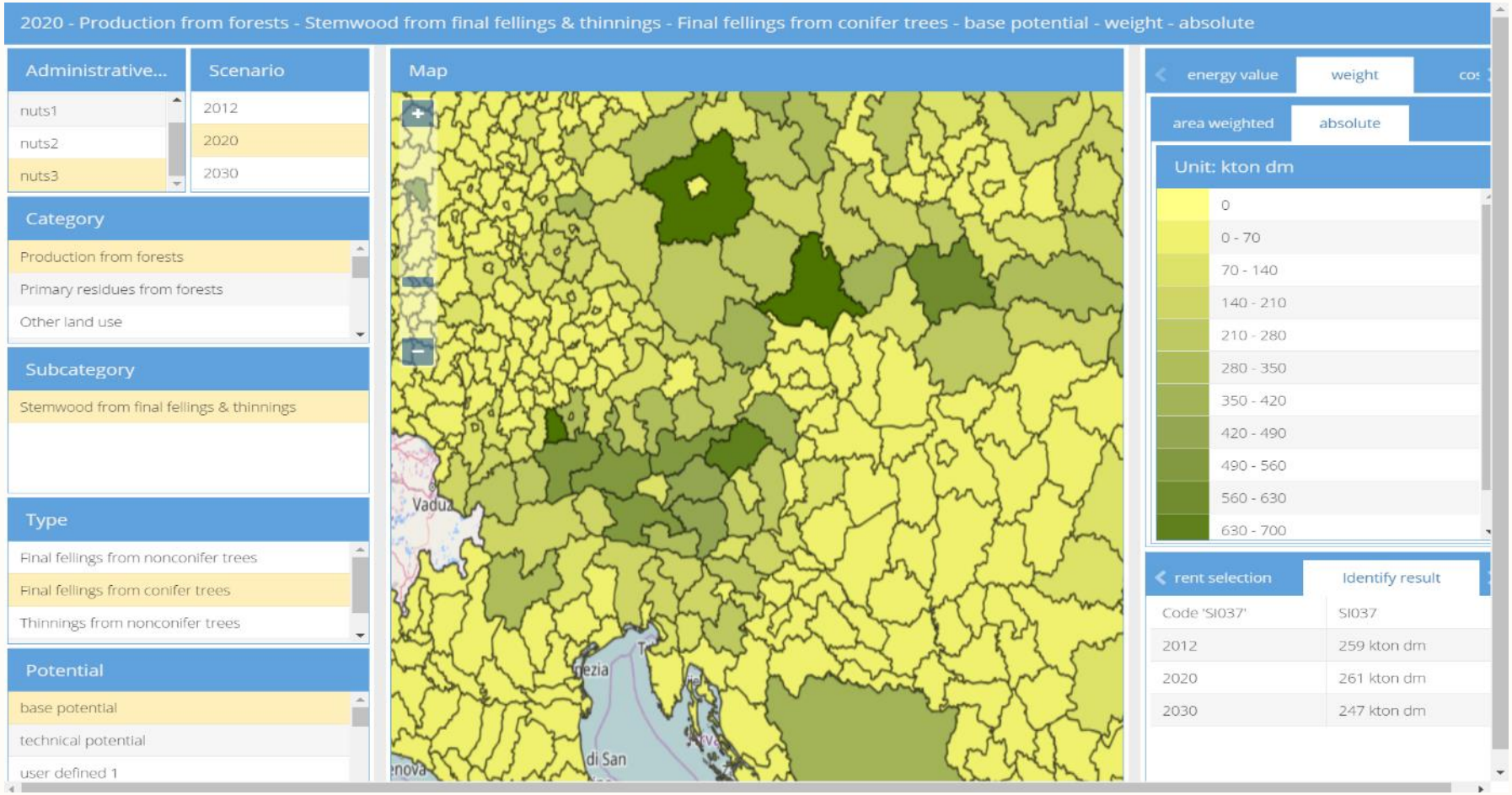
Forest biomass availability in Slovenian regions by 2020 ('000 dry tonnes/ year)







c: conifers; nc: non conifer species



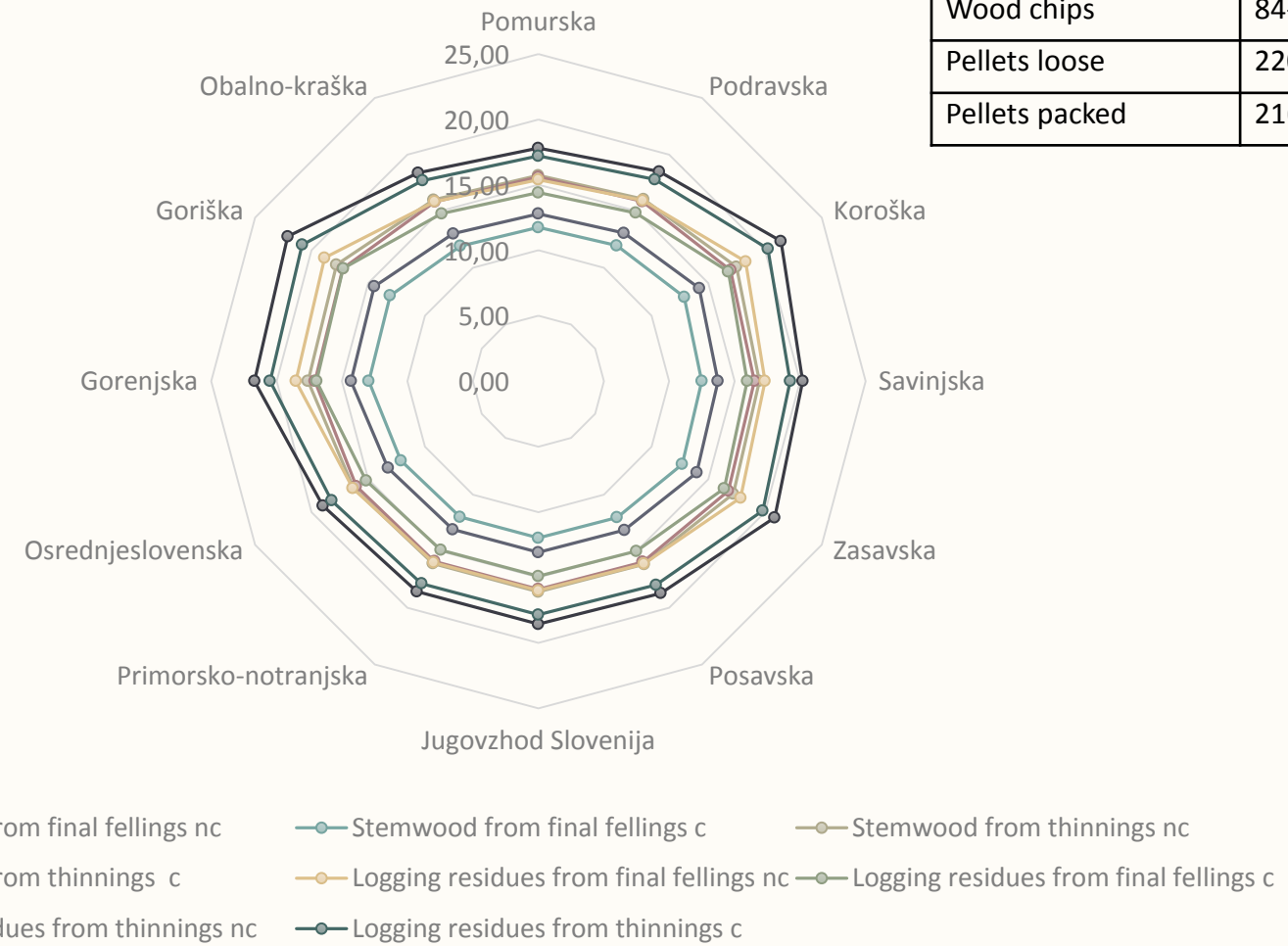
More detailed information can be viewed & downloaded

www.s2biom.eu

Costs* and market prices of feedstocks

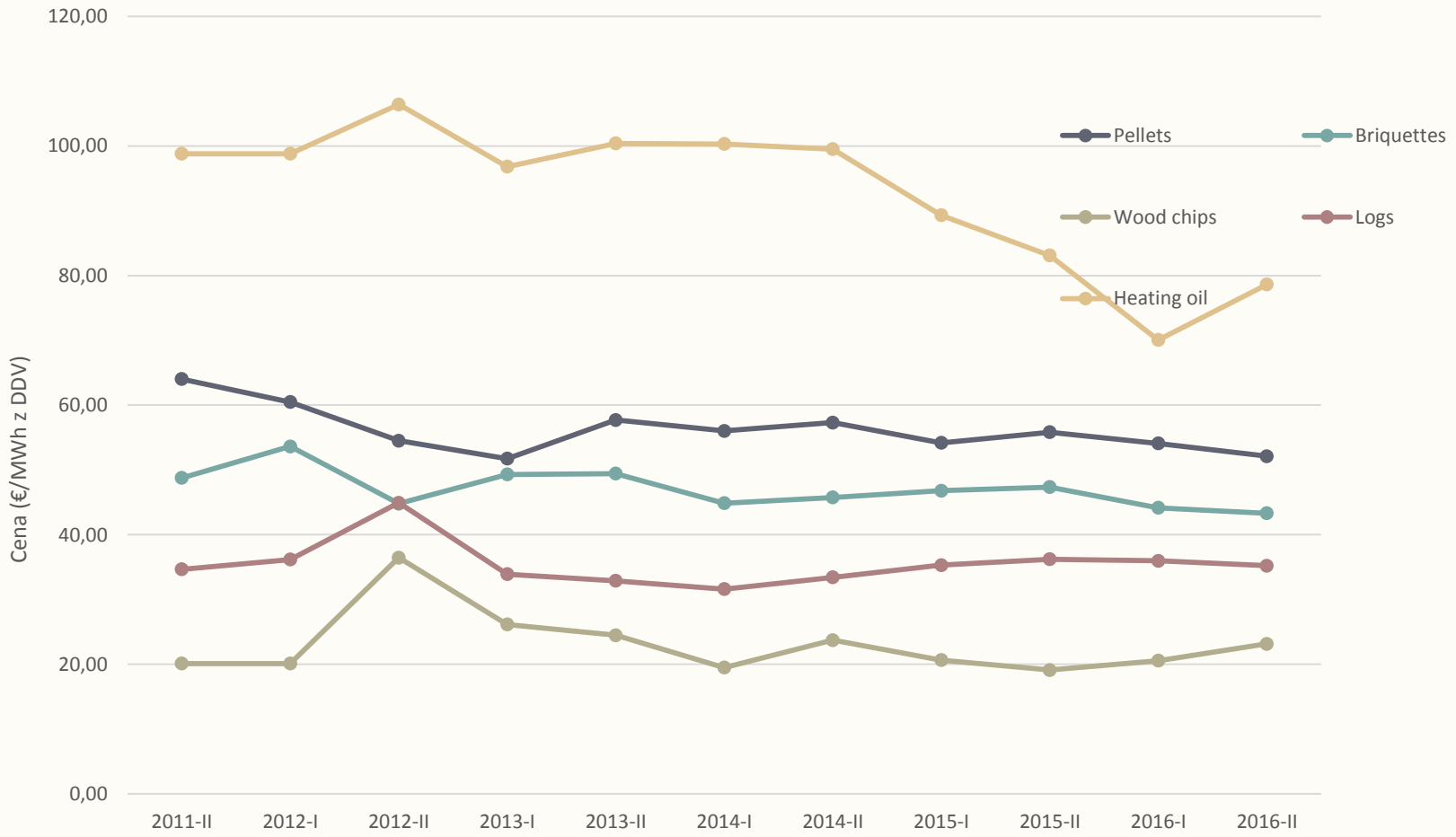
(€/t dry matter; including VAT)

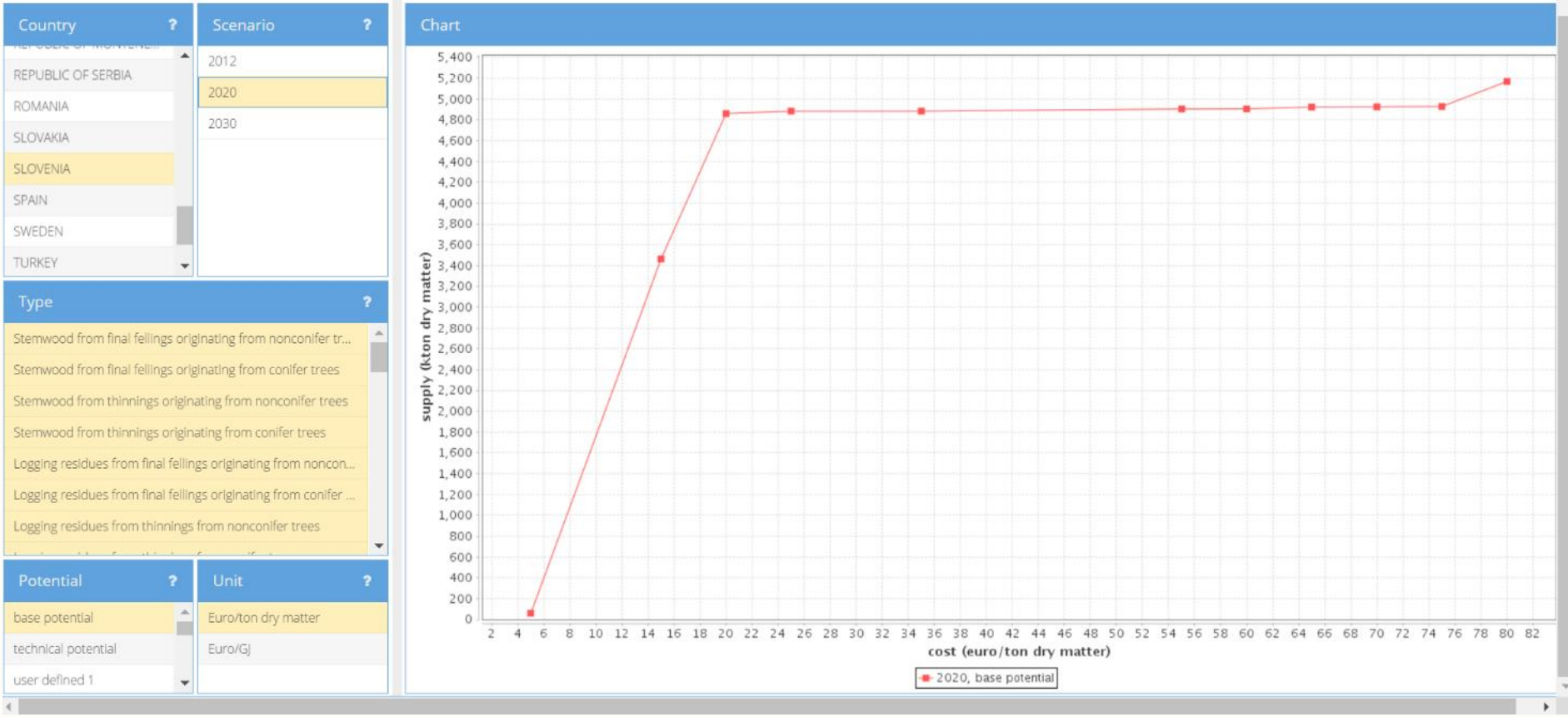
Type	Price (€/t dry matter) including VAT
Wood chips	84- 94
Pellets loose	220 – 250
Pellets packed	216 – 228



* Costs in figure refer to roadside production costs

Prices of wood fuels in last 5 years





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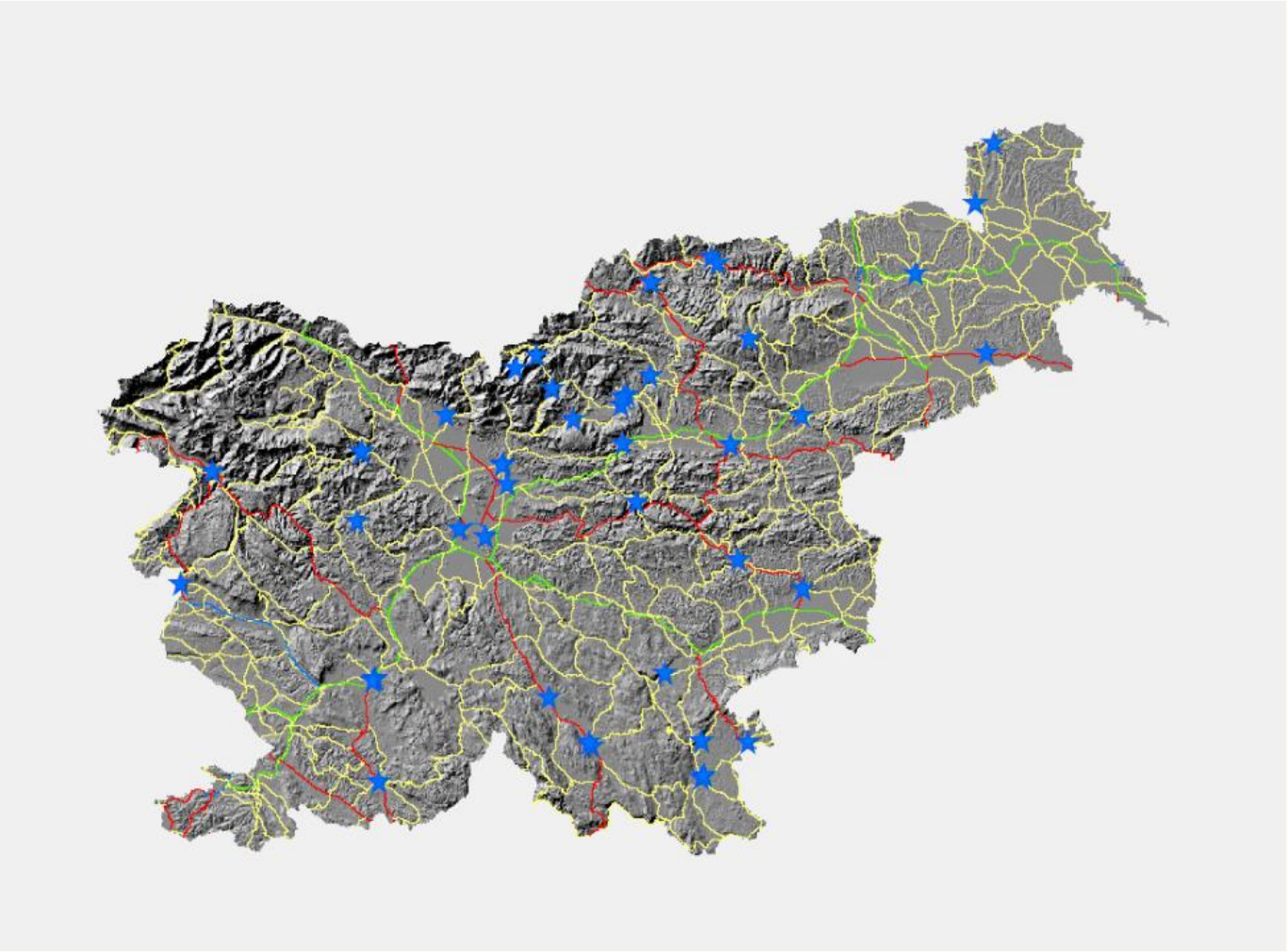
Infrastructure & contracts



Locations of existing CHP and DH plants in Slovenia (Source: SFI and EnGIS)

Analysis of biomass supply infrastructure

While conventional fossil fuels are commodities with well-established supply, biomass fuels have not yet attained similar status.

The establishment of guaranteed supply is a key area for potential plant owner / operator, with significant risks.

In the biomass industry, two approaches have commonly been used for procuring biomass feedstocks for plant that do not use residues generated on-site:

- Plant operators contract directly with independent biomass fuel suppliers.
- Plant operators contract with independent fuel brokers who agree to provide biomass fuel at set terms and to take on the risks of negotiating with independent suppliers.

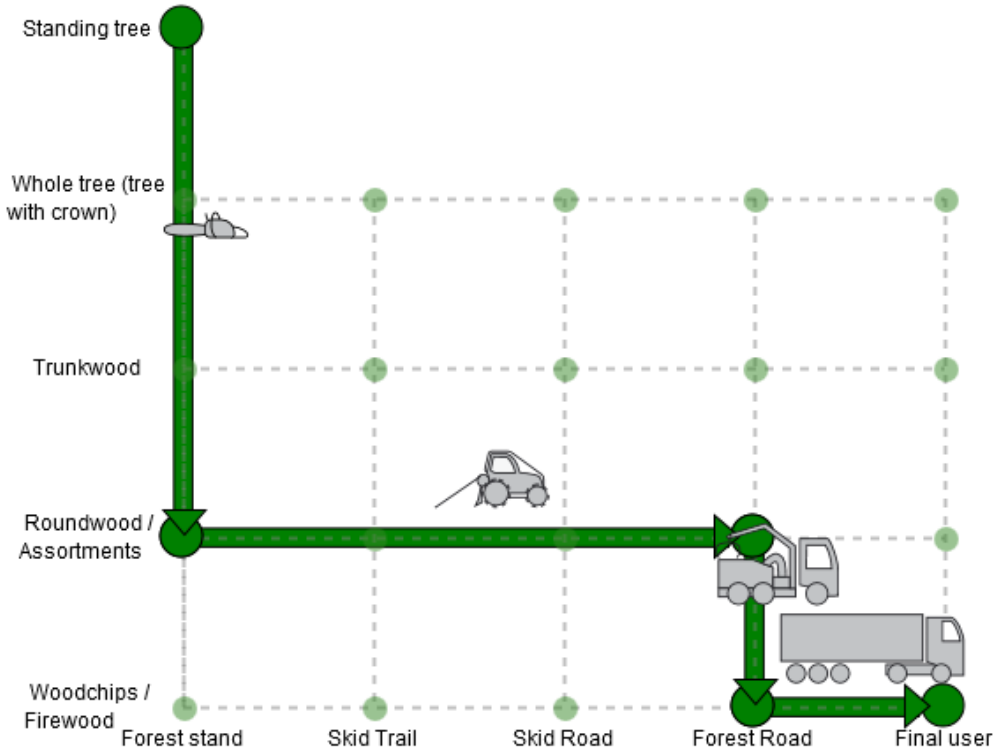
Biomass supply contracts: terms & conditions

Biomass delivery contracts typically include the following terms and conditions:

- Term of contract and notice of termination.
- Agreed quantity of biomass, including provisions in the event of increase/decrease in the consumption of biomass, non-delivery due to decrease in harvested yield etc.
- Terms of delivery, including type of biomass fuel, water content, and other specifications.
- Basic price and the regulation of price in proportion to water content and time of delivery.
- Provisions concerning the regulation of the basic price.
- Provisions concerning arbitration.

Which value chains have high resource and energy efficiency?

Visualization of supply chain

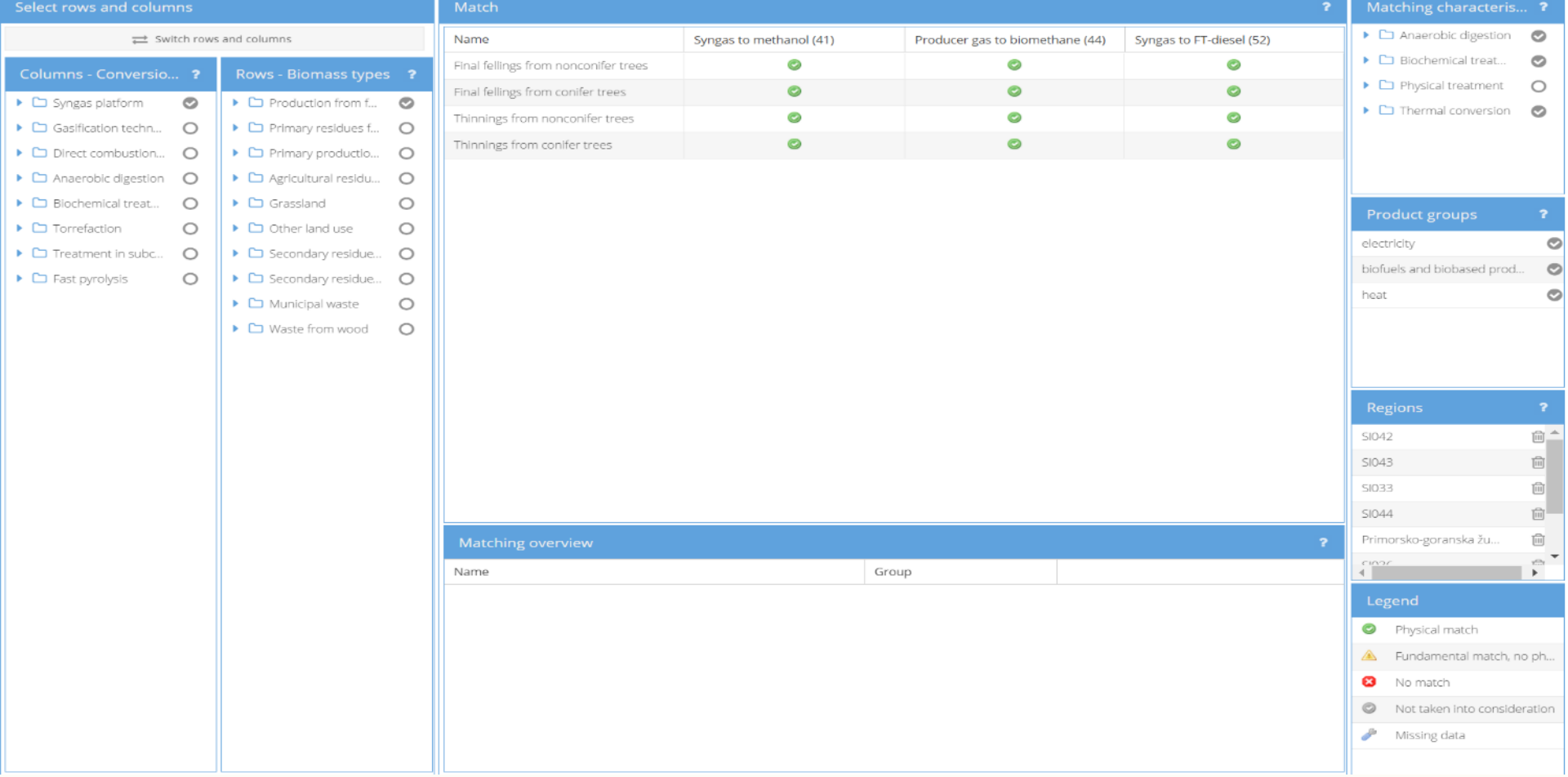


Matching regional biomass to conversion technologies

In S2BIOM a database for standardised biomass characterisation was developed and populated for all lignocellulosic biomass types covered in the project.

This database was intended to be used to determine, if certain biomass types can be used as feedstocks for specific conversion technologies. For this purpose an extensive characterisation for the conversion technologies was also made with regard to minimal biomass characteristics requirements.

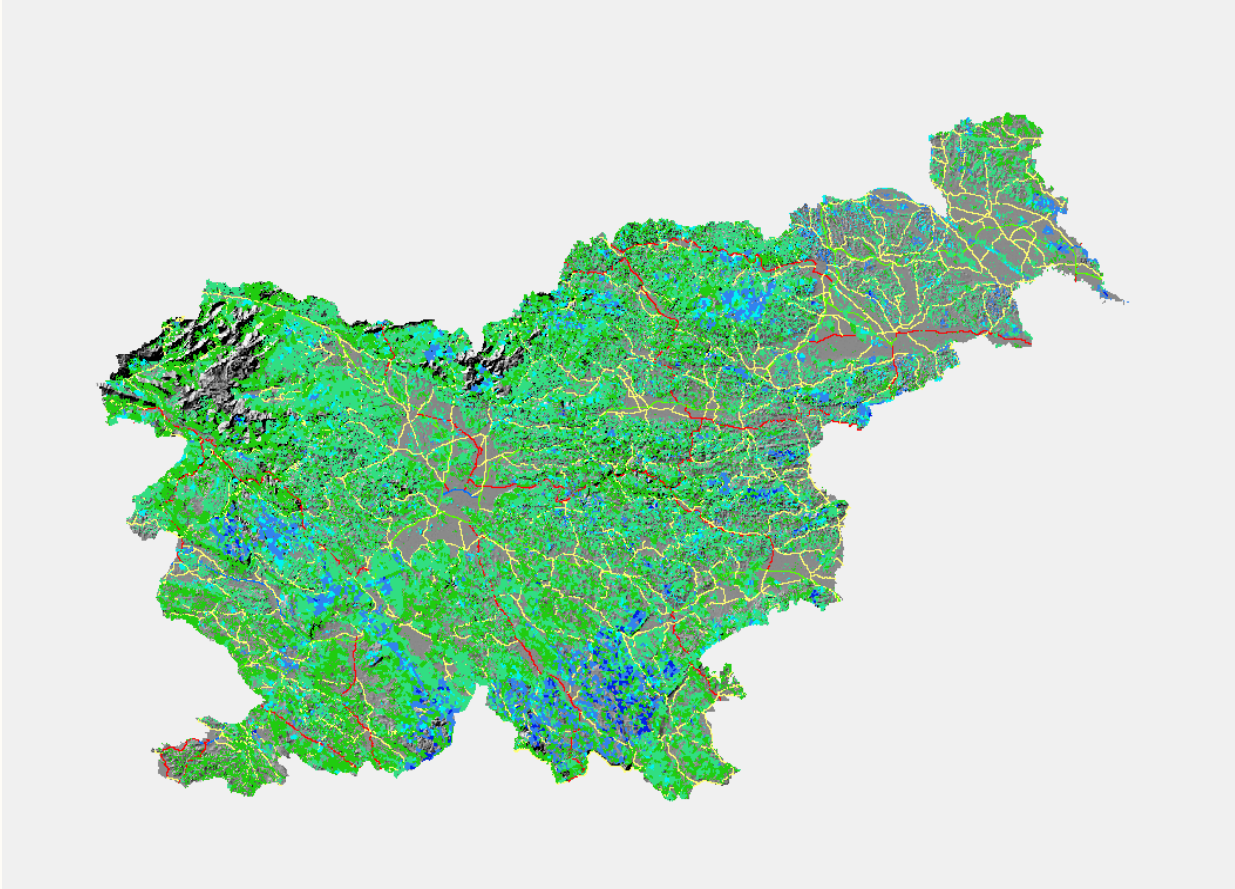
The biomass characteristics and the conversion technology requirement characteristics were then used to develop the biomass matching tool (Bio2Match) which is accessible via the project website.



More detailed information can be viewed & downloaded

http://s2biom.alterra.wur.nl/web/guest/bio2match

Feasibility of forest biomass CHP

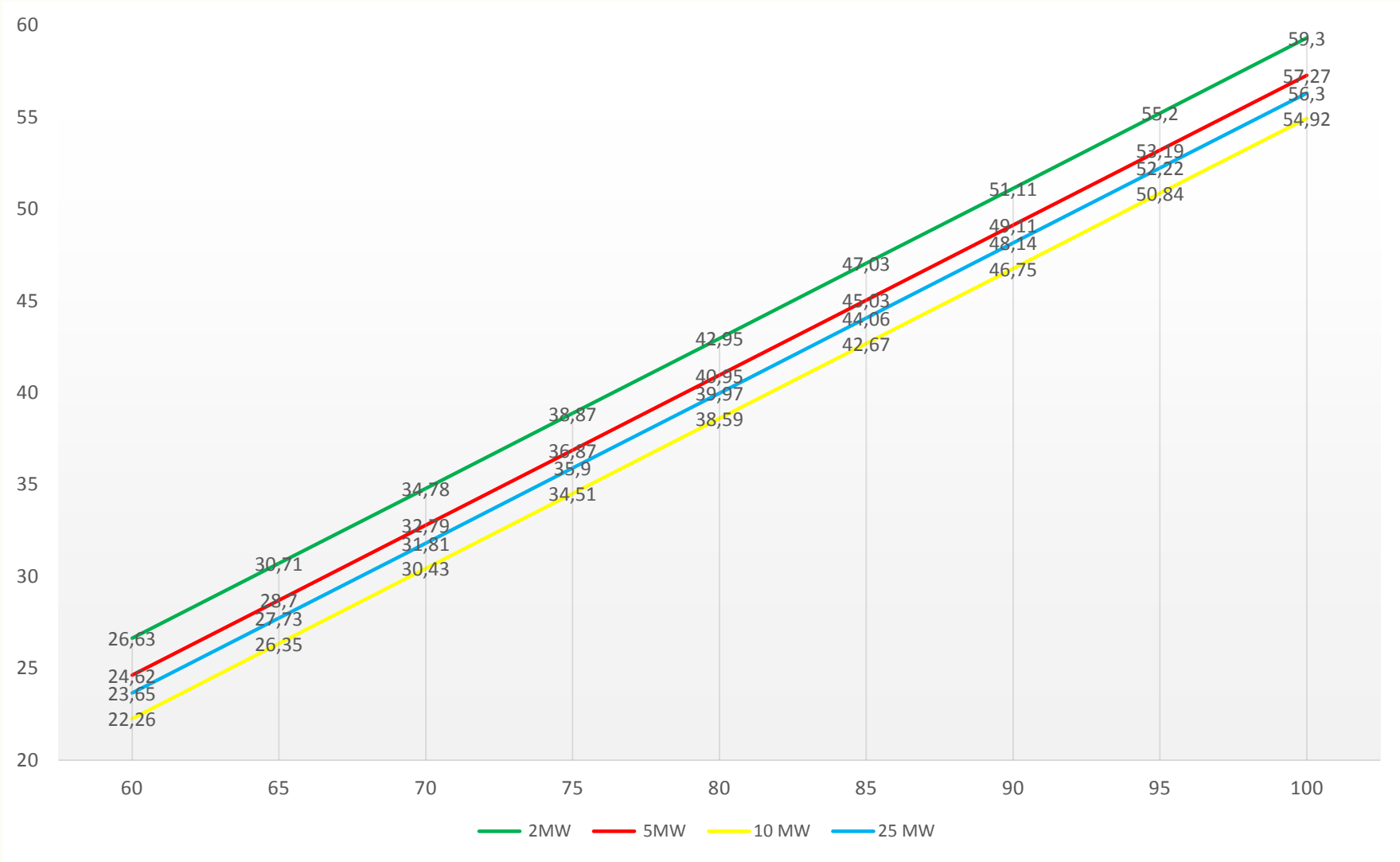


Map of marketable quantities of lower quality roundwood (SFI, 2016)

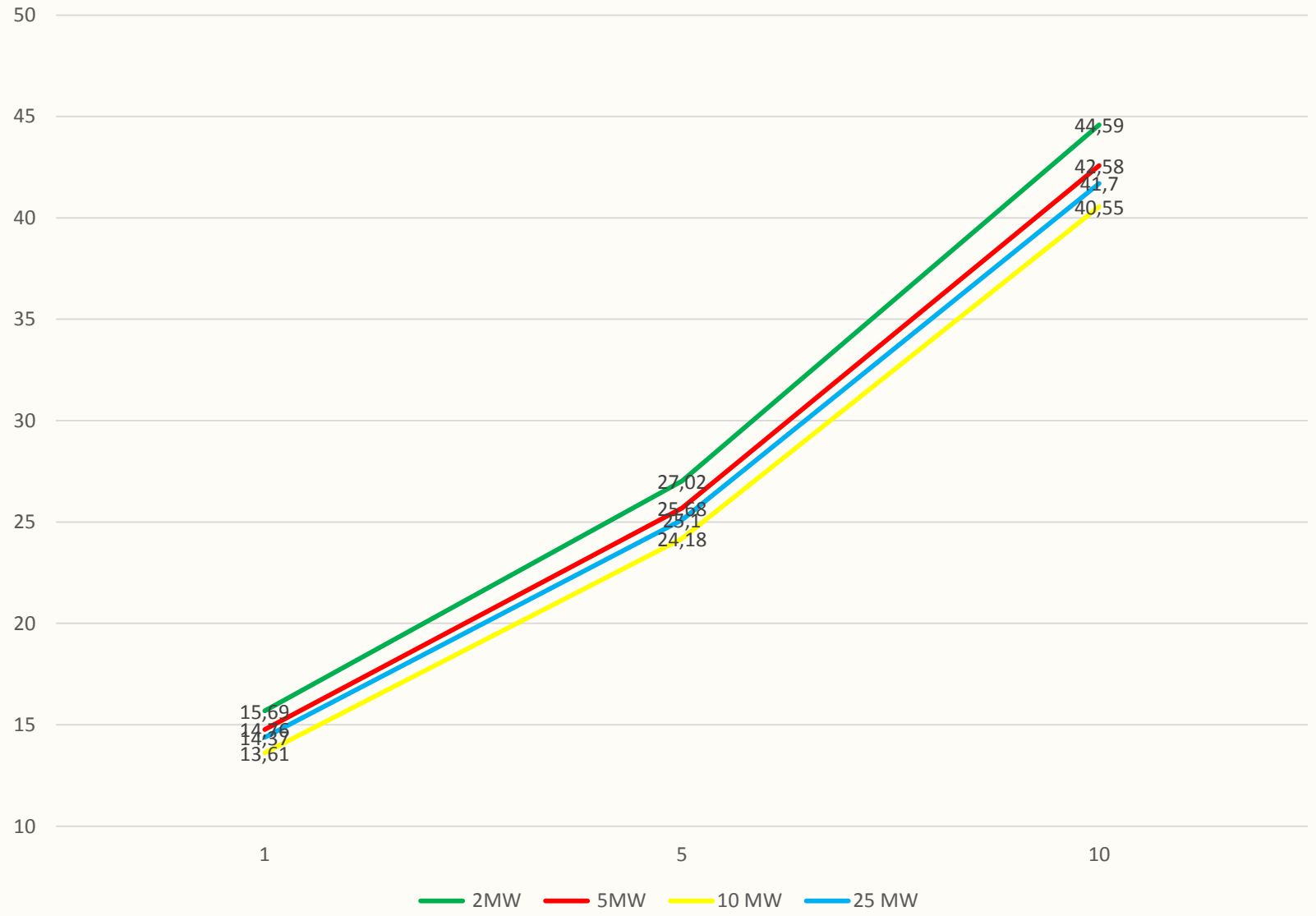
Outline of key cost parameters

Nominal capacity (MWel)	2	5	10	25
CONSTRUCTION				
land cost (Euro)	300,000	400,000	500,000	700,000
environment, planning, legal (Euro)	10,000	10,000	15,000	15,000
plant & equipment (Euro) (eligible for grant aid)	5,000,000	12,500,000	24,000,000	63,000,000
construction, commissioning (Euro) (eligible for grant aid)	250,000	300,000	1,000,000	1,000,000
CAPITAL COST	5,560,000	13,210,000	25,515,000	64,715,000
OVERHAUL & MAINTENANCE				
annual cost (Euro) (2.5% of plant & equipment)	125,000	312,500	600,000	1,575,000
OPERATION				
no of operators	2	3	3	5
average cost of operators including overheads (Euro)	35,000	35,000	35,000	35,000
operator cost	70,000	105,000	105,000	175,000
FEEDSTOCKS / DISPOSAL				
Operating hours per year	8,000	8,000	8,000	8,000
Wood fuel consumption (oven dry tonnes per hour)	1.6	4.0	8.2	20.5
Wood fuel consumption (oven dry tonnes per year)	12,800	32,000	65,600	164,000
Wood fuel cost (Euro per oven dry tonne delivered)	82	82	82	82
Wood fuel cost (Euro total)	1,049,600	2,624,000	5,379,200	13,448,000
CONVERSION PLANT IRR	10%	10%	10%	10%
HEAT REVENUES				
Selling price of electricity (euro/ MWh el)	45.8	42.6	40.4	41.6
Annual electricity production (MWh el)	12,800	32,000	64,000	160,000
Present value of electricity sales	4,121,431	9,607,504	18,247,635	46,942,429
Annual heat production (MWh th)	22,400	55,040	110,080	275,200
Selling price of heat (euro/ MWh th)	50	50	50	50
Present value of heat sales	7,721,532	19,339,380	38,678,760	96,696,901

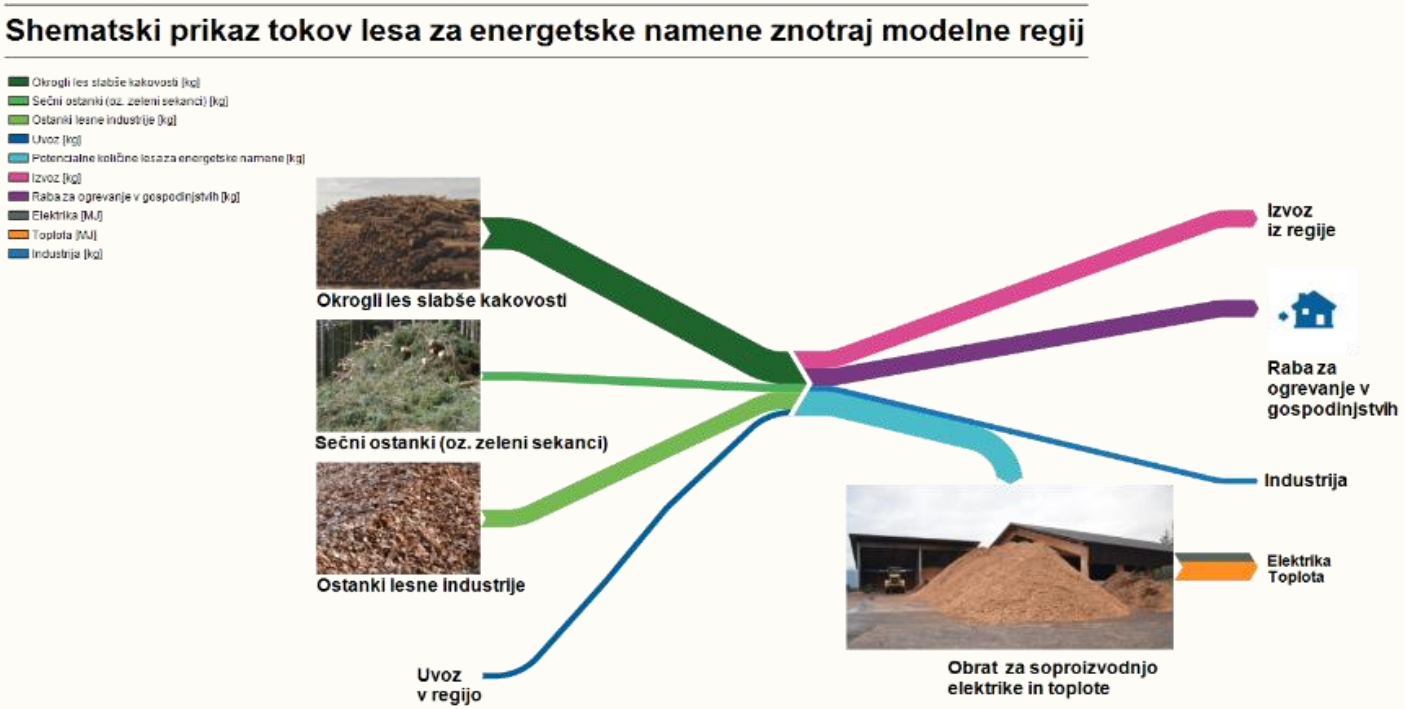
Electricity selling prices for different wood price variations (60- 100 €/tonne), heat selling price: 50 €/MWh and plant IRR:10%



Impact of electricity selling price to conversion plant IRR

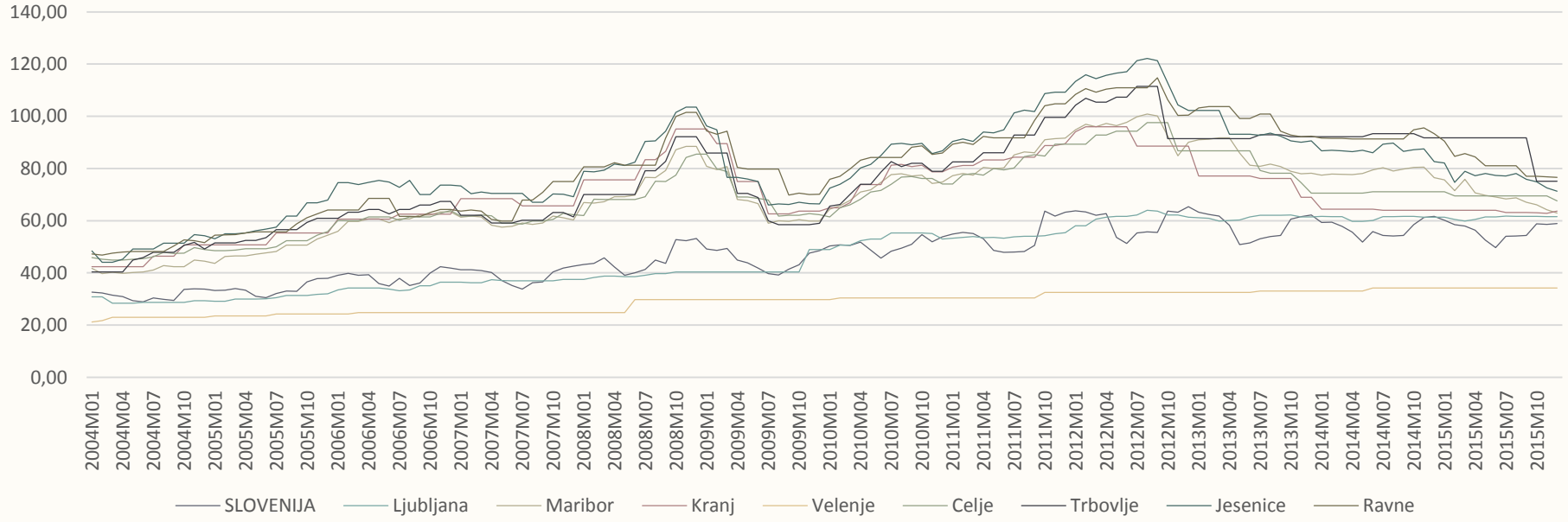


Feasibility of forest biomass for district heating



Schematic flow of lower quality wood in Slovenia

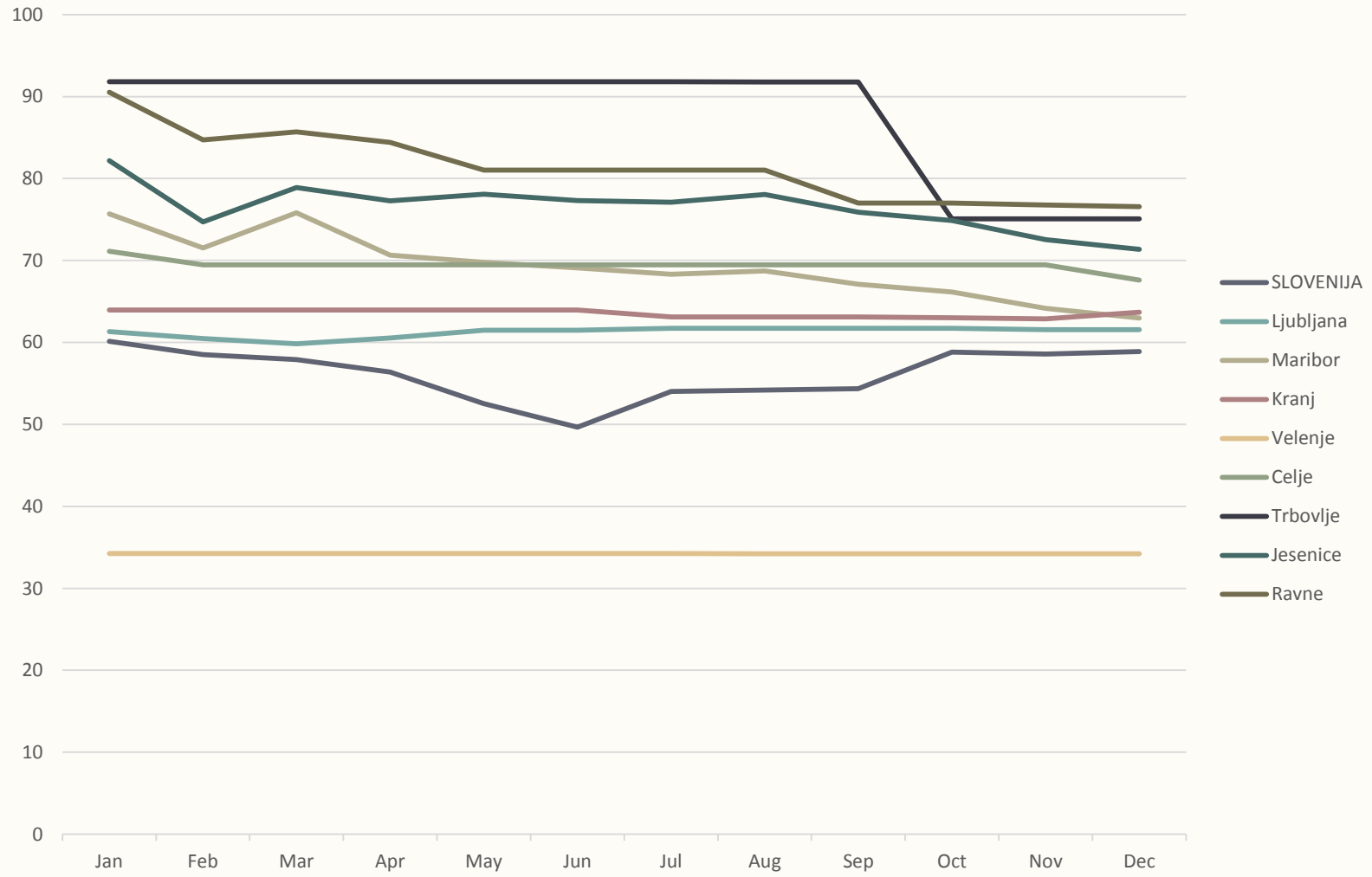
Heat selling prices in Slovenia (€/MWth; Slovenian Ministry for Infrastructure, 2016)



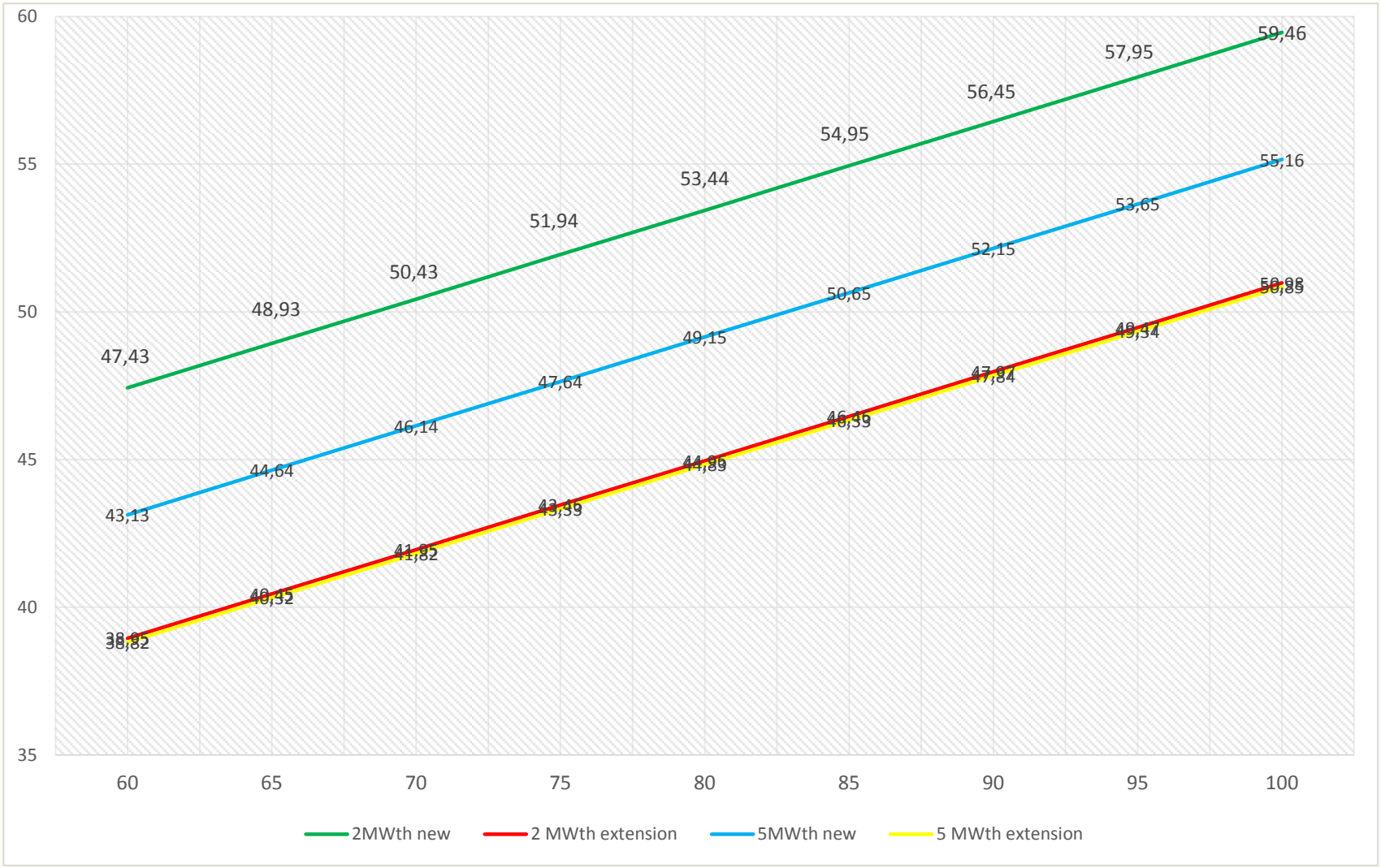
Outline of key cost parameters

Nominal capacity (MWth)	2MWth new	2 MWth extension	5MWth new	5 MWth extension
CONSTRUCTION				
land cost (Euro)	300,000	-	400,000	-
environment, planning, legal (Euro)	10,000	10,000	10,000	10,000
plant & equipment (Euro) (eligible for grant aid)	1,100,000	1,100,000	2,750,000	2,750,000
construction, commissioning (Euro) (eligible for grant aid)	250,000		300,000	
CAPITAL COST	1,660,000	1,110,000	3,460,000	2,760,000
OVERHAUL & MAINTENANCE				
annual cost (Euro) (2.5% of plant & equipment)	27,500	27,500	68,750	68,750
OPERATION				
no of operators	2	0	2	0
average cost of operators including overheads (Euro)	35,000	0	35,000	0
operator cost	70,000	0	70,000	0
FEEDSTOCKS / DISPOSAL				
Operating hours per year				
Wood fuel consumption (oven dry tonnes per hour)	1	1	2	2
Wood fuel consumption (oven dry tonnes per year)	3,008	3,008	7,519	7,519
Wood fuel cost (Euro per oven dry tonne delivered)	82	82	78	78
Wood fuel cost (Euro total)	246,615	246,615	586,466	586,466
CONVERSION PLANT IRR	10%	10%	10%	10%
HEAT REVENUES				
Selling price of heat (euro/ MWh th)	54.043	45.564	49.713	45.396
Present value of heat sales	3,041,961	2,564,688	6,995,545	6,388,107

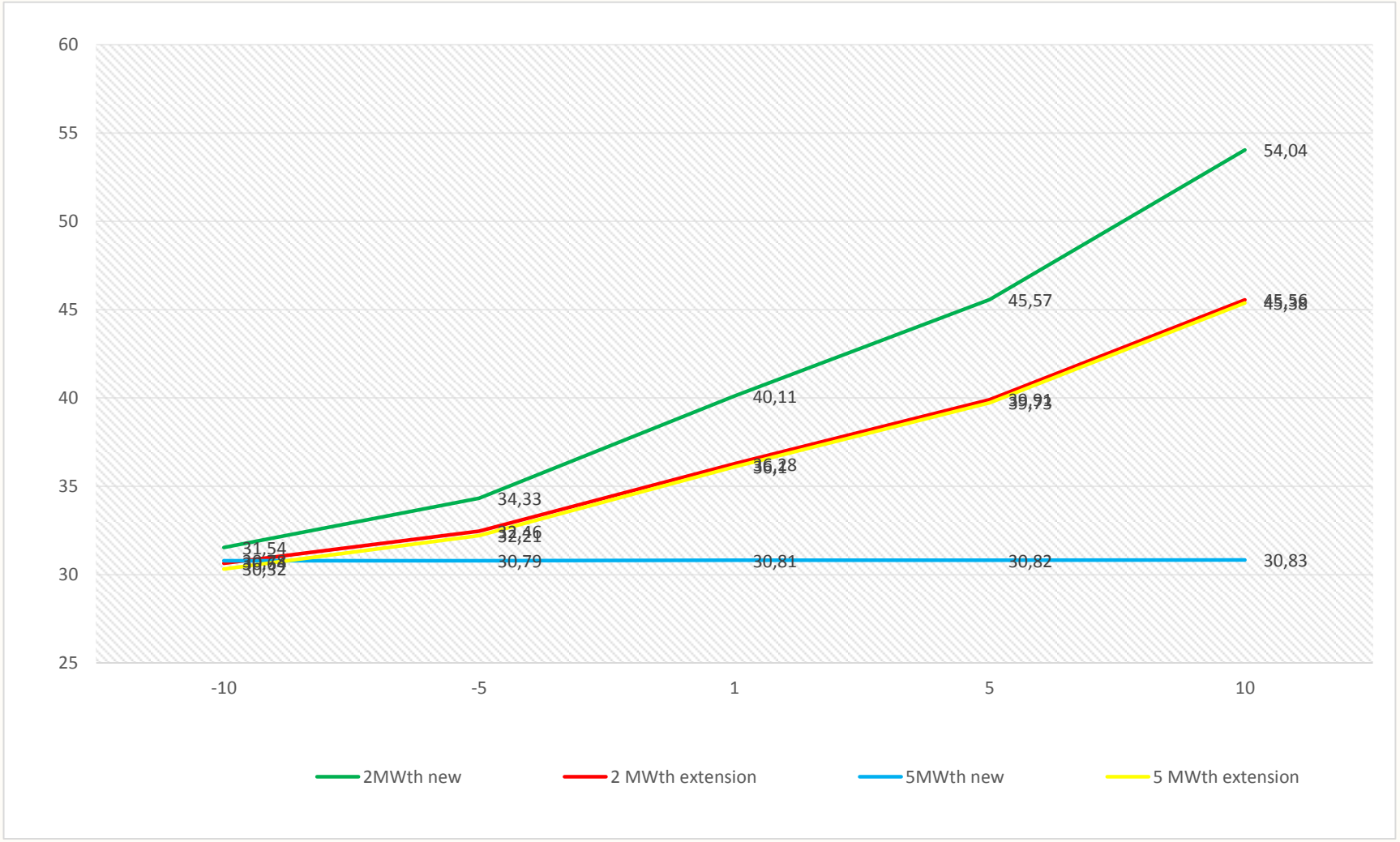
Heat price variations (€/MWth) for the district heating plants in Slovenia and the respective cities in 2015



Heat selling prices for different forest biomass prices (60- 100 €/tonne) and plant IRR 10%



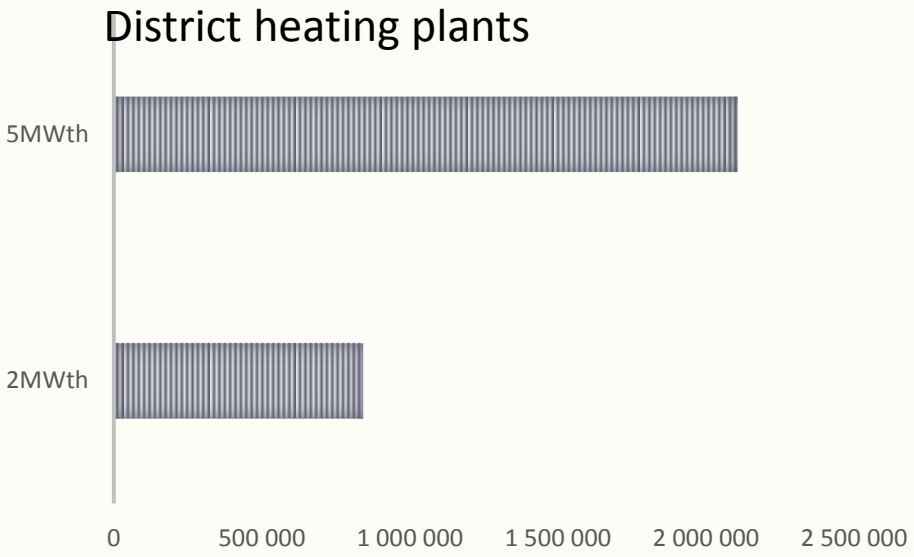
Impact of heat selling price to conversion plant IRR

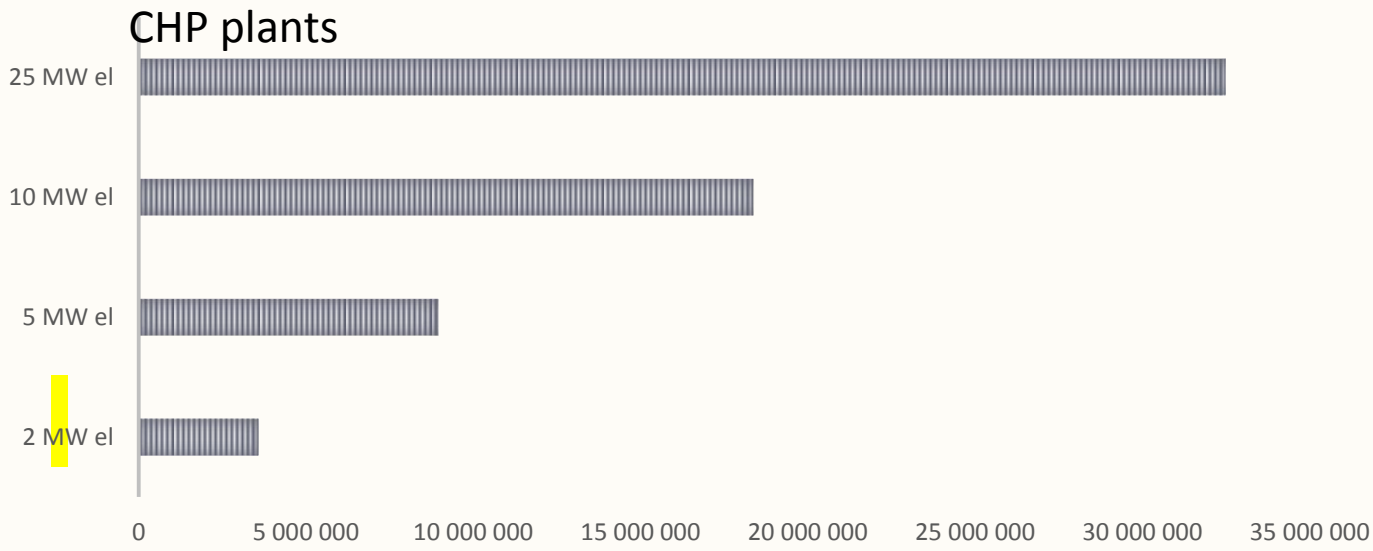


Overview of impact indicators

Output service quality

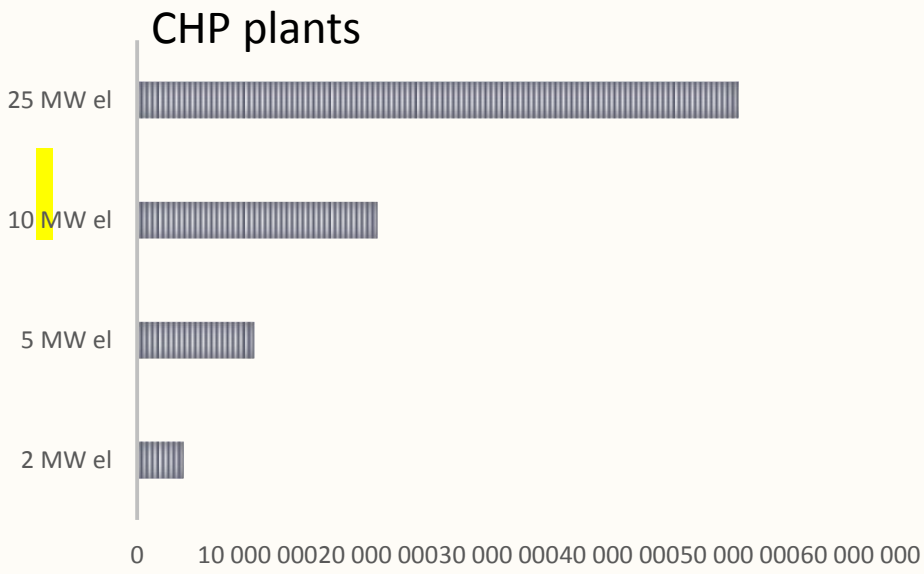
The output service quality presented in this slide in euros (**€**) indicates the economic value of the outputs in relation to the dry biomass inputs. The indicator is calculated as follows: economic value of the outputs (€/GJ x GJ energy carriers + €/ton x ton materials) – economic value of the inputs (excl. the biomass) (€/GJ x GJ energy carriers + €/ton x ton materials).

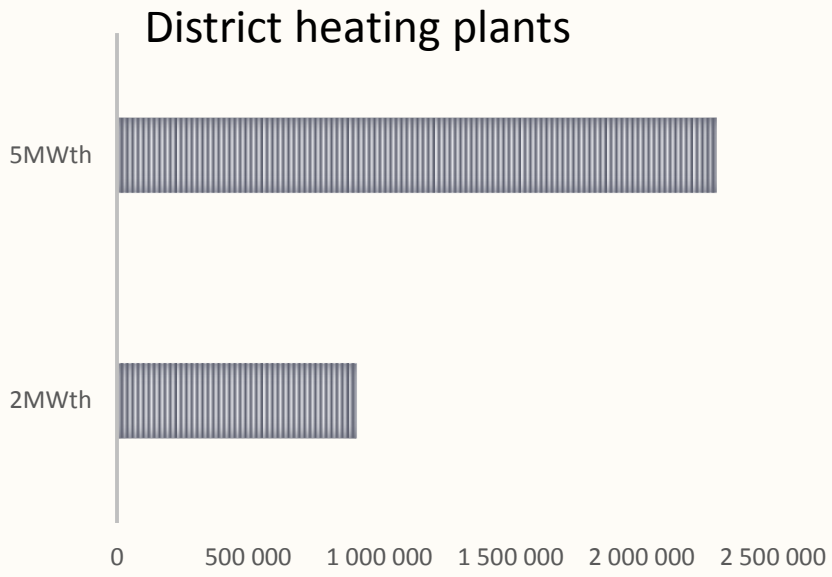




Levelised life cycle costs

The indicator is expressed in **€.** It measures value across the longer term, showing projected life-cycle costs

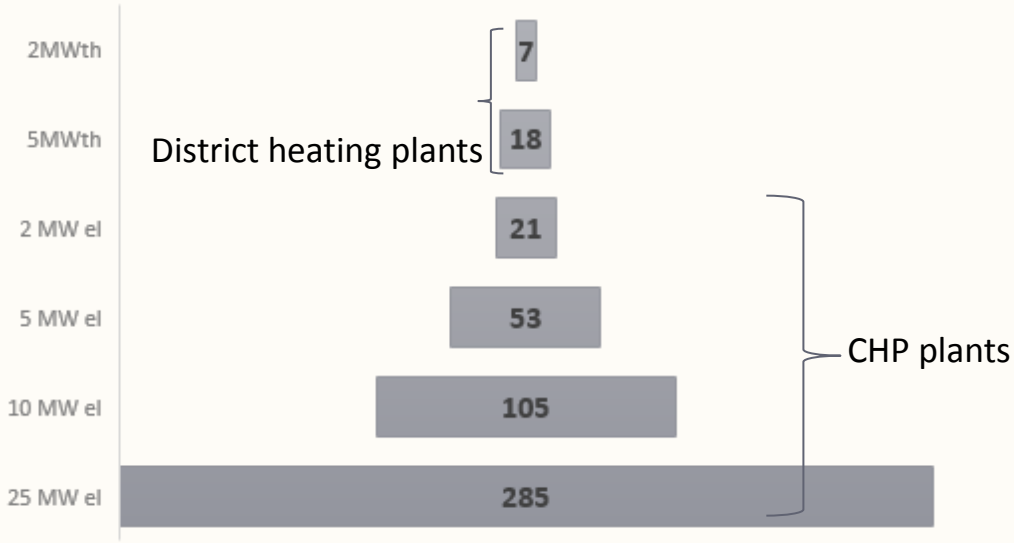




Direct jobs

The following value chain steps require employment that is included in the measurement of direct jobs created:

- bioenergy feedstock production;
- biomass transportation;
- biomass conversion and processing;
- manufacturing of equipment;
- installation of conversion plants and other equipment;
- operation and maintenance of conversion plants and other equipment
- distribution and sales.



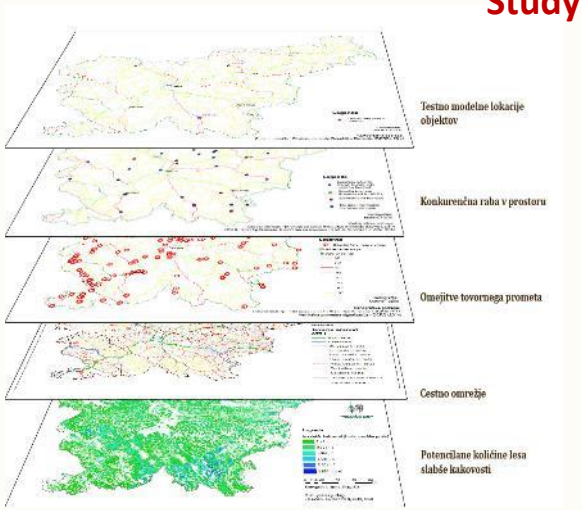
The indicator is expressed here in **number of full-time jobs per value chain**

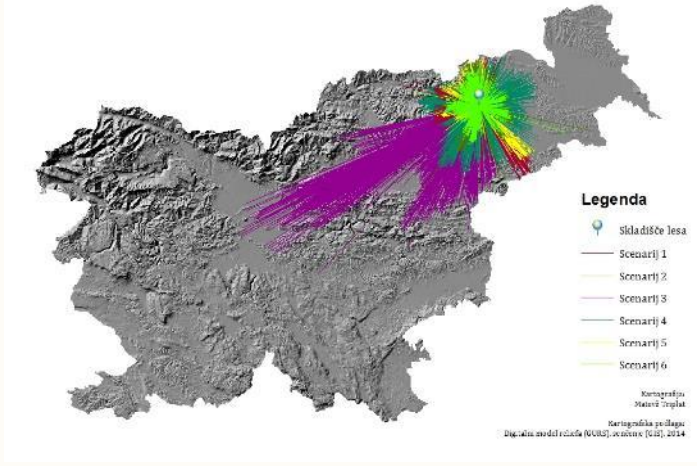
Further reading – pilot project: DH in Maribor

Aim of Pilot project

- Specify the availability of wood biomass potential and amount of wood biomass available depending on required quality (moisture, type of wood – deciduous/coniferous, …);
- Figure out whether there is enough available feedstock in the nearby forests – distance to feedstock with various forms of ownership (state or private forests) – 5 scenarious were made;
- Prepare recommendations for the storage of wood biomass as roundwood;
- Analyze the production cost of wood chips;
- Present the idea to decision makers In local community, Ministry of environment and to investor.

Study is available on: www.s2biom.eu





Further reading

- www.s2biom.eu
- http://www.s2biom.eu/en/publications-reports/s2biom.html
- http://s2biom.alterra.wur.nl/web/guest/biomass-characteristics
- http://s2biom.alterra.wur.nl/web/guest/country-downloads
- TRIPLAT, Matevž, PRISLAN, Peter, KRAJNC, Nike. Decision-making tool for cost-efficient and environmentally friendly wood mobilisation. *South-east European forestry*, ISSN 1847- 6481, 2015, vol. 6, no. 2, str. 179-190, ilustr. http://www.seefor.eu/vol-6-no2-triplatet- al-decision-making-tool.html, http://dx.doi.org/10.15177/seefor.15-16, doi: 10.15177/seefor.15-16.
- ŠČAP, Špela, TRIPLAT, Matevž, PIŠKUR, Mitja, KRAJNC, Nike. Metodologija za ocene potencialov lesa v Sloveniji = The methodology for wood potential assessment in Slovenia. *Acta silvae et ligni*, ISSN 2335-3112. [Tiskana izd.], 2014, [Št.] 105, str. 27-40, ilustr. http://dx.doi.org/10.20315/ASetL.105.3,
- http://eprints.gozdis.si/id/eprint/1609, doi: 10.20315/ASetL.105.3
- LOPEZ, Ignacio, KRAJNC, Nike, TRIPLAT, Matevž. *Development of a geo-information system for potential forestry biomass management : setting up of integrated strategies for the development of renewable energies : final reports of pilot actions : pilot action 1.2*. [S. l.: s. n.], 2014. ilustr.
- http://proforbiomed.eu/sites/default/files/1.2%20-%20Biomass%20potentials.pdf

S2Biom

Project coordinator

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Fachagentur Nachwachsende Rohstoffe e.V.

Scientific coordinator

Imperial College London

Project partners

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IINAS International Institute for Sustainability Analysis and Strategy
CEI CENTRAL EUROPEAN INITIATIVE
btg biomass technology group
biomass research




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