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Report WP 1 – Blockchain4Prosumers

Regulatory Framework Conditions for Decentralized Microgrids and P2P Sharing Concepts in The Netherlands

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ABOUT BLOCKCHAIN4PROSUMERS

The Interreg EMR Blockchain4Prosumers project aims to develop a framework, new business models and demonstrators to develop the potential of the energy market that prosumers – households and businesses that generate energy locally – create using blockchain technology.

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List of Acronyms

ACM	Authority for Consumers and Markets
AI	Artificial Intelligence
BC4P	Blockchain for Prosumers
BRP	Balance Responsible Parties
CBS	National Census Bureau
CEC	Citizen Energy Community
CEP	Clean Energy Package
DNB	De Nederlandse Bank
DSO	Distribution System Operator
EDSEP	Experimentation Decree
EU	European Union
EV	Electric Vehicles
GVO	Guarantees of origin
GW	GigaWatt
HTV	Heat Transition Vision
IEA	International Energy Agency
IMED	Internal Market for Electricity Directive
ISDE	Investment Subsidy for Sustainable Energy and Energy Saving
kWh	kilo Watt hour
kWp	kilo Watt peak
LEF	Local, Energy and Flexibility
ODE	Opslag Duurzame Energie
P2P	Peer-to-Peer
PBL	Netherlands Environmental Assessment Agency
PV	Photovoltaic
REC	Renewable Energy Community
REDII	Renewable Energy Directive (recast to 2030)
RVO	Rijksdienst voor Ondernemend Nederland (The Netherlands Enterprise Agency)
SCE	Cooperative Energy Generation Subsidy
SDE	Sustainable Energy Transition subsidy scheme
SME	Small and Medium Enterprises
TSO	Transmission System Operator
VAT	Value-added tax

1. The Dutch Energy Market: Generation, Retail and Regulation

Traditionally the Dutch electricity market used gas and coal driven power plants. Although there where initiatives to move towards a more sustainable power production, it was the Urgenda foundation that forced the Government to move faster and to phase out coal. Today, the Dutch electricity market is getting more mature, transparent, and liberalised. It enjoys a high degree of consumer confidence, strong (green) product innovation, and a willingness among consumers to pay a premium for green electricity albeit within limits (Mulder & Willems, 2019).

A defining element of the Dutch power / generation market is the strict separation between network infrastructure ownership and the carrying out of commercial activities including energy generation, distribution, and retail (Electricity Act, 1998). As a result, the national high-voltage grid is ran by a single state-owned Transmission System Operator (TSO), TenneT, who delivers electricity to medium and low-voltage grids which are managed by eight heavily regulated and privately owned Distribution System Operators (DSOs) whom are territorial organised and form natural monopolies. In Limburg, the electricity gas and electricity DSO is Enexis B.V..

To accommodate the unbundled system, a 'balancing market' consisting of Balance Responsible Parties (BRP) enables real-time balancing of electricity supply and demand. Examples of BRPs are the energy suppliers but a full register can be found on Tennet's website[1].

The 'retail market' has been completely liberalised since 2004, however 80% of the market is concentrated by Essent, Vattenfall and Eneco. Energy prices are relatively homogenous and market competition is based on product innovation rather than price (Mulder & Willems, 2019).

Electricity, gas and heat markets are regulated and monitored by the autonomous 'Netherlands Authority for Consumers and Markets' (ACM), who oversees competition, regulates actors (including TSOs, DSOs and suppliers), and enforces consumer protection laws. Important regulatory activities include granting electricity supply permits and monitoring the retail price of electricity and heat. Table 1 provides a summary of the names, roles and responsibilities of the most important actors in the energy market (Buth, 2018).

[1] Register of BRPs in The Netherlands: https://www.tennet.eu/electricity-market/dutch-market/brp-register/

Table 1. Overview of Actors in the Dutch Energy Market

Actors in the Dutch Energy Market		
Actor	Name(s)	Roles and responsibilities
Power Generators	Main players: Vattenfall/Nuon, RWE/Essent, Eneco	Over 25 producers generate electricity in the Netherlands. The power generation market is however dominated by three main players (Deloitte, 2017)
Transmission System Operator (TSO)	TenneT	State-owned entity which operates the transmission system, stabilises the high voltage grid and manages cross-border activities
Distribution System Operators (DSO)	Coteq Netbeheer B.V., Liander N.V., Enexis B.V., GasUnie Transport Services B.V., Stedin Netbeheer B.V., Westland Infra Netbeheer B.V., N.V RENDO, Tennet TSO B.V.	DSOs are private owned entities which are heavily regulated by the ACM and form regional monopolies. They are tasked with managing the distribution system and providing reliable power to consumers no middle to low voltage grids
Balance Responsible Parties (BRP)/traders	Mostly represented by energy companies but this is not required nor always the case.	BRPs balance the purchase and sale of electricity, plan daily usage and presenting planning to TSO at the end of the day to secure grid balancing.
Aggregators	Some players: Eneco, CrowdNett, Next Kfraftwerke	Aggregators bundle small and medium-sized power resources connected to the distribution network to engage as a single entity – a virtual power plant (VPP) – in power or service markets. They manage demand response patterns i.e., selling flexibility services to the market (system operators) and offering technical and economic services to other actors.
Data Facilitator	Energie Data Services Nederland (EDSN)	Advance administrative data exchange between market parties (such as system operators, metering companies, BRPs and suppliers) while acting as a platform for consumers to switch supplier.
Retail Suppliers	Dominant: Essent, Vattenfall, Green Choice, Budget Energie, Vandebron, Engie	Intermediary parties between producer and end-user, supplying electricity and natural gas to end-users
Market Regulator	ACM	Oversees consumer protection and free market competition.
Independent Aggregator	Future market actor	A new market actor introduced in the IMED 2019/944 to provide greater access for prosumers to participate in the electricity market. This actor may purchase surplus energy from prosumers and resell to consumers.

2. Overview of the Regulatory Landscape in the Netherlands

To understand the regulatory framework for peer-to-peer (P2P) energy trading in the Netherlands this section provides an overview of the legislative landscape in the Netherlands by detailing and exploring relevant European Union (EU) regulation, as well as national legislation, subsidies, and tariffs.
At the EU level, the Renewable Energy Directive 2018/2001 (REDII) and the Internal Electricity Market Directive 2019/944 (IMED 2019/944) are particularly important since they provide regulatory frameworks for P2P energy trading among prosumers and energy communities. As a Member State, the Netherlands is legally bound to mandate these frameworks into national law and will do so through its new 'Energy Act 2022'.
Currently at the national regulatory level, the 'Electricity Act 1998' provides the foundation for the energy system in the Netherlands. Since 2004 this law has allowed for prosumers to engage in net-metering i.e., selling their excess energy to the national grid. The law also allows for 'regulatory sandbox' experiments to take place in the pursuit of improving future policy. A regulatory sandbox was permitted in 2015, known as the 'Experimentation Decree 2015-2018' whereby energy cooperatives and homeowner associations could conduct P2P energy trading outside of normal regulatory rules. As for heat networks, the regulatory framework is provided by the 'Heat Act 2014', which is due to be replaced and updated in the near future by the 'Collective Heat Supply Act (aka Heat Act 2)'. In terms of national support schemes for increasing the uptake of renewable energy, owners of sustainable energy generation can avail of the ISDE installation subsidy scheme (RVO, 2021b) and/or the SDE++ operating subsidy (RVO, 2021c). Meanwhile, an operating subsidy known as the SCE is available to energy communities (RVO, 2021e).
In recent years, Dutch energy policy has been increasingly aimed at accelerating the transition to a carbon-neutral economy (IEA, 2020). A key element of Dutch climate policy is the 2019 'Climate Agreement' ('Klimaatakkoord') which sets target of reducing greenhouse gas emissions against 1990 levels by 49% by 2030 and 95% by 2050. In light of EU policy and these new targets, national energy regulation will be updated in 2022 and beyond to ensure that legislation will realise climate goals. Specifically, a new 'Energy Act 2022', will replace the 'Electricity Act 1998', while the 'Collective Heat Supply Act' will replace the 'Heat Act 2014'.

2.1. European Union Regulation

Energy and climate regulation at the EU level is continuously and rapidly developing, but the most up-to-date EU energy policy framework at the time of writing is the '2019 Clean Energy Package' (CEP); which contains directives and regulations with a high degree of influence over internal energy markets and renewable energy communities. Specifically, the 'Renewable Energy Directive' and the Internal Electricity Market Directives provide frameworks for peer-to-peer energy trading, which the Netherlands will ratify into national law in its upcoming 2022 Energy Act.
In July 2021 however, the European Commission unveiled a newer policy package: the 'Fit for 55' energy climate law, which will include updated versions of the directives listed in the CEP. The aim of this package is to increase reduction targets of greenhouse gas emissions against 1990 levels by 55% by 2030, and to increase the target for the EU's overall share of renewable energy from 32% to 40% by 2030 (European Council, 2021). However, it is expected that the new package won't be enacted until 2023 (PWC, 2021), thus only the CEP is discussed in this report. As for the current CEP, the following directives are most relevant for BC4P:

- The Renewable Energy Directive (REDII) (recast) EU 2018/2001
- The Internal Market for Electricity Directive (IMED) EU 2019/943
- Common Rules for the Internal Market for Electricity Directive (CRIMED) EU 2019/944

In the following, each of the three directives are discussed in more detail.

2.1.1. The Renewable Energy Directive EU 2018/2001 (REDII)

The Renewable Energy Directive EU 2018/2001 (REDII) provides a common framework for all Member States to achieve a collective renewable energy share of 32% by 2030. REDII is particularly important for BC4P, as it for the first time in EU law, as it legally entitles consumers to participate in the energy market through participating in 'Renewable Energy Communities' and 'peer-to-peer trading' and provides a framework for their operation.

Article 2.16 of the REDII defines 'Renewable Energy Communities' (RECs) as legal entities which are:

a) Autonomous, open and based on voluntary participation, effectively controlled by shareholders located in proximity to the RE project; where
b) shareholders or members are natural persons, SMEs or local authorities including municipalities; and
c) their primary purpose is providing environmental, economic, or social benefit for its shareholders or members for the local area, rather than financial profit.

Furthermore, Article 22.4. provides an 'enabling framework' for RECs (Appendix A), which the Netherlands as a Member State will enact in order to promote and facilitate REC development, and to solidify member's rights to energy sharing and accessing all suitable markets.

Meanwhile, Article 2.18 defines peer to peer trading of renewable energy as:

> *'The sale of renewable energy between market participants by means of a contract with pre-determined conditions governing the automated execution and settlement of the transaction, either directly between market participants or indirectly through a certified third-party market participant, such as an aggregator. The right to conduct peer-to-peer trading shall be without prejudice to the rights and obligations of the parties involved as final customers, producers, suppliers or aggregators'*

Article 21.2 necessitates that all Member States including the Netherlands, must ensure 'renewable self-consumers' i.e., prosumers, are entitled to generate, store, and sell their excess renewable energy, including through peer-to-peer arrangements without being subject to discriminatory procedures, charges, or fees.

2.1.2. The Internal Market for Electricity Directive EU 2019/943 (IMED 2019/943)

Together with Directive EU 2019/944 discussed below, the Internal Market for Electricity Directive 2019/943 establishes new internal market rules to ensure the proper functioning of an internal market for electricity, facilitating the continuously developing renewable energy.

Article 5 of this directive is of importance to BC4P, as it prescribes that:

> *'All market participants shall be responsible for the imbalances they cause in the system… and shall either be balance responsible parties or shall contractually delegate their responsibility to a balance responsible party of their choice'.*

As market participants, prosumers are therefore responsible for balancing the grid, unless they delegate this responsibility to another party (i.e., an existing BRP).

2.1.3. Common Rules for the Internal Market for Electricity Directive EU 2019/944 (IMED 2019/944)

The Common Rules for the Internal Market for Electricity Directive (hereafter: IMED 2019/944) sets rules for the generation, transmission, distribution, supply and storage of electricity, and an important aspect is its focus on consumer empowerment and protection (FSR, 2020).

A key aim of the IMED 2019/944 is establishing end consumers as important actors who actively participate in the electricity market. Article 15 provides legally entitles end consumes to:

a) Operate directly or through aggregation,
b) Sell self-generated electricity (including through power purchase agreements)
c) Participate in flexibility and energy efficiency schemes
d) Delegate installation, operation, data handling and maintenance of installations to a third party, without being considered an active customer
e) Enjoy cost-reflective, transparent, and non-discriminatory network charges that account separately for electricity fed into the grid and electricity fed into the grid while ensuring that they contribute in a balanced way to systems costs
f) Be financially responsible for any imbalances they cause to the electricity system, although this responsibility may be delegated to a balancing responsible party.

While the REDII introduces Renewable Energy Communities (RECs), Article 2 (11) of the IMED introduces Citizen Energy Communities (CECs) [2] as legally defined entity that:

a) is based on voluntary and open participation and is effectively controlled by members or shareholders that are natural persons, local authorities, including municipalities, or small enterprises;
b) has for its primary purpose to provide environmental, economic, or social community benefits to its members or shareholders or to the local areas where it operates rather than to generate financial profits; and
c) may engage in generation, including from renewable sources, distribution, supply, consumption, aggregation, energy storage, energy efficiency services or charging services for electric vehicles or provide other energy services to its members or shareholders

Moreover, article 16 provides a five-point framework for inclusive energy communities (Appendix B) which have far reaching community benefits and will eventually be replicated in Dutch law.

[2] At their core, RECs and CECs are both energy cooperatives, but they differ in terms of technologies and frameworks. RECs are autonomous, utilise renewable energy sources, located in close proximity to the project, membership is restricted, are controlled by members, and economic profit is not their primary activity. CECs on the other hand are not necessarily autonomous, technologies can be renewable or carbon-based, communities don't need to be located in close proximity to the project, membership is open, but those who engage in large-scale commercial activity cannot exercise decision making power.

Table 2 below summarizes the three European Union Regulations discussed so far.

Table 2. Overview of EU legislation

<table>
<tr><th colspan="2">European Union Regulations</th></tr>
<tr><th>Renewable Energy Directive
REDII 2018/2001</th><th>Internal market in Electricity Directive
IMED 2019/943</th></tr>
<tr><td rowspan="3">Requires that Member States provide enabling frameworks for RECs and ensure that they can produce, consume, store, and sell energy including through power purchase agreements, and can share their produced energy within their community.

Requires that Member States ensure prosumers can store and sell excess production directly or through power purchase agreements, electricity suppliers and peer-to-peer arrangements (without disproportionate procedures or charges); install and operate storage systems for self-consumption; and maintain their rights as final customers and receive remuneration

Provides legal definitions for Renewable Energy Communities (RECs) and peer-to-peer energy trading.</td><td>Requires that prosumers become responsible for any balances they case to the electricity grid unless they delegate this responsibility to another party.</td></tr>
<tr><td>Internal market in Electricity Directive
IMED 2019/944</td></tr>
<tr><td>Aims to encourage end customers in becoming active in the energy market.

Requires Member States to ensure that prosumers can directly or through an aggregator sell self-generated energy, participate in flexibility/efficiency schemes, delegate certain activities to third parties, enjoy cost-reflective network charges, and be financially responsible for imbalances they cause.

Provides legal definitions and frameworks for Citizen Energy Communities</td></tr>
</table>

2.2. National Energy Regulation

The Dutch energy system is heavily reliant on fossil fuels and in 2018, only 7.4% of the country's total energy consumption derived from renewable sources; the third lowest share among International Energy Agency (IEA) member countries and well below the IEA medium of 12.1% (IEA, 2020). However, renewable energy deployment is progressing, and national energy policy is increasingly targeted at reducing natural gas production and transitioning to a low-carbon economy. For BC4P, key national regulation includes:

- The Electricity Act 1998
- The Experimentation Decree 2015-2018
- The Energy Act 2022
- The Heat Act 2014
- The Collective Heat Supply Act (aka Heat Act 2)

2.2.1. The Electricity Act 1998

Dutch: Electriciteitswet

The Electricity Act 1998 is the regulatory foundation of the Dutch electricity system, and since its introduction has supported an affordable, high-quality, and secure energy supply for consumers (Buth, 2018). It establishes a liberalised electricity market, where production of electricity is unbundled from its trade and supply, and where the balance of

supply and demand is determined by a free market (NMa/DTe, 2006). Key features of this market include:

- Ownership and management of energy infrastructure and commercial activities is strictly separated
- Only DSOs are permitted to operate and manage the electricity system
- Suppliers of electricity must hold a sales licence granted by the ACM
- Suppliers have a responsibility to ensure grid balancing or to hold a contract this responsibility with a BRP
- Grid tariff prices are fixed and regulated
- Households and Small Medium Enterprises (SMEs) are allowed to deliver their surplus energy into the national grid, where the feed-in is deducted from their consumption. As such this results in an annual tax reduction, a market principle called 'net-metering'.

However, as the Electricity Act 1998 is tailored to support a centralised (fossil fuel based) system, it does not provide room nor opportunity for innovative strategies that defer from the established norm, including P2P energy trading and decentralised energy systems. The Dutch government did however acknowledge the Act's limitations to the energy transition, and in 2015 declared an 'Experimentation Decree' (EDSEP) which granted innovative energy projects a legal exemption to operate outside of the normal (restrictive) regulations of the Electricity Act 1998. Several of the projects listed later in the paper were recipients of this grant. Furthermore, in the view that this law is too out-dated for the energy transition, a new Energy Act will be released in 2022.

2.2.2. The Experimentation Decree 2015 – 2018

Dutch: Besluit experimenten decentrale duurzame elektriciteitsopwekking

Article 7a of the Electricity Act 1998 includes a provision where the government can create a "regulatory sandbox"; i.e., permitting policy experiments to inform future energy policy. Recognising that the E-Act entails many regulatory obstacles to the energy transition and the importance to stimulate renewable energy at the local level; in 2015 Article 7a was activated and an executive order of 'Experiments Decentralized, Sustainable Electricity Production (EDSEP)' was issued (Schittekatte, 2020). This granted 20 projects per year (until 2018), consisting of homeowners associations and energy cooperatives with a maximum of 10,000 customers, the freedom to conduct energy pilot experiments outside of the normal regulatory rules. The three main exemptions to the are listed below (Ministry of Economic Affairs and Climate, 2015):

- Exemption to Article 16.3: where 'producers, suppliers and traders shall refrain from any involvement in the performance of the tasks assigned to a network operator'; **thereby permitting pilot projects to own energy infrastructure, operate the electricity system, install and maintain the network, connect a resource, and carry out commercial activities.**
- Exemption to Article 95a: which requires that sellers of electricity (including prosumers) require a permit; **thereby allowing prosumers to supply electricity to peers without a licence.**
- Exemption to Article 29: which determines that tariff prices shall be fixed for all consumers on a network; **thereby allowing suppliers within energy projects to set their own electricity prices**.

2.2.3. The Energy Act 2022

Dutch: Energiewet

As discussed, the current Electricity Act 1998 will soon be updated by a new Energy Act with the planned introduction date of 2022 (RVO, 2021a). The new law will provide new rules on energy markets and systems to bring energy policy up to date with EU and national level climate goals. Importantly, the bill will provide specific legal definitions and frameworks for peer-to-peer energy trading, energy communities and electricity supply. The bill is not yet finalised, but draft versions have been released to public view for consultation. Drafts released in July 2020 and November 2021 provide insight into what new law will include (Ministry of Economic Affairs and Climate Policy, 2020b; Ministry of Economic Affairs and Climate Policy, 2021). Specifically, the July 2020 draft presented the objectives of the new law and details 6 pillars of amendments (see Appendix C), while the later November 2021 version provides a more complete draft of specific articles and frameworks.

According to the July 2020 working paper, the new Energy Act will (Ministry of Economic Affairs and Climate, 2020 p.34):

1. Reinforce the current framework for future system integration by merging gas and electricity laws to create a uniform framework for greater legal clarity (Pillar I)
2. Establish energy data as a necessary and promising raw material for the system through higher quality and frequency data collecting (Pillar II)
3. Revise the roles and tasks of system operators through modernising the regulatory framework and supporting the energy transition (Pillar III)
4. Creating room for new market initiatives (Pillar IV)
5. Provide greater protection for end consumers (Pillar V)
6. Supervise national regulations (Pillar VI)

While an in-depth exploration of these pillars and their amendments is offered in Appendix C, amendments of particular importance to BC4P include that:

- System Operators will have the right to deny a grid connection when there is physical congestion present on the grid (Pillar III)
- A new basis for determining allocation keys for tariffs will be introduced, with the hope of abandoning the 'capacity tariff' of small-scale consumer connections (Pillar III)
- Dynamic network tariffs including an electricity grid tariff structure will be introduced which is based on incidental peak electricity consumption (Pillar III)

The November 2021 working paper provides legal definitions and frameworks for activity in the energy market, including models and frameworks for: suppliers, obtaining a licence, peer-to-peer trading, energy communities, data collection and grid balancing (Ministry of Economic Affairs and Climate Policy, 2021 p1-9). This draft is not a finalised and details could be subject to change. However, as it is, it gives significant indication of how the new regulatory framework for peer-to-peer trading in the Netherlands will look. According to this draft, when enacted the new law will for the first time in Dutch legislation, provide legal definitions for prosumers ('active customers'), energy communities and peer-to-peer trading; providing them with legitimate standing in the energy market. Table 3 lists these definitions according to the working paper.

Table 3 Energy Act 2022: Legal Definitions

Energy Act 2022 Legal Definitions
• **Final Customer**: natural or legal person who has a connection and who buys or wants to buy electricity or gas for their own use. • **Active customer**: final customer of electricity that consumes, stores, or sells electricity produced within its own facility, or who uses flexibility or energy efficiency services, provided that those activities do not constitute its main commercial activity. • **Energy Community**: legal person that carries out activities in the energy market on behalf of its members or shareholders and whose main purpose is to provide environmental or economic or social benefits to its members or shareholders or to the local areas in which it operates, and not to make a profit. • **Peer-to-Peer Trade Supply Agreement**: An agreement on the basis of which peer-to-peer trade can take place on behalf of a final customer. • **Economic Operator**: Natural or legal person who buys, sells, or produces electricity or gas, who is a balance responsible party for electricity or gas, who aggregates, who facilities peer-to-peer trading or who provides demand response services or energy storage services for electricity. • **Peer-to-Peer Trading**: supply of renewable electricity produced by an active customer to a final customer, under predefined conditions for the automatic execution and settlement of that supply, directly or through the market participant that realizes the automatic execution and settlement.

In accordance with the requirements of the EU Clean Energy Package, the new Energy Act will contain rules and frameworks for peer-to-peer trading, energy communities, and models for suppliers, which are detailed in the Table 4 to Table 11.

Table 4 Energy Act 2022: The Rights Of 'Final' And 'Active' Customers Participating in Peer-To-Peer Trading (Ministry of Economic Affairs and Climate Policy, 2021 p9)

The rights of 'final' and 'active' customers participating in P2P trading:
• Both final customers (consumers) and active buyers (prosumers) are free to enter into peer-to-peer trade / supply agreements or demand response agreements with any market participant of their choice. • Both final and active customers are free to enter into peer-to-peer trade, to the extent that: ○ They own smart metering device ○ Each contracted participants acts on one allocation point; and ○ The offtake/feed-in benefit of an economic operator can be determined on the basis of measurement data generated using devises compliant with rules laid down for metering devises in Article 2.45 • Prosumers ('active customers') are free to conclude a demand response agreement with economic operators who is not their licenced supplier, so long as they have a metering device that's communication is functionally used. • Prosumers are entitled to enter into feed-in agreements, peer-to-peer trade supply agreements or demand response agreements with any market participant of their choice.

Table 5 Energy Act 2: Framework for Energy Communities (Ministry of Economic Affairs and Climate Policy, 2021 p9-10)

Conditions for citizen and renewable energy communities:
Energy Community members must be guaranteed that: • Their participation is open and voluntary • They have the right to leave • Control of the community's activity rests with them Additionally, *Renewable* Energy Communities membership: • Is limited to natural persons, local authorities or small/medium-sized enterprises; who • are located in close vicinity to the project

Table 6 Energy Act 2: Framework for the Electricity Supply Licence (Ministry of Economic Affairs and Climate Policy, 2021 p13-14)

The Electricity Supply Licence

A licence is required to supply electricity to a final customer with a small connection, or to facilitate peer-to-peer trading for a final customer with a small connection.
 	
Exemptions to the licence requirement:
• Energy communities; providing:
  ○ The community does not provide more electricity on an annual basis than it feeds into the system
  ○ Members are shareholders of the energy community
  ○ The number of members/shareholders does not exceed the number determined by ministerial regulations
  ○ Prosumers or groups of prosumers do not supply more electricity on an annual basis than is fed into the system itself
 	
• Prosumers / groups of prosumers; providing:
  ○ They do not supply more electricity on an annual basis than is fed into the system itself
 	
• Prosumers / groups of prosumers may supply or facilitate P2P trade with an unlicensed supplier if there is an agreement with a group of final customers, whereby:
  ○ The majority of customers participating in the group have technical, organizational or functional ties to each other
  ○ The representative is authorised to represent final customers involved in the agreement
  ○ The final customer with a small connection is aware of and agreed to their legal position prior to the conclusion of the supply agreement by the representative
 	
• Producers of electricity; providing:
  ○ The final customer with a small connection is a subsidiary of the producer
 	
• Supplier; providing:
  ○ Supply is to final customers with a small connection, who are connected to a closed distribution system
 	
• Suppliers based outside the Netherlands who supply or facilitate unlicenced P2P trading up to 500 final customers with a small connection; providing:
  ○ They are located in areas on the Dutch national border

Table 7 Energy Act 2: Conditions for Suppliers (Ministry of Economic Affairs and Climate Policy 2021 p10)

Conditions for suppliers of electricity and suppliers facilitating P2P trading
Suppliers of electricity must: • Be reliable, transparent and have reasonable prices and conditions • Present prices, terms, and conditions in a way that customers are able to compare with other suppliers Specifically, *suppliers facilitating peer-to-peer trade on behalf of a consumer* must*:* • Be reliable, transparent, and reasonable • Ensure that the quantity of electricity supplied does not exceed the amount of electricity returned by the prosumer on the basis of P2P trade supply agreement Suppliers must ensure agreements with final customers are: • Transparent and complete • Written in intelligible language • Provided to the consumer before closing • Suppliers facilitating on behalf of a final customer in a P2P energy trade must enter into a P2P trade supply agreement for this purpose Suppliers to final customers must: • Enter into a delivery agreement • Provide the consumer a summary of the main terms and conditions in plain language, prior to concluding agreements • Register whether the agreement has been concluded with a consumer, micro, small or large-sized enterprise • Conclude a new supply agreement if the registered consumer changes

Table 8 Energy Act 2: Framework for Suppliers (Ministry of Economic Affairs and Climate Policy 2021, p15-16)

Framework for Suppliers (Supplier Model)

• Suppliers operating at a primary allocation point of a final customer with a small connection are responsible for:
  ○ Invoicing and collecting tariffs owed to the DSO
  ○ Facilitating information exchange between connected party and DSO
  ○ Dealing with complaints and compensations
  ○ Accepting net metering offers (until 1 January 2031)
  ○ Keeping records of customer agreements
 	
• Prosumers who have been granted an exemption to the supply licence are not bound to fulfil:
  ○ Customer Invoices
  ○ Complaint procedures
  ○ Dispute settlements
  ○ Balance responsibility

Table 9 Energy Act 2: Framework for Peer-to-Peer Facilitation (Ministry of Economic Affairs and Climate Policy, 2021 p17)

Framework for redelivery, peer-to-peer trade facilitation and demand response for active customers
• Not yet specified

Table 10 Energy Act 2: Framework for Balance Responsibility (Ministry of Economic Affairs and Climate Policy 2021, p18-19)

Framework for Balance Responsibility
Article 5 of the IMED 2019/943 requires that a BRP is active at each allocation point assigned to its connection Household and micro-enterprise prosumers: • Unless explicitly stated otherwise, must transfer financial balance responsibility to the supplier • This must be stipulated in supply / peer-to-peer trade supply agreements • If desired, these prosumers may bare the financial responsibility or transfer it to another BRP, if explicitly stated

Table 11 Energy Act 2: Framework for data collection (Ministry of Economic Affairs and Climate Policy 2021, p70-78)

Insights into data collection
• Prosumers and consumers will have the legal right to share their data with third parties • Certain actors will be obliged to make certain types of data available • DSOs will increase the amount of data extracted from remote smart meters

2.2.4. The Heat Act 2014

Dutch: Warmtewet

Heat networks are defined by the Ministry of Economic Affairs and Climate (2020c) as 'a network of mutually connected pipes, associated installations and other resources for the transport of heat to and from a building'. Currently, heat networks in the Netherlands are under the jurisdiction of The Heat Act ('*Warmtewet*') which came into effect in 2014. It includes a national maximum price for heat which is based on a 'no more than usual' principle, where the price for heat is based on the costs of heat from a natural gas boiler (Ministry of Economic Affairs, 2013). The Heat Act is based on the fact that district heating requires large infrastructure which can only be provided by one supplier in a certain area. As such giving the local supplier a monopolist position. The Heat Act is due to protect the end consumer for abuse of the local supplier's monopoly position. The current Heat Act will soon be replaced by the Collective Heat Supply Act, more commonly referred to as the 'Heat Act 2', which is discussed below.

Please note: The Dutch pilot project (Mijnwater), partner in the BC4P project, operates as a *district heating (DH) network*, thus it is important to consider national heat network regulations in the project.

2.2.5. The Collective Heat Supply Act (expected 2023)

Dutch: Wet Collectieve Warmtevoorziening (aka: Warmtewet 2)

Heat supply in the Netherlands is highly dependent on natural gas, which in 2018 was good for 90% of residential heating. (IEA, 2020). Since the earthquakes in the Norther part of the Netherlands, the national energy policy shifted towards phasing out natural gas, with reduction targets of 49% by 2030 and 95% by 2050 compared to 1990 levels (PBL et al., 2020 p6). This induces the need for 7 million households to replace their heat sources.
With targets requiring a rapid decarbonisation of the gas-intensive heating sector, the 'Collective Heat Supply Act' ('Heat Act 2' / 'Warmtewet 2') is being drafted as an update to the current Heat Act, and key changes include an update to market conditions and regulations, as well as generating a new heat tariff system (van Vulpen, 2021). The new act was expected to come into force in 2022, however the draft version released for consultation received criticism from local authorities, requiring political reconsideration of certain elements of the act which will delay its induction date (Rus-van der Velde & Gayir, 2021).
The new act focuses on accelerating the roll-out of *collective heat networks*, which will bring significant changes for (i) municipalities, (ii) heat network companies and (iii) heat network tariffs.
The following paragraphs explain these changes in further details.

Municipalities shall:

- Draw up their own 'Heat Transition Vision' (as required by the Climate Agreement 2019)
- Choose in which districts new heat plots will be located
- Choose a single company to be responsible for the development of that heat plot

In the future, municipalities will have a substantial amount of responsibility in coordinating the development of collective heat plots. The 2019 Climate Agreement instructs that each municipality draws up a *Heat Transition Vision (HTV)*: a district-specific implementation plan detailing a step-by-step approach to phasing out natural gas (Ministry of Economic Affairs, 2019, p29). The Collective Heat Supply Act will build upon this by vesting municipalities with the responsibility to determine which districts in the built environment shall be transitioned onto a renewable energy based collective heat network (criteria for which is prescribed in According to Article 2.1. paragraph 1) (Brans & van Mannekes, 2020). Once the decision is finalised, heating companies can submit bids for certain districts. The municipality will choose a single heat network company to build and operate the new heat network and the provincial government who has the power to change the decision, assesses the choice[3]. This decision of who is designated is however assessed by the provincial government, who has the power to order changes if necessary (Van Vulpen, 2021).

The successful heat network company will:

- Receive exclusive rights to the development of heat plot for a minimum of 20 years and a maximum of 30 years
- Exclusive rights to the supply and transport of heat within the plot

A significantly important feature of this act is that the chosen heat company shall receive exclusive rights to the ownership and development of the heat network. They will be legally bound to complete the construction of the new network by installing, managing, and maintaining it (Dieperink & deWitt, 2020) and executing the project as cost effectively and sustainably as possible (De Rijke, 2020a). In doing so, the heat network company becomes the single point of contact for the entire heat chain. This task begins as soon as the environmental plan is adopted by the municipal council. Before the company can start the building and operation phase however, it must first produce an investment plan detailing how it will guarantee a secure heat supply for the first 10 to 15 years, which will also be assessed by the ACM.
In the interests of mitigating investor risks and ensure the profitability of the project, several safeguards are in place to substantiate the networks business case. Firstly, if a building owner agrees on a connection to the network, they cannot opt-out within the first five years. Secondly, large consumers (with a connection larger greater than 100kW) must notify and inform the municipality of their reluctance at an early stage (before environmental planning) since their participation will greatly affect the project (Van Vulpen, 2021). For small consumers, with connections less than 100kW, a 'yes-unless

[3] Article 2 of Heat Act 2 holds that the designation process must be transparent, non-discriminatory and importantly, open to both public, private and public-private-partnership companies. It also provides a framework for scoring applications on durability, cost-efficiency, security of supply, participation, technical feasibility, financial feasibility, organizational feasibility. However, the council is able to change the weighting of these scores to take into account local preferences and circumstances (Van Vulpen 2021). As a safeguard, the ACM oversees the designation of the chosen company and will continuously monitor their financial situation. Meanwhile, the chosen company is required to submit annual updates to the ACM on its organisational, technical and financial situation and capacity. Furthermore, the company is also legally required to immediately report to the ACM if their financial situation deteriorates, whereby the ACM provides advisory plans to improve the outlook (Van Vulpen 2021)

clause' will be applied which will allow consumers to refuse a connection to the heat network. But only if they are able to prove that an alternative sustainable heat source, which is equivalent to the heat network in terms of energy efficiency and environmental protection, is more favourable to them (Van Vulpen, 2021).

Tariff regulations and models will:

- Replace the current 'no more than 'no more than usual' principle with a 'cost-based' tariff system
- Not be applied to small collective heating systems, homeowners associations or landlords

To ensure that heating costs for small consumers remain competitive regardless of technology, the current Heat Act establishes a principle of 'no more than usual' where tariffs are based on the average expenditure of a household heated by natural gas (Rus-van der Velde, 2020). By current law district heat suppliers cannot charge rates exceeding the costs of an individual owned gas boiler. In principle, a district heat consumer should not pay more than a gas connected consumer. However, since the government decided to abandon gas in the coming decade, it was deemed necessary to replace the former 'no more than usual' principle with a *cost-based tariff system* (Rus-van der Velde, 2020).
The new Heat Act will detail a step-by-step process for this new tariff system which is expected to be completed by 2030 (Rus-van der Velde, 2020). The ACM will provide a cost-based correction of the gas reference rate, setting rates based on certainty that the heat company can recoup its costs; hence each heating system will have its own rate. It should be noted however that the new tariff won't apply to small collective heating systems in flats and apart building (Rus-van der Velde, 2020).

Table 12 provides a summary of the National Legislation in The Netherlands.

Table 12 Summary of National Legislation

National Regulations		
The Electricity Act 1998	The Experimentation Decree 2015 – 2018	The Energy Act 2022
- Separates ownership and management of energy infrastructure from commercial activities - Only DSOs can operate and manage the electricity system - Electricity suppliers require a permit to sell electricity - Grid tariffs are fixed and regulated - Households may sell their excess energy back to the national grid - Allows for prosumers to	- Provided energy pilot projects exemptions to certain regulations within the 1998 Electricity Act. Exemptions: - Permitted projects to own energy infrastructure and to carry out the DSO task of operating the system - Allowed suppliers to sell electricity without a licence - Allowed projects to set their own electricity prices	Will replace the current Electricity Act Features relevant to BC4P include: - Certain actors will be obliged to make certain types of data available - DSOs will increase data extraction from meters - Consumers will have the legal right to view and share data with third parties - System Operators may deny a connection request when congestion is present (although temporary, till the congestion problems are fixed). - DSO supporting services will be bought from the market - Space for the development of blockchain like platforms - Allowing prosumers to legally enter into agreements with other market parties - Allowing prosumers to sell their generated energy through an independent aggregator

engage in 'net-metering' to sell their excess energy to the national grid		- Strengthening the preconditions for prosumers wishing to enter the market by: → Regarding prosumers as 'suppliers' in the market → Vesting prosumers with balancing responsibility → Making prosumers financially responsible for the imbalances they cause - But also allows households and microenterprises to delegate supplier and balance responsibilities to a third party - Granting an exemption to the supply licence in certain scenarios - Ensures the supplier model is only applied to licenced suppliers - Grants customers the freedom to choose their own suppliers, switch supplier, and partake in collective switching schemes - Grants customers the right to dynamic electricity price contracts or aggregation contracts - Abandoning the 'capacity tariff' - Introducing dynamic network tariffs - Abolishes the 'safety net regulation' - Allows suppliers to set their own prices
Heat Act 2013	Heat Act 2 2022	
- Includes a maximum price for heat networks that cannot be higher than customers connected to gas	- Will replace the current 2013 Heat Act - Municipalities will decide which districts are transformed onto a heat network - Municipalities will choose a single heat network company to be solely responsible for the development of the heat plot - The company receive exclusive rights to the development of the network for a minimum of 20 and maximum of 30 years - The company will hold exclusive rights to the supply and transport of heat within the plot - Will include a new heat tariff model which will replace the 'no more than usual' principle (based on natural gas boilers) with a cost-based system - The new tariff will not apply to small collective heating systems, homeowners associations or landlords	

2.3. Tariff Structures: Electricity and Gas

In the Netherlands, energy bills typically have variable supply costs, fixed supply costs and network costs. A complete overview how the Dutch energy bills is constructed is highlighted in Figure 1. Each of these parts of the energy bill, is further explained in the following sections.

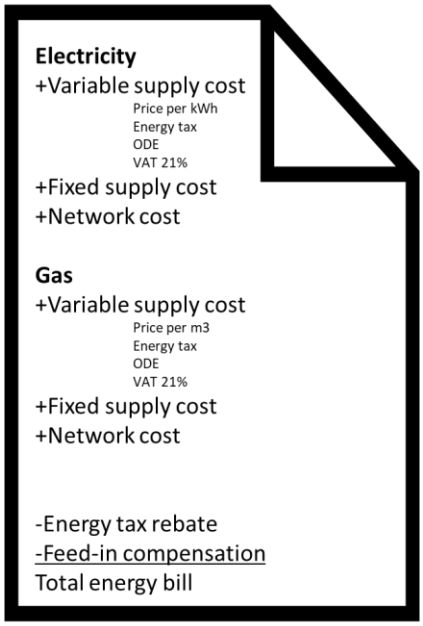

Figure 1 Overview energy bill for electricity and gas

2.3.1. Variable supply costs

The variable supply cost includes:

- amount of energy consumed (in kWh for electricity or m3 for natural gas)
- energy taxes
- ODE
- VAT (21%)

Amount of energy consumed

For electricity, the energy price is in kWh. The average energy price in the Netherlands is €0,22 per kWh of electricity and €0,75 per m3 of gas (CBS, 2021). For the past decades these prices have been quite stable, only raised by imposed tax charges. During 2021 a sharp rise of prices occurred, resulting in a double tariff for both sources.

The end consumer price depends on the type of energy contract with the energy supplier and consumers are free to choose their own energy suppliers. The supplier can offer two different types of energy tariffs to choose from.

There is a fixed tariff which will not change during the term of the contract and a variable tariff which updated twice a year. There is also a difference in a single or double tariff (day and night) paid per kWh of electricity, this depends on the type of meter. A single meter only charges a universal kWh price. With a double meter, a lower rate per kWh is used in the off-peak hours compared to the peak hours[4].

[4] https://www.energievergelijken.nl/energieprijzen/opbouw-energierekening

Energy tax
The Dutch government aims to encourage a more economic and efficient use of energy and levies a tax on the consumption of electricity and natural gas. This tax increases the variable price of energy, as such encouraging people to use less energy. The energy tax is adjusted every year by the central government. The government's strategy is to increase the energy tax for natural gas and lower the energy tax for electricity. Therefore, electricity taxes hAve been decreased in the past year, while the taxes on gas have been increased, to incentivise a move towards electrical heating and cooking in Dutch homes (Belastingdienst, 2021).

Opslag Duurzame energie (ODE)
In addition, there is the so called Opslag Duurzame Energie (ODE) levy which was introduced to stimulate the development of renewable energy. The revenues from the ODE levy are used to stimulate investments in sustainable energy production. The subsidy scheme Stimulering Duurzame Energieproductie (SDE++) is financed with this. The Tax and Customs Administration is responsible for levying and collecting the ODE. The energy supplier charges the ODE and remits it to the government. The bill for financing was divided equally between businesses and individuals, but this has changed in 2020. Companies will bear two-thirds of the cost and individuals one-third. This means that companies with high energy consumption will face high costs as they pay more ODE tax (Belastingdienst, 2021).

VAT
VAT on energy amounts 21% in The Netherlands and this includes Energy tax and ODE (Belastingdienst, 2021).

2.3.2. Fixed supply costs

There are also fixed supply costs paid that have to be paid to the energy supplier. It involves a fixed amount per month or year and is independent of the amount of energy consumption. These costs have to be paid separately for gas and for electricity. Fixed delivery charges are also known as fixed fees[5].

2.3.3. Network Costs

Network costs are paid to the DSO for the transport of electricity and gas and the maintenance of the energy network. The network operator charges a fixed amount per year and the amount of the fee is determined by the grid operator. The costs are paid to the energy suppliers who in turn pay them to the grid operator. Network costs are the same for each energy supplier[6].

2.3.4. Energy tax rebate

There is an *energy tax rebate* which is the amount the government deducts for the energy tax paid. Since part of the energy consumption is seen as a basic need, tax is not paid on that part. These reductions are standardized and can be found on the Dutch government's website[7] (Belastingdienst, 2021).

2.3.5. Feed-in compensation

In case a consumer has solar panels, it is generating its own electricity. Surplus electricity, i.e., not consumed by the consumer itself, can be fed back to the energy grid for which the consumer is compensated. The energy bill shows how many kWh's have

[5] https://www.energievergelijken.nl/energieprijzen/opbouw-energierekening
[6] https://www.energievergelijken.nl/energieprijzen/opbouw-energierekening
[7] https://tinyurl.com/3jus4nft

been generated and this is subtracted from the total amount of KWh's that have been consumed from the grid. If a consumer feeds back more energy into the grid then it consumes, it receives a flat rate for the extra electricity produced. Typically, this flat rate is lower than what the consumer has to pay for a Kwh (in 2021 it varied from 0,08 – 0,12 eurocent per Kwh).
Moreover, citizens and companies that generate their own electricity with solar panels and that consume electricity themselves do not have to pay energy tax on the electricity they generate themselves (Belastingdienst, 2021).

2.3.6. Total costs

Total energy costs are paid to energy suppliers in a monthly instalment, with the supplier determining the total amount of this instalment. At the end of the year, an annual statement from the supplier is released and if too little has been paid for the energy, an extra payment must be made. Conversely, if too much has been paid, the consumer is refunded.
In a semi-detached house inhabited by two people, the average energy consumption is 1.560 m³ of natural gas and 2.800 kWh of electricity (Nibud, 2021). Based on the energy prices of October 2021 of CBS (2021) the amount of energy paid per year is showed in Figure 2. This shows that the amount of tax is almost as high as the amount of supply cost and the network cost are relatively low. However, it should be noted that the total costs are without any discounts or tax rebates.

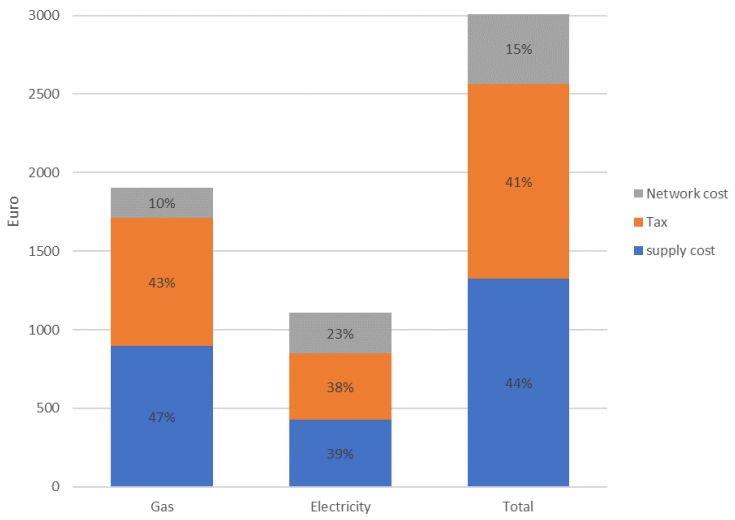

Figure 2 Composition of energy cost

2.3.7. Tariff structures: Heating

At some locations in The Netherlands, heat is provided through a (local) heat network. A household connected to a heat network receives hot water for heating and returns cooled off water into the heat network. The heat from the heat network is also used for heating tap water/shower water, which is done though a heat exchanger (i.e., closed system). A heat network is typically operated by one provider and it is operating stand alone, i.e. it is not connected to a national grid as is the case for electricity and gas. This results in a situation where the customer is totally dependent on the provider (i.e., monopoly). To protect the customer the Heat Act defines the services that need to be provided as well as the maximum price per GigaJoule (Gj) of heat. Currently, the price of heat is connected to the price of gas. The idea here is that a customer of a heat provider is not paying more than what is paid for heating a home with gas. However, there is currently a debate going to disconnect the price of heat from the gas price. Especially, since the

price of gas has increased significantly in the past year. Therefore, it is proposed to base the price of heat on the actual cost for generating the heat. Where the ACM, the market authority, will determine the maximum price that can be charged for a Gj.

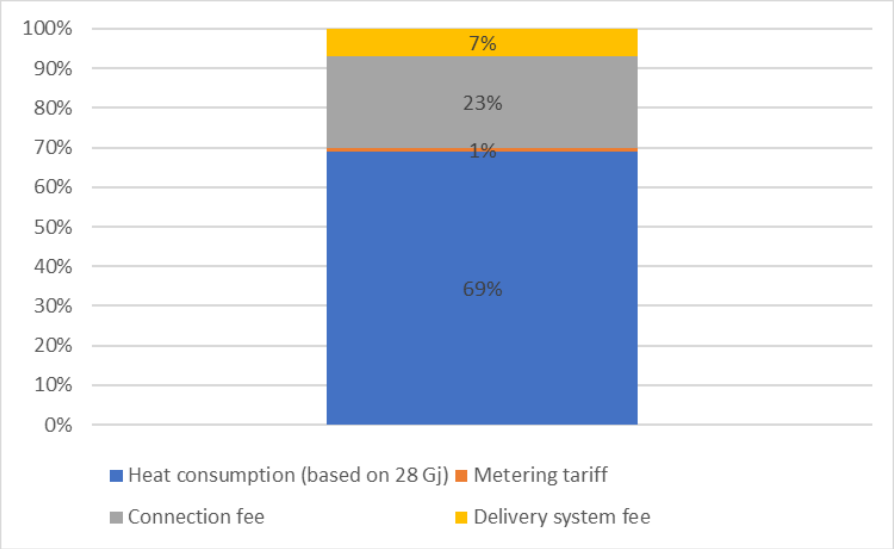

Figure 3 Composition of heat cost[8]

Like the price of gas and electricity, also the price of heat consists of variable and fixed cost. The variable cost consists soley of the amount of heat that has been consumed (in Gj). The fixed cost consists of three components:

- Metering tariff: cost for measuring the amount of heat consumption
- Connection fee: cost for heat supply and maintenance of the heat network
- Delivery system fee: cost for renting a piece of equipment that distributes the heat in the building

Also, the fixed cost is regulated by the market authority (ACM). As opposed to electricity and gas, there is no energy tax paid for heat in The Netherlands.

2.4. Dutch Support Schemes for Prosumers

2.4.1. Investment Subsidy for Sustainable Energy and Energy Savings (ISDE) 2021

Dutch: Investeringssubsidie Duurzame Energie en Energiebesparing

The Investment Subsidy for Sustainable Energy and Energy Saving (ISDE) is a yearly investment subsidy currently in operation and will continue until 2030 (RVO, 2021b). With the investment, homeowners and companies can apply for subsidies. For homeowners this can include a solar water heater, a (hybrid) heat pump, insulation measures and connection to a heat network. However, to qualify for a subsidy a combination of two measures/technologies must be used.
Companies are eligible for subsidies for a solar water heater, a heat pump, connection to a heat network and for small-scale wind turbines and solar panels.
In 2022, a total budget of € 228 million will be available for solar boilers, (hybrid) heat pumps, insulation measures and connection to a heat network. For small-scale wind turbines and solar panels, a budget of € 30 million will be available in 2022. A new budget will become available each year. The ISDE subsidy runs until 2030 (Anciaux, 2019).

[8] Based on: https://www.eneco.nl/duurzame-energie/warmte-koeling/tarieven/2022/

2.4.2. Sustainable Energy Production Incentive Scheme (SDE++) 2021

Dutch: Stimuleringsregeling Duurzame Energieproductie

The Sustainable Energy Production Incentive Scheme (SDE) is a government funded operating subsidy to stimulate the development of renewable and carbon saving energy sources by compensating differences in income per kWh and production costs per kWh. The SDE was first introduced in 2008 as a fixed-premium mechanism to stimulate the production of clean energy through paying a fee to the producer per amount of electricity generated (Dóci & Gotchev, 2016). The most recent version, the SDE++ only includes companies and a wider range of eligible technologies; including those targeted at CO2 reduction such as carbon capture (RVO, 2021c). Furthermore, it is also available for companies and organisations in sectors such as industry, mobility, electricity, agriculture, and the built environment. The total funding budget was about 5 billion euros in 2021.

2.4.3. Net-metering 2004-2031

Dutch: Salderingsregeling

Articles 95 and 31 of the Electricity Act 1998 grant household and SME prosumers (with a maximum self-consumed energy of 10.000 kWh/year) the right to 'net-metering'. Introduced in 2004, 'net-metering' allows small scale prosumers to inject their surplus energy into the national grid for a tax refund at the end of the year (Milieu Centraal, 2021), with an estimated investment payback time of 5-7 years (Lettner et al., 2018). However, with the cost of solar panels continuously falling, as of January 1, 2023, the returns for net-metering will gradually decrease every year until it eventually reaches zero in 2031 (Ministry of Economic Affairs and Climate, 2020a). It will still be possible to feed electricity back into the grid, but it will no longer be possible to completely offset the cost of excess energy generated. Instead, the prosumers will receive a flat rate for each kWh generated.

2.4.4. Postcoderoos Scheme

Dutch: Postcoderoosregeling

The Postcoderoos Scheme[9] or 'Reduced Rate Scheme' was an incentive established in the 'Environmental Taxes Act' which ran from 2013 until 2020 (RVO 2021d). It granted a tax relief for electricity generated by an energy cooperative or association of homeowners, where members share the same (or adjacent) postal code with the generation plant. Members were entitled to exemptions from energy tax and VAT on revenue up to 10,000 kWh per participant. However, the scheme was replaced by the 'Cooperative Energy Generation Subsidy Scheme' in April 2021.

[9] https://www.rvo.nl/initiatieven/co%C3%B6peratieve-energieprojecten/zon-op-nederland-postcoderoos-co%C3%B6peraties

2.4.5. Cooperative Energy Generation Subsidy Scheme (SCE) (2021 - 2026)

Dutch: Subsidieregeling Coöperatieve Energieopwekking

The Cooperative Energy Generation Subsidy Scheme[10] (SCE) is an operation grant available to homeowner associations and energy cooperatives with solar PV, wind, or hydropower energy sources. It was opened in 2021 with a budget of 92 million euros and will run until 2026 (RVO, 2021e). Unlike the previous Postcoderoos Scheme which provided a tax discount to members of the cooperative. The SCE is an operating grant, whereby a subsidy (based on the type of installation and what is required to make the installation profitable) is paid directly to the energy cooperative, in the form of an amount per kWh produced, for a period of 15 years. The subsidy per kWh, which differs per technology installed, is the difference between the cost of green energy generation and the market price for energy (RVO, 2021e). Should the energy price rise, a lower subsidy is paid, and conversely if energy prices fall, higher subsidies are paid. To be eligible for the subsidy, the energy produced must be certified with guarantees of origin (GO) (RVO, 2021e)

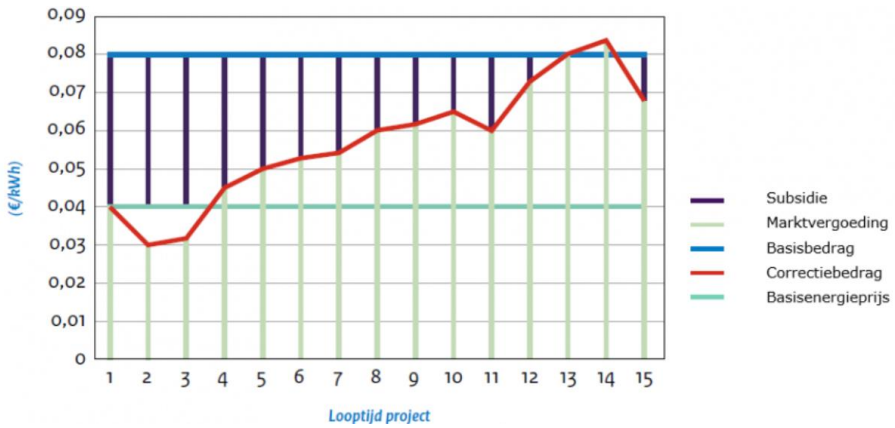

Figure 4. SCE Subsidy Scheme (RVO 2021e)

There are also several conditions that must be satisfied, specifically: all members must have access to meetings and equal voting rights, only one member or company can be registered per address, and all members must have a small consumer connection from the beginning. Furthermore, specific conditions are in place for each technology. Subsidies may be granted for solar panels with a peak capacity between 15 kWp and 500 kWp, with small consumers defined as those with a connection between ≥ 15 kWp and ≤ 100 kWp and large consumers defined as those with a connection between ≥ 15 kWp and ≤ 500 kWp. One member may participate per 5 kWp power at a production installation of solar PV (RVO, 2021f). Likewise, wind and hydropower energy subsidies are also categorized into small and large-scale consumer connections which determines subsidy rates. Small-scale wind consumers are defined as connections between ≥ 15 kWp and ≤ 100 kWp, while large-scale consumers are defined as connections between ≥ 15 kWp and ≤ 1000 kWp. Where wind power is the chosen energy source, a minimum of one member must participate per 2 kWp of production (RVO, 2021g). Meanwhile, small-scale hydropower consumers are deemed as those with connections between ≥ 15 kWp and ≤ 100 kWp, and large-scale as connections between ≥ 15 kWp and ≤ 150 kW. In the case of hydropower, a minimum one member may participate per 1 kW at a production installation (RVO, 2021h).

[10] https://www.rvo.nl/subsidie-en-financieringswijzer/sce

2.4.6. Energy investment deduction (EIA)

Dutch: Energie-investeringsaftrek

The Energy investment deduction (EIA) is a tax deduction scheme. The scheme offers direct financial benefits to entrepreneurs who invest in energy-saving assets and sustainable energy. The purpose of the EIA is to stimulate investments in energy-saving business assets or in sustainable energy. The scheme is intended for entrepreneurs who pay income or corporation tax in the Netherlands. It allows 45.5% of the investment costs to be deducted from the profit. This reduces the taxable profit. The scheme provides an average benefit of 11%. For 2022 there is a budget of € 149 million. The EIA is for all entrepreneurs who are liable for income tax or corporation tax. Also, a government organization, foundation or association can use the EIA, if it is liable for corporate income tax. The scheme is not available to individuals (Belastingdienst, 2021).

Table 13 provides an overview of all national subsidy schemes as discussed in this section.

Table 13 Summary of National Subsidy Schemes

	National Support Schemes for Renewable Energy				
ISDE (2021)	SDE++ (2021)	Net-Metering Principle (2014 – 2031)	Postcoderoos Scheme (Expired April 2021)	SCE: (Opened April 2021)	Energy deduction schema (EIA)
An investment subsidy available to homeowners and private businesses to subsidise the purchasing cost of renewable energy technologies.	An operating grant which offers multi-year subsidies to compensate the installation costs for sustainable energy generation (connections larger than 3 x 80 ampère)	Allows prosumers to inject self-generated energy into the grid which they are remunerated for at the end of the year (connections up to 3 x 80 ampère)	Tax reduction scheme for local and jointly generated renewable energy	Subsidy scheme for local and jointly generated renewable energy	Tax deduction for entrepreneurs who invest in energy-saving assets and sustainable energy

3. The Regulatory Framework for BC4P

3.1. Prosumers

3.1.1. Current regulatory framework for small-scale prosumers

In the Netherlands, solar PV is the dominant technology in the prosumer market and the typical size for a household PV system is 3-4kWp (Lettner et al., 2018). Market growth (accelerated by support schemes) has been steadily increasing and as of 2019, 7 GW of PV was installed across the country, with an estimated one million active prosumers (van Sark, 2020). However, recent estimations based on current market developments predict that this number will increase up to 2.5 million by 2030 (van Sark et al., 2020).

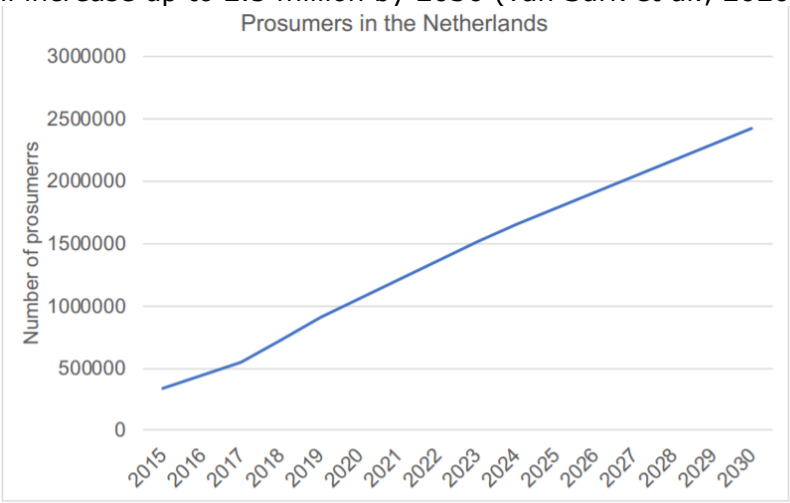

Figure 5 Estimated number of prosumers in the Netherlands (van Sark et al. 2020 p5)

At present, the 'Electricity Act 1998' establishes the regulatory framework for prosumers. Under its jurisdiction, ownership of energy infrastructure and sale of electricity is strictly separated, and only DSOs are permitted to manage electricity grids. This means that a peer-to-peer trading platform on a decentralised microgrid is incompatible with the current law since it is not permissible for a producer of energy to own the energy infrastructure *and* be involved in commercial sale of electricity.
Suppliers of electricity require a sales permit from the ACM to certify their capabilities and resources, and are responsible for administration, collecting bills and balancing the grid (if not contracted with a BRP). Such requirements are broadly speaking beyond the capabilities of small scale prosumers. Furthermore, only one supplier may be allocated to a single allocation point, while a second allocation point would be required for a prosumer to supply its peers with electricity. Finally, grid tariffs are fixed and there is minimal bandwidth in which energy prices can vary, providing no incentives for users to reduce their consumption at peak usage times (Reijnders et al., 2020).
The 'net-metering scheme' (whereby prosumers could sell their surplus energy back to the national grid) is the only viable mechanism for their participation in the electricity market; thus injecting surplus energy into the national grid is the standard practice for prosumers in the Netherlands. Aside from this, another other option for consumers with surplus energy generation is to request a second allocation point from their System Operator (such as an EV charging point) to channel their surplus.
However, beginning 2023 net-metering will be gradually phased out due to the falling price of solar PV, and the return rate on net-metering will be reduced on a yearly basis until it is eventually terminated in 2031 (Rijksoverheid, 2019). It will however still be possible to inject surplus energy back into the grid, but a feed-in-like tariff will apply ('terugleversubsidie') (Rijksoverheid, 2019). Net-metering was a convenient mechanism

for prosumers to earn financial returns on their solar PV investments, but it also flattened out commercial incentive for them to store their energy or engage in peer-to-peer trading. With little incentive to sell energy back to the grid, the market for energy storage solutions may grow and more importantly, the phasing out of net-metering could improve the business case for peer-to-peer trading since prosumers may be more inclined to engage (Buth, 2018). Moreover, the Electricity Act 1998 will soon be replaced by an updated Energy Act (2022) which should increase the viability for prosumers to participate in the electricity market.

3.1.2. Evolving prosumer framework: 2022 and beyond

Prosumer markets in the Netherlands are set to undergo a shift with the introduction of the 'Energy Act 2022' and the gradual phasing out of the 'net-metering scheme'. Traditionally, large energy companies have been hesitant to allow prosumers access to the electricity market (de Almeida et al., 2021) and as explained, net-metering is the predominant means of prosumers participation in the electricity market. However, reforms to EU energy law introduced in the Clean Energy Package (2019) (particularly REDII and the IMED), will encourage innovation and will open up the market to prosumers, by providing legal frameworks entitling them to the same market access as traditional suppliers. Specifically, Article 15 of the IMED 2019/944 stipulates customers will have a legal right to become prosumers, and Member States must ensure they do not face 'disproportionate or discriminatory technical requirements, administrative requirements, procedures and changes, and to network charges that are not cost-reflective'.

As a Member State, the Netherlands is enacting these requirements via the new Energy Act 2022. As discussed, the new act will for the first time in Dutch law, legally define 'final customers', 'active customers' (prosumers), 'energy communities' and 'peer-to-peer trading. From this, prosumers will have the legal right to sell their energy either via a trading platform, directly to another consumer, or through the newly introduced actor: an independent aggregator (positioned as 'middle-men' who will buy electricity from a prosumer to sell on to a demanding customer). Moreover, final customers will be free to enter into P2P trade agreements with other actors, providing they have a smart meter. The bill will also provide frameworks for energy communities, suppliers, facilitating P2P energy trading, balance responsibility and data collection from metering devices. However, while the new law is set to provide a framework for facilitating P2P trading, this section (section 2.3) has been left blank in the most recent 2021 working paper, and it remains to be seen how this framework shall look in the future.

For suppliers, the Energy Act 2022 will stipulate that a licence will be requires for any actor wishing to supply electricity to a customer with a small connection, and for facilitating P2P trading for a customer with a small connection. As Suppliers, they will be tasked with carrying certain duties, including: ensuring correct energy payments and taxes, dealing with consumer complaints, and having a balance responsibility.

However, as mentioned the IMED 2019/944 (Article 15) requires that prosumers must not face any disproportionate barriers to entering the market; yet obtaining a supply licence is a particularly difficult task for a small-scale prosumer (since they require a certain customer base and a possess substantive financial, organisational and technical competences (van der Waal et al., 2020)). To address this issue, the new Energy Law will grant exemptions to the supplier licence requirement under certain conditions. Those exempt from the requirement include: energy communities, prosumers, groups of prosumers, suppliers operating on a closed distribution system, and suppliers based on the Dutch border. More specifically, the 2021 draft of the new Energy Act states that prosumers with an exemption to the supply licence are not bound to fulfilling complaint procedures, dispute settlements or balance responsibilities.

Unfortunately, although exemptions exist for small-scale prosumers, administrative burdens for supplying electricity will still remain, including: energy registration,

communication protocol and paying energy tax and VAT. As a result, it will remain difficult for neighbours to supply one another. Instead, it will be more convenient for a prosumer to sell energy to an independent aggregator from whom they would receive a compensation. In short, the new law will in practice enable prosumers to engage in peer-to-peer trading, but the administrative requirements they will be subject to will remain a significant obstacle.

In a different vein, article 5.1 of the IMED (EU) 2019/944 requires that 'suppliers shall be free to determine the price at which they supply electricity to customers' and supply prices must not be subject to any form of government intervention. The norm in the Dutch energy market has been for the ACM to supervise supply tariffs on the premise of a so-called 'safety net regulation' (Electricity Act 1998); whereby suppliers are required to submit their yearly price changes to the ACM for monitoring, who have the power to adjust prices and conditions. When enacted, the new Energy Act will however abolish the safety net regulation and instead suppliers will be able to set their own prices free of government intervention.

As for grid balancing, article 16 of the IMED holds that all actors will be held financially responsible for any imbalances they cause to the grid. However, since the responsibility for balancing the grid for small-scale consumers has always been the responsibility of suppliers in the Netherlands, the working papers for the new Energy Act stipulate that households and micro-enterprise prosumers (unless they have explicitly stated an objection), should transfer their balance responsibility to their supplier.

Another significant change which the new Energy Act will incur for the prosumer and broader energy market will be changes to electricity pricing mechanisms. Currently, the grid tariff is fixed and is 'capacity-based' whereby a connection's capacity determines the price. With this model, there is no incentive for consumers to reduce energy consumption at peak times, thus no compensation for consumption at lower peak loads, nor opportunity to attain savings on energy transfers within a community (which would be the same as everywhere else) (Reijnderse et al., 2020). However according to its drafts, the new Energy Act will contain a new basis for how tariffs are determined. This will include leaving room for the possible abandonment of the current capacity tariff for small-scale consumer connections, and import 'dynamic network tariffs', including an electricity grid tariff structure based on peak electricity consumption (Ministry of Economic Affairs and Climate, 2020b p53).

According to its draft paper (Ministry of Economic Affairs and Climate, 2020b), the new Energy Act will provide that a large part of consumer protection regulations, namely regarding contracts, termination, and dispute settlements, which will still apply to those with licence exemptions. Furthermore, in the event of bankruptcy, the unlicenced supplier will be obliged to clearly inform the consumer on their rights in the event of energy delivery being terminated and may be expected to find a replacement. As well as this, households, small/micro-sized enterprise consumers will be entitled to: freely choose their own supplier, hold the right to switch suppliers, hold the right to cancel their contracts, and have the right to dynamic electricity prices or aggregation contracts.

3.1.3. Summary

Table 14 provides a summary of the Dutch regulatory framework for prosumers.

Table 14. Summary of the Dutch regulatory framework for prosumers

Summary of the Dutch Regulatory Framework for Prosumers
• The SDE++ offers an operating grant to subsidise installation costs for sustainable energy generation • The ISDE offers an investment subsidy to subsidise the purchase cost of renewable energy technologies • 'Net-metering' is at present the standard practice for prosumers wishing to sell energy • It is not possible to own a network *and* partake in commercial activities such as sale of electricity • Only DSOs are permitted to manage electricity grids • Tariff models are fixed and are based on the size of a given connection • Suppliers of electricity require a licence from the ACM • Supplier responsibilities include administration, collecting bills, balancing the grid (if not contracted with a BRP) and dealing with complaints When the new Energy Act is introduced: • Collection and utilisation of data will increase • Consumers shall be entitled to more than one supply contract and to switch suppliers • Prosumers shall be entitled to sell energy to the grid, an independent aggregator, or to a peer • Peer-to-peer trading platform • Peer-to-peer will be legally defined and a framework for its facilitation provided • A licence will be required for supplying electricity • Supply licence exemptions will be granted to prosumers, energy communities and foreign cross-border suppliers under certain conditions • Administrative burdens will still pose barriers to prosumers entering into peer-to-peer trading • Prosumers will be responsible for grid balancing, but are encouraged to transfer this responsibility to their supplier • New tariff models shall be introduced • The capacity tariff model shall be abandoned • Suppliers shall be free to set their own prices

3.2. Energy Communities

3.2.1. Current framework for energy communities

In line with the definition provided in the REDII pilots in the BC4P project can be considered 'Renewable Energy Communities' (RECs) since they will typically involve people who live in the same area and who will share the benefits of their renewably generated energy within their locality. The revised REDII strengthens the standing of energy communities within EU energy markets by providing them with legal right generate, consume, store, and sell electricity between community members. Characteristically, the REDII requires that RECs shall be 'autonomous', 'controlled by shareholders or members in close proximity to the project' where membership is 'open and voluntary' and confined to 'natural persons, SMEs or local authorities including municipalities'. All these provisions will be incorporated into Dutch legislation via the Energy Act 2022.

At present, the Netherlands does not have a specific legal framework for energy communities. Instead, the subsidy schemes available to energy communities (Postcoderoos Scheme and its replacement installation grant scheme, the SCE have specific eligibility requirements (such as members having to share a similar postal code) which has in effect created a framework for energy communities. Regarding energy prices, there is currently no possibility within law (except for the EDSEP) for energy communities to negotiate a specific energy tariff for their community.

However, the Energy Act 2022 will legally define 'energy communities', specifying their activities and purpose. It will also provide legal frameworks for their operation, detailing member participation, composition, and control. Furthermore, energy communities will be subject to supplier regulations and models for electricity supply and will also have responsibility to balance the grid. As discussed, it will be possible for energy communities to be granted exemptions to the supplier licence under certain conditions.
The 2019 Dutch Climate Agreement also includes important changes for energy communities. The Agreement pledges to increase the participation of citizens in the energy transition and stipulates that ownership of future renewable energy projects should be shared 50/50 between companies and local citizens. Municipalities will be the leading authorities for local spatial planning, and they are required by the Climate Agreement to formulate a Regional Energy Strategy outlining their energy transition strategies. Of the draft strategies currently released, almost all are aiming for a 50% ownership of energy production in the local environment (Ministry of Economic Affairs and Climate, 2019). However, it is not yet clear if energy cooperatives will be significantly involved in RES processes, despite the importance for energy communities to be involved in the design of assessment frameworks to compete with commercial initiatives (Hier & RVO, 2021).

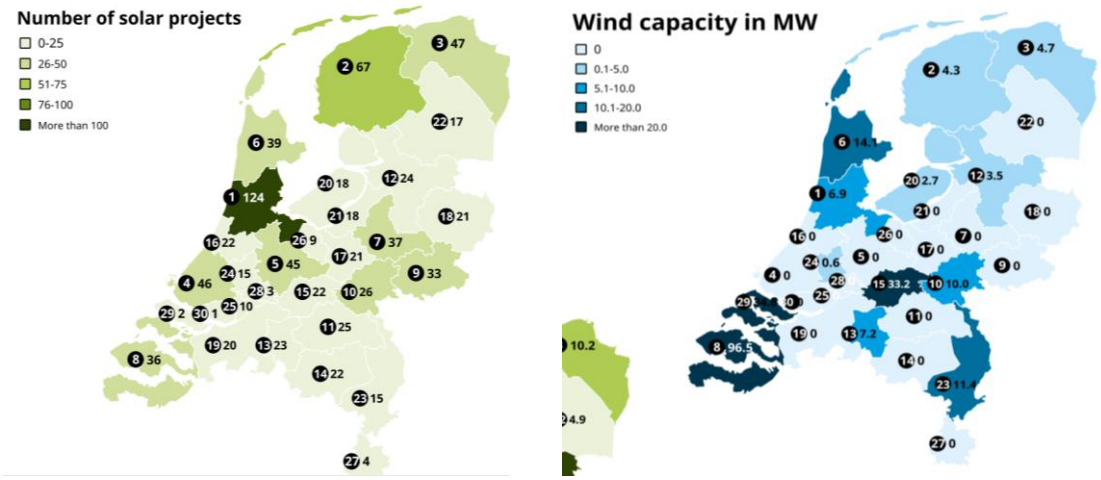

Figure 6 Cooperative Solar and Wind Projects per RES Region (Hier & RVO, 2021 p8)

Dutch culture of energy cooperatives

It is worth noting that the Netherlands is a European frontrunner in the field of energy communities (commonly referred to as 'energy cooperatives') (Horstink et al., 2020). At present, 95% of Dutch inhabitants live in a municipality where an energy cooperative is active (Hier & RVO, 2021). See also Figure 6 for the spread of energy communities per region in The Netherlands.
The Climate Foundation 'Hier Opgewekt' release a yearly Local Energy Monitor to provide insights into the impacts and operations of Dutch energy cooperatives. Its latest report reveals that in 2020, a total of 623 energy cooperatives were active in the Netherlands, of which 70% were solar projects and 19% wind projects (Hier & RVO, 2021). An interesting find in this year's report is that for seven years, energy communities have grown steadily in number (see Figure 7) ; yet it now appears that a saturation point has been reached, and energy communities are now growing in quality and expertise rather than quantity (Hier & RVO, 2021). Furthermore, existing cooperatives are becoming more professional and diverse in their activities (evolving from simply energy production to now include activities such as district heating, renovation, and mobility) (Schockaert, 2021).

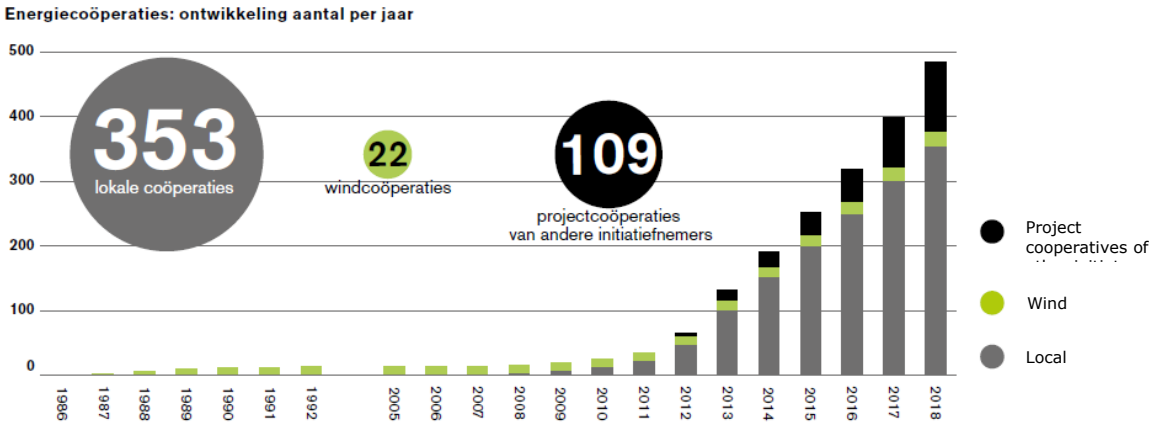

Figure 7. Energy cooperatives: development number per year (HIER, 2021)

Table 15 provides a summary of the Dutch Regulatory framework for Energy Communities.

Table 15. Summary of the Dutch Regulatory Framework for Energy Communities

Summary of the Dutch Regulatory Framework for Energy Communities
• The Netherlands has a strong culture of energy communities • The Cooperative Energy Generation Subsidy Scheme (SCE) will run until 2026 to subsidize installation costs for community generation of energy within a shared postal code area When the new Energy Act is introduced: • Energy Communities and Renewable Energy Communities will be legally defined • Legal frameworks for energy communities will be established • Membership will be open and voluntary • Control of the community will rest with its members • In Renewable Energy Communities, membership will be limited to 'natural persons', local authorities and small/medium-sized enterprises; and membership will be limited to the vicinity of the project • Energy communities will have balance responsibilities • Energy communities may receive an exemption to the licence requirement for the supply of electricity based on certain conditions

3.3. Blockchain

In a peer-to-peer platform, blockchain would store time-stamped data on energy transactions in "blocks" in a chronological order to form "chains" of data to facilitate trading between sellers and consumers. The data itself is stored on a network of computers where transactions are visible to all members of the network. Furthermore, there is no central actor verifying transactions, nor any intermediary charge fees.
The use of blockchain is widespread across industrial sectors in the Netherlands, but decentralised environments are difficult from a legal perspective and as of yet, there is no Dutch law that specifically regulates blockchain technologies (Röell et al., 2021). The most relevant legal bodies are however the Data Protection Authority ('Autoriteit Persoongegevens'), the ACM ('Autoriteit Consument en Markt'), the Dutch Central Bank ('De Nederlandsche Bank') and the Dutch Authority for Financial Markets ('Autorteit Financiële Markten') (Röell et al., 2021).
Academic research on the integration of blockchain into energy systems is lacking, however a Master thesis conducted by Buth (2018) provides insights into how blockchain

facilitated peer-to-peer trading could occur in the Dutch context. Specifically, the research investigates a normative 2030 scenario where blockchain becomes the IT infrastructure facilitating peer-to-peer trading within local energy markets in 2030, and how this will change the Dutch energy system and its actors. In this scenario, it is imagined that: feed-in tariffs are abolished, its more profitable for prosumers to sell energy to peers rather than the national grid, households have batteries to buffer and store energy, special meters bilaterally trade stored energy, the traditional grid remains as a backup, traditional suppliers provide large-scale consumers, and grid balancing is conducted locally. Results found that the electricity system is likely to become more hybrid with actor functions intertwined. It is possible that blockchain could offer aggregating services and prosumers could become aggregators, thus creating a system with an abundance of small aggregators operated by individual households. Alternatively, suppliers could take over the role of aggregator with smart use of consumer/prosumer pattern loads, creating a system where a few large aggregators serve all households. With data for energy generation and storage put on a blockchain, trading would require a certain level of supervision, thus the DSO could supervise the status of the grid and possibly take over balance responsibilities for the local grid. For consumers, it is likely that they will rely on the supplier when energy cannot be generated locally, with the producer remaining important for the provision of backup energy, and with the DSOs responsible for managing portfolios in their geographically specific area. For suppliers, the study suggested that it is possible they could become obsolete if electricity is bought directly from producers via blockchain, become intertwined with BRP, or alternatively, they would still be needed in the case of local electricity shortages. Another finding of the study was that a new actor, a 'blockchain operator' could emerge, who would have a major influence over the design of the blockchain algorithms and could form a threat to privacy and data. Therefore, it is suggested that ideally, multiple blockchains would co-exist next to each other to avoid a situation where power is concentrated with a single actor who is responsible for setting up and developing blockchain algorithms; fearing that blockchain could be misused as a powerful form of authority and supervision.

4. Review of P2P Blockchain Projects in The Netherlands

To gain insights in the current initiatives regarding blockchain for P2P trading, desk research and interviews were conducted in the summer of 2021. For the desk research, the Andoni et al. (2020) paper was used as a start as it reviewed more than 140 international P2P blockchain projects. From those 140 projects, seven projects were Dutch initiatives. The analysis of initiatives revealed that since 2017 the number of international initiatives has increased. However, it also showed that 4 of the 7 projects from Andoni et al. (2019) did not to exist anymore, since the source material was inaccessible anymore and no contact information was found anymore.
Also, a review of Dutch energy suppliers was conducted, by searching their websites "blockchain" and "block chain". The search included all the 47 energy suppliers who deliver electricity and gas to private and business clients, of which 12 are suppliers who are only delivering to small and/or large business market (Energievergelijk, ND).
Furthermore, a number of interviews were conducted with actors in the Dutch energy market including academic experts on blockchain and peer-to-peer energy trading in the Netherlands, an energy industry expert, a policy maker from the national government, and members of Dutch blockchain facilitated peer-to-peer energy trading pilots. The goal of these interviews was on one hand: to learn the experiences of decentralised peer-to-peer blockchain projects that have already been conducted or are currently still running in the Netherlands. Aiming to gather insights into their design, successes, and pitfalls, to better inform later Work Packages in the BC4P project. On the other hand, research also sought to investigate how projects experienced using blockchain to support peer-to-peer platforms; thus understanding the successes and challenges of blockchain for peer-to-peer energy trading.
The following section provide details on Dutch peer-to-peer energy pilots which have been facilitated with blockchain existing. Next, it explores *non-blockchain* peer-to-peer energy trading solutions. The section concludes with lessons and insights learned.

4.1. Existing Blockchain-based Peer-to-Peer Energy Pilot Projects

As mentioned previously, in 2015 the Dutch parliament issued an Experimentation Decree (EDSEP) that ran until 2018 which allowed up to 20 pilot projects per years to conduct operations outside the normally restrictive regulatory rules and encouraged the testing of blockchain as a platform for energy trading in energy cooperatives. Often these initiatives involved energy suppliers, DSOs, and/or TSOs as partners (see Figure 8). Following the EDSEP, the number of peer-to-peer initiatives increased, particularly in the year 2017. Interestingly however, a considerable number of projects no longer exists after just two years (2019), which provides useful insights into the success and particularly the challenges of blockchain and P2P trading platforms.
According to Schittekatte (2020), projects suffered under the EDSEP due to no financial support being made available for experiments, projects having to rely on their own internal expertise, poor communication between project/ACM/DSO and no special taxation conditions. Additionally, interviewees revealed that certain projects abandoned blockchain due to the high amount of energy it requires, challenges in setting energy taxes and issues with price mechanisms that are discussed later in the report.

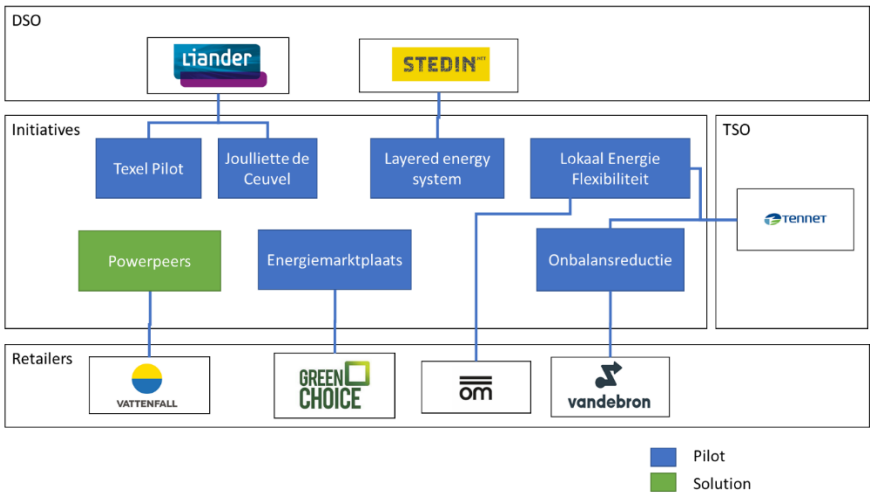

Figure 8 Project Format

4.1.1. Energy 21 and Stedin: Layered Energy System

Private companies Energy21 and Stedin created a blockchain solution that enables local energy markets to trade with each other and with wholesale energy markets. They have conducted a pilot in the district Hoog Dalem in Gorinchem. This forms a layered energy system that links local energy markets and microgrids to wider national markets, taking a system and market-based approach rather than depending on P2P energy transactions. The local markets act as an aggregator/supplier, by providing a local market transaction platform. This approach leads to more efficient operation of the energy system by considering network constraints and incentivizing energy balancing and flexibility services. The solution used is a consortium blockchain system developed by Quantoz (Stedin, 2018). However, despite blockchain has been considered a stable, cheap, and easily replicated system compared to a data server with a client with an API layer, the pilot decided to discontinue using blockchain for peer-to-peer energy trading. Their conclusion was that blockchain was a promising and interesting technology, but for the initiative alternative techniques will be suitable for an open market.

4.1.2. Alliander: Texel and Jouliette de Ceuvel

The Dutch Island of Texel was host to Alliander's peer-to-peer energy trading pilot where electric vehicles (EVs) traded energy with a beer brewery. Alliander deployed blockchain connected smart meters which were used for real-time settlement and trading between residents, and residents and the wholesale market. The project took place in the Dutch island of Texel, where an active network management system is put in place. Smart meters were linked to Ethereum blockchain via Raspberry Pi 3. Metering data were used to enable smart contracts and transactions between residents that are recorded in a public ledger. System operation is monitored by visualization tools and end-user mobile apps. The pilot revealed speed, performance, and scalability issues of the tested technology. At the same time, the potential of blockchain technologies was also revealed. However, after three months customers became disengaged and uninterested in trading because they were only interested in financial gains and since they regarded energy as a commodity. The pilot was input for the follow up at Jouliette de Ceuvel project.
The Jouliette de Ceuvel project is a collaboration between Alliander, Spectral Energy and De Ceuvel whom developed a peer-to-peer energy sharing platform, called Jouliette at De Ceuvel in Amsterdam. The pilot was based on a private and permissioned blockchain solution that can achieve faster transactions and improve performance. Spectral Energy launched an energy token called 'Jouliette' to facilitate P2P energy transactions. De Ceuvel is a private behind-the-meter smart grid which consists of 16 office buildings, a

greenhouse, a restaurant, a small hotel and several photovoltaic (PV) panels. Energy is exchanged within the smart grid on a P2P fashion. The Jouliette platform can display real-time power flows of the community and uses artificial intelligence (AI) algorithms to predict energy production and consumption (Spectral, 2018). The platform was a success when it was operational and resulted in an energy bill that was "basically zero". Participants trusted the system enough to ask that transactions become automated.

4.1.3. Vandebron: Imbalance Reduction

The imbalance reduction project uses blockchain in electric cars. Electric cars are one of the most promising forms of flexibility. This turns the threat of the increasing share of electric cars, which burden the electricity grid at peak times, into a great opportunity. In a cooperation between project partners, a platform has been developed that enables to use car batteries for balancing the grid via the blockchain. This means that Vandebron can direct electric cars to stop charging when TenneT requests them to do so and if there is an imminent power shortage. Shortage of energy on the grid and to start charging when there is a surplus of energy surplus (Onbalansreductie, 2017).

4.1.4. Greenchoice, HanzeNet, LochemEnergie: Virtuele Energie marktplaats

Together with energy marketplace HanzeNet and sustainable energy cooperative Lochem Energie, Greenchoice started a pilot project with a blockchain-based virtual 'energy marketplace'. In the project, a decentralized energy marketplace was imitated and tested through the use of a blockchain-based system to which all participants are connected. At the local level, smart meters measure the supply and consumption of energy. Local storage (neighborhood battery) is simulated in the project by calculating the amount of netted energy. Also, the administrative actions between the participants, such as invoicing of consumed and delivered energy, are integrated in the system. The ultimate wish of the initiators is to be able to use the system in the future as a total solution for, for example, an energy cooperative, a gas-free neighborhood or other similar initiatives where the users help each other by sharing energy and infrastructure. However, they concluded that it is currently not feasible to continue in the project due to regulations in Dutch Electricity Laws (Greenchoice, ND).

4.1.5. Local Energy and Flexibility

The Local, Energy and Flexibility (LEF) project started in 2019 in Eemnes and was one of the projects granted an exemption by the Ministry of Economic Affairs (2018-2027). This initiative is part of the Renaissance project that received funding from the European Union's Horizon 2020 research. Eemnes energy is a cooperative run by volunteers, decisions are taken by the members and the users in the market. This is a European pilot project, which aims to use locally generated, sustainable energy, also as much as possible locally. This can be done through direct use, through selling to your neighbors, or through storage in a shared battery. A smart calculation system that can determine the current electricity price every 15 minutes (on the spot market) is part of this new form of energy supply and use. Eemnes was the first in the Netherlands to introduce this system. The national grid manager TenneT has since embraced the idea. Other partners are Bax & Company and Renaissance (Renaissance, 2019). However, they concluded that Blockchain was not useful for them. The excess energy of prosumers is transferred to a community pool. This creates and equal price for all consumers. Where the project first aimed to use blockchain it decided not to continue with the technology.

4.2. Future Initiatives

4.2.1. Spectral

Spectral has a future project with the municipality of Groningen. Their ambition is to be energy-neutral in 2025, with all energy in the city coming from renewable sources. Their goal is to be a powerful example of sustainability for other cities in the Netherlands and part of this vision is the "Share energy with your neighbors" project. The first phase focuses on households (including prosumers) in the Reitdiep neighborhood, exchanging energy with each other using blockchain as the main supporting technology (Spectral, ND).

4.2.2. NRG2peers

Another recent initiative where spectral is involved is NRG2peers. This is a European project funded under the Horizon2020 framework. The main aim of NRG2peers is to support European peer-to-peer Energy Communities by setting up a gamified platform. The platform supports residential energy communities, to increase energy efficiency and to integrate a higher share of renewable energy. They want to establish and run real local energy communities of peer-to-peer energy traders and share lessons in different European Member States, as there is a need for clear guidance, education and support for the set-up and take-off of successful energy communities on both local and EU level. They will do this by collecting experiences, providing smart demand-response mechanisms (to optimize energy consumption and peak demand at the community level) and motivating (via the NRG2PEERS platform) the maximal implementation and consumption of (local) renewable energy source production and consumption (NRG2peers, ND).

4.3. Existing (Non-blockchain) Solutions

Although Blockchain is an interesting technology, Power-Peers and Energy Cooperatives are pre-existing solutions for peer-to-peer energy trading in the Dutch electricity market that are worth mentioning.

4.3.1. Powerpeers

Dutch energy provider 'Powerpeers' which is part of the production company Vattenfall, offers customers with solar panels the option to purchase energy from other 'Powerpeers' through peer-to-peer energy trading (Powerpeers, ND). Customers can choose who should supply their energy demand and they can offer the energy they produce themselves to other Powerpeers customers. However, the energy provider still operates as the central actor in the energy trading and there is one fixed price per KwH. So customers can choose whom they get their energy from but they cannot negotiate a price with them.
If private producers generate more energy than they use, they can offer this through Powerpeers. Via the energy supplier's platform, the customer chooses from whom they want to purchase energy. If their 'generators' do not have a surplus, the energy supplier supplements this with energy from Dutch windmills. In addition, the customer always pays a fixed amount for energy per kWh from the energy company.

4.3.2. Energy cooperatives

Another existing solution for doing peer to peer energy trading is through the use of an energy cooperative, where a group of local residents who want to make their village or city more sustainable set up a cooperative. This allows them to determine where their energy comes from and to become independent from a (commercial) supplier. Most of these initiative use solar energy, for example with solar panels on the roof of a school or

a piece of land in the neighborhood. Some cooperatives realize their own windmill in the neighborhood. Others focus on energy from biomass or heat.
The cooperative owns the production installation and the sustainable energy it generates. It is responsible for all related agreements. For example, the cooperative makes agreements with its members, the roof owner, the installer, the energy supplier, insurers, etc. The cooperative manages the solar power plants and takes care of the maintenance and assumes all management and maintenance costs. The cooperative also takes care of the administrative processing. The rights and obligations between member and cooperative are recorded in a member agreement. Because you become a member of the cooperative you can influence issues such as the board, the annual plan and the distribution of profits. An example of such an initiative is Buurtstroom in Utrecht (Buurtstroom, ND)

4.3.3. Conclusion

Objectively speaking, it can be concluded that for realizing a peer-to-peer energy trading by means of blockchain, a local grid and a central transaction platform are essential. The local grid should disseminate the energy and the platform should serve as a kind of open market or a pool as is done at Layered energy system, energy marketplace and Juliette de Ceuvel. In this platform, using blockchain technology, the energy transaction administration is regulated. Instead of returning unused energy to the grid, it is traded locally on the platform and distributed by the local grid. Jouliette de Ceuvel has even designed its own currency for trading this energy. The initiatives use smart meters to measure the supply and consumption of energy. When there is not enough energy available in the local grid this can be compensated by a supplier.

5. Insights from interviews

This section discusses the insights gathered from interviews with academics, industry experts and project coordinators regarding blockchain and more broadly peer-to-peer energy trading on decentralized microgrids.

5.1. Insights on Blockchain for Peer-to-Peer Energy Trading Platforms

Amongst the participants interviewed, there was general consensus that blockchain is relatively easy to operate, which was seen as one of its key benefits. Also, some participants praised blockchain for the fact that once an algorithm is established and the platform is stable, it is easy to replicate this solution in other scenarios or in other projects. Moreover, participants explained that replicating the platform is relatively inexpensive.

However, several participants shared the belief that blockchain was chosen as the technology due to the current hype it is experiencing in the industry sector, rather than it being the best solution available. Indeed, participants argued that there are other technologies which are also for the purpose of facilitating a peer-to-peer energy trading platform. This notion is also represented in literature by Buth (2018).

A significant downfall of blockchain according to one of the project coordinators was the "shockingly" large amount of energy used to run the blockchain platform, which outweighed the energy efficiencies gained through peer-to-peer sharing. Furthermore, interviewees also pointed out that cryptocurrency is incompatible with some national legislation, and it also clashes with the EU's General Data Protect Act (GDPR) (de Almeida et al., 2021). Meanwhile, the European Union Blockchain Observatory & Forum has published a report investigating that tensions between GDPR and blockchain can only be resolved by the EDPB, the courts, and other regulators and government agencies (Lyons et al., 2018).

Taxation was as another substantial obstacle to peer-to-peer energy trading raised in an interview. Namely, energy tax constitutes a substantial amount of a consumer's energy bill, but since blockchain transactions are only accessible to the trading party, energy tax is avoided. As a result, projects had to go to a great effort to arrange a solution with national tax authorities.

5.2. Insights on Peer-to-Peer Energy Trading Platforms

To begin with, an interesting finding from the interviews was that a prosumer's willingness to be involved in a project as well as their level of engagement, was influenced by whether or not the project in question reflected their personal values. The Texel project which was located on an island (where owners of EVs traded energy with a local beer brewery) was initially seen as an excellent setting for an independent P2P energy community, since it appealed to the inhabitants' values of autonomy. However, the participating prosumers soon became disengaged and un-motivated to participate in trading as their interests were only economical. Conversely, the Jouliette de Ceuvel project (which is established in an artist's neighborhood with a heightened sense of community) was a success, and this is due in part to the fact that the project appealed to the community's value of cooperation and shared resources. Moreover, an academic interviewee pointed out that financial motivation isn't always the best case for establishing a P2P community. This notion is also supported by Georgarakis et al. (2021), who found that environmental factors rather than financial factors are the most motivating value to Dutch prosumers who participate in P2P energy trading. However, cognitive dissonance should not be disregarded, and it may be the case that prosumers' motivations could be more financially driven in practice.

Another important finding revealed in the interviews is that structurally speaking, it is currently only possible to conduct peer-to-peer energy trading with access to two meters; with one being connected to the grid and the other being a secondary allocation.

Also, desk research found that currently deployed smart meters cannot enable peer-to-peer energy trading since they lack the necessary computing power, and physical hardware is expensive (Buth, 2018). A further issue is that peer-to-peer energy trading market requires time-reviewed prices, yet one interviewee pointed out that very few suppliers offer this. Moreover, energy prices fluctuate every hour and regulation protects residential customers form being exposed to volatile energy prices.

According to several interviewees, grid congestion is a significant problem arising from P2P networks; with one participant expressing that insufficient focus is being paid to expanding the national grid to meet the new demands of renewable energy generation. It is indeed uncertain whether grid capacity will develop at the same speed as the number of prosumers, and a lack of grid capacity in certain regions will pose a barrier to project developments in certain areas. Already, the province of Utrecht is reaching its capacity limit and cannot add any new solar parks or large solar roofs (van Gastel & Boss, 2021). Furthermore, with the enactment of the new Energy Act, System Operators will have the legal right to deny a new connection when there is physical congestion present on the grid.

Some energy justice concerns were also raised during interviews. Firstly, one interviewee raised the point that if P2P networks become more popular and prosumers leave the main grid, maintenance and update grid costs will be distributed over a smaller number of consumers (with low-income households being hit hardest). In other words, people without access to decentralised networks will pay more, and balancing will be more difficult. Secondly, if P2P is developed exclusively in new housing stock, a large inventory of households will be left behind. Thirdly, one interviewee was concerned that since energy pricing in a P2P blockchain network is often determined by the prosumer, information asymmetry may occur, and prosumers could exploit paying customers. Similarly, energy prices will differ across every energy community depending on how successfully the project is managed. However, members in an energy community universally enjoy lower energy prices than consumers connect to the main grid, so even if one community enjoys less discount than another, it will still be a discount.

Finally, it was felt by some that P2P energy trading will be difficult to achieve in cross-border scenarios, due to the variability in regulation across different countries and federations, and solutions may not be replicable.

6. References

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Appendix A. Renewable Energy Community Enabling Regulatory Framework: RED II 2018/2001 (recast) Article 22.4

Member States shall provide a framework for RECs that ensures:

a) unjustified regulatory and administrative barriers to renewable energy communities are removed;
b) renewable energy communities that supply energy or provide aggregation or other commercial energy services are subject to the provisions relevant for such activities;
c) the relevant distribution system operator cooperates with renewable energy communities to facilitate energy transfers within renewable energy communities;
d) renewable energy communities are subject to fair, proportionate and transparent procedures, including registration and licensing procedures, and cost-reflective network charges, as well as relevant charges, levies and taxes, ensuring that they contribute, in an adequate, fair and balanced way, to the overall cost sharing of the system in line with a transparent cost-benefit analysis of distributed energy sources developed by the national competent authorities;
e) renewable energy communities are not subject to discriminatory treatment with regard to their activities, rights and obligations as final customers, producers, suppliers, distribution system operators, or as other market participants;
f) the participation in the renewable energy communities is accessible to all consumers, including those in low-income or vulnerable households;
g) tools to facilitate access to finance and information are available;
h) regulatory and capacity-building support is provided to public authorities in enabling and setting up renewable energy communities, and in helping authorities to participate directly;
i) rules to secure the equal and non-discriminatory treatment of consumers that participate in the renewable energy community are in place

Appendix B. Citizen Energy Community Enabling Regulatory Framework: IMED 2019/944 Article 16.1

Member States shall provide an enabling regulatory framework for CECs which ensures that:

a) participation in a citizen energy community is open and voluntary;
b) members or shareholders of a citizen energy community are entitled to leave the community, in which case Article 12 applies;
c) members or shareholders of a citizen energy community do not lose their rights and obligations as household customers or active customers;
d) subject to fair compensation as assessed by the regulatory authority, relevant distribution system operators cooperate with citizen energy communities to facilitate electricity transfers within citizen energy communities;
e) citizen energy communities are subject to non-discriminatory, fair, proportionate and transparent procedures and charges, including with respect to registration and licensing, and to transparent, non-discriminatory and cost- reflective network charges in accordance with Article 18 of Regulation (EU) 2019/943, ensuring that they contribute in an adequate and balanced way to the overall cost sharing of the system.

Appendix C. Energy Act Pillars

Pillar I: Reinforcing the current regulatory framework (Ministry of Economic Affairs and Climate 2020b p35).

The first pillar focuses primarily on strengthening and improving the general regulatory framework. The working paper acknowledges that the current energy system will be increasingly integrated with more and more connections from various connections, particularly gas and electricity, which will blur distinctions between gas and electricity markets. As such, amendments in pillar I will seek to provide clarity on the roles of various actors and reinforce the regulatory framework for the future system by:

- Creating one overarching law which combines both electricity and gas for a unified framework (with the possibility to later add on other energy carriers)
- Improving clarification on legislation and regulation by emphasising transparency and consistency within laws
- Strengthening the overall legal basis of the energy system by revising which conditions, methods and rules can be checked by the ACM, and recasting certain 'codes' (mainly concerning data exchange) to a higher level of regulation

Pillar II: Increasing the uptake and utilization of energy data (Ministry of Economic Affairs and Climate 2020b p39-43):

- Oblige certain actors in the energy system to make certain types of data available in the interest of increasing the availability and quality of data
- Oblige DSOs to increase data extracted from remotely readable smart meter systems from daily to hourly for small gas consumers, and from daily to quarterly for electricity consumers
- Give consumers with the legal right to view and share their data with third parties

Pillar III: Revising actors' roles to support the energy transition (Ministry of Economic Affairs and Climate 2020b p47-53):

- Afford system operators the right to deny a producer's connection when there is physical congestion present on the grid
- Limit the range of DSO activities and require that supporting services be bought from the market
- Introduce a new basis for determining allocation keys for tariffs, with the hope of abandoning the 'capacity tariff' of small-scale consumer connection (where the capacity of a connection determines the transmission tariff, rather than the use of that connection)) (p53).
- Introduce dynamic network tariffs including an electricity grid tariff structure based on incidental peak electricity consumption

Pillar IV: Encouraging new market initiatives (Ministry of Economic Affairs and Climate 2020b p54-65):

- Constitute that prosumers must be able to sell electricity to the market independently from their supplier (directly to customers, through a platform, or through an independent aggregator).
- Allow prosumers to legally enter into agreements with other market players
- Provide scope for the development of platforms to facilitate contracts between market players and ensuring a correct allocation of energy flow
- Grant all consumers the right to more than one electricity supply contract at the same time
- Grant consumers the right to request more allocation points
- Deem prosumers with balance responsibility

- Allow prosumers to delegate balance responsibility
- Consider prosumers, energy communities and independent aggregators 'suppliers' by law and thus subject to supplier requirements: holding a sales permit, conducting balance responsibilities and ensuring payments of energy tax and VAT
- Provide exemptions to the ban on electricity supply without a licence

Pillar V: Ensuring consumer protection (Ministry of Economic Affairs and Climate 2020b p59-64):

- Afford final customers the right to:
    - Free choice of supplier
    - Ability to switch suppliers, partake in collective switching schemes (amongst households and micro-enterprises) and to cancel contracts
    - Dynamic electricity price contracts and/or aggregation contracts
- Ensure the current supplier model (where the supplier deals collects costs and network tariffs and deals with consumer complaints) will only apply to the (licenced) supplier at the primary allocation point
- Abolish the current Dutch 'safety net regulation' and allowing suppliers to set their own price (in line with the IMED)

Pillar VI: Supervising Regulations

The final pillar of the new energy bill concerns regulations for the supervision of the energy system. Throughout various articles, the IMED 2019/944 determines what energy system supervision should look like; however, these descriptions are already largely in line with the current supervision, thus little change will ensue, and the ACM will continue to be the designated regulatory authority for the energy system. The new bill will however impose a large number of tasks, requirements and obligations for system operators to sustain reliability, affordability and sustainability (p65). The 'quality assurance system' (which contains plans, processes and procedures required for grid operators to register, monitor, and adjust the quality of systems and performance of statutory duties) is an important instrument in this regard, as it establishes quality guarantees for grid operators (p66). System managers will be responsible for the implementation of quality assurance, but performance indicators will be specified in.