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# Energetika: Gleb Krzhizhanovskii's Conception of the Nature–Society Metabolism

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## Abstract

In recent years, there has been a growing interest in the relation between Marxism and the Soviet productivist economy. While historical scholarship rarely explores the intellectual context in which the Soviet experiment unfolded, ecomarxists tend to describe the Soviet Union's mistaken path as a result of the loss of 'metabolic' thinkers following the rise of Stalin. This article challenges the neat, purported divide between a 'metabolic' and 'productivist' Marxism by analysing the energy-economic thinking of Gleb M. Krzhizhanovskii, a Bolshevik engineer and old friend of Lenin. As chairman of both the electrification commission (GOELRO) and the State Planning Commission (Gosplan), Krzhizhanovskii conceptualised the energy economy as something embedded in the metabolism of nature and society and as the technical-economic basis of the socialist economy. This argument drew its strength from his idea that production is part of the general, ongoing life-process, and the hope that large-scale electrification and electro-chemistry could help govern the metabolism between nature and society more rationally – both arguments commonly found among contemporary natural scientists. Any ecomarxist attempt to recover the concept of metabolism today has to come to terms with its productivist and technocratic history.

## Keywords

Soviet Union – energy history – electrification – productivism – metabolic rift

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> The engineer arrives at communism not like the propagandist or author, but through the data of his science
>
> LENIN

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## 1 Introduction[1]

In 1923, the head of the Soviet electrification commission Gleb M. Krzhizhanovskii called the energy sector the 'skeleton'[2] of the new society the Bolsheviks were creating. In doing so, he was alluding to Marx's metaphor of the instruments of labour as 'bones and muscles of production'.[3] Krzhizhanovskii sought to highlight the significance of energy relations for the reproduction of society in the twentieth century. Unlike other engineers, he preferred the metaphor of the backbone to that of the motor: energy did not fuel the economy, it constituted the structure through which society could grow and which enabled its movement. The metaphor of a moving and growing body was both organistic and productivist; it placed the productivist economy squarely within nature. This energy base of the productive forces was called *energetika* (energetics), denoting both the energy system and the science studying it.

Over the last decades, there has been a growing interest in making connections between Marxism and ecology,[4] and in environmental and energy histories of Russia and the Soviet Union.[5] Historical scholarship has documented the Soviet Union's impact on nature in greater detail, but has, apart from a few references to Marx's concept of productive forces, rarely explored

1 The author would like to thank Katja Bruisch, Sebastian Budgen, Simon Pirani, Thomas Turnbull and three anonymous reviewers for comments and feedback on an earlier version of this article.

2 Planovoe Khoziaistvo 1923, p. 46.

3 Marx 1992, p. 286.

4 See for ecomarxism: Burkett 1999; Foster 2000; Saito 2017.

5 Weiner 2000; Josephson 2002, 2013; Gestwa 2012; Bruno 2016; Frey 2019; Bruisch 2018.

the intellectual context in which the Soviet experiment unfolded. At the same time, ecomarxists have tried to show how Marx should have been read as an ecological thinker all along, and they tend to explain the Soviet Union's mistakes as a result, partly, of the loss of 'metabolic' thinkers following the rise of Stalin.[6] However, *energetika* and other theories of Soviet productivism were neither fixed ideological backgrounds nor did they constitute misunderstandings of Marx – they were readings of the Marxist discourse within a specific historical context.[7] Here, I put forth the argument that a 'productivist' reading of Marx was not necessarily less 'metabolic'. Indeed, it drew its strength from the claim that conscious, human production marked an immanent improvement upon the general, ongoing life-process – an argument that drew on the biological, chemical and engineering knowledge of the time.

We can study one of these pre-Stalinist readings in the practical and theoretical work of Gleb M. Krzhizhanovskii, one of Lenin's closest friends since their early revolutionary activities in St Petersburg. Krzhizhanovskii held a degree in engineering from the prestigious Saint Petersburg State Institute of Technology, and became a well-read Marxist during his exile in Siberia, well-versed in technical literature and revolutionary poems. As head of GOELRO and Gosplan,[8] Krzhizhanovskii is present in many accounts of economic planning in the 1920s. However, his career is sometimes described as anticlimactic: a fine engineer, but a failed administrator.[9] Due to an alleged 'anti-Bolshevik conspiracy' among Gosplan technocrats and disagreements with Stalin in 1930, Krzhizhanovskii left the centre of Soviet planning and went to work at the Academy of Sciences. As a Bolshevik engineer and member of the Party's central committee who fell out with Stalin but did not fall prey to the purges against technical experts of the late 1920s, Krzhizhanovskii often vanishes largely unnoticed from the later historical record.

Krzhizhanovskii is most famous for his work in the electrification commission and his contributions to early economic planning – a history that has been told many times.[10] Where his energetic thought is mentioned at all, it is treated as an awkward idea by an otherwise competent power engineer, or as evidence of his politicisation.[11] The Soviet official memory has been more

6 Foster and Burkett 2017, p. 33; Foster 2000, p. 228.

7 Cf. Malm 2017, p. 272.

8 GOELRO stands for 'State Plan for the Electrification of Russia', and Gosplan for 'State Planning Commission'.

9 Davies 1960, p. 303.

10 Haumann 1974; Cummins 1988; Coopersmith 1992.

11 Davies 1960, pp. 302–3; Coopersmith 1992, p. 251.

comprehensive, particularly after Stalin's death.[12] Within Soviet energy engineering, Krzhizhanovskii is seen as the founder of a distinctly Soviet school of energy economics, which conceived of energy relations as a 'major link of the productive forces' and as forming 'a single organic whole with the economy'.[13] While the role of energetics in Soviet energy politics, and economic planning more broadly, has yet to be discerned, we know that Krzhizhanovskii's early ideas influenced a series of planning decisions from peat-fired power stations, to the formation of economic regions, and the construction of economic indicators up to at least the 1930s.

The purpose of this paper is to take *energetika* – as formulated by Krzhizhanovskii[14] – seriously as a reading of the Marxist discourse and a theory that could guide the economic emancipation of the young Soviet Union. To contextualise this reading, I sketch out the debates within Russian Marxism, Krzhizhanovskii's activities before GOELRO, and explain the situation in Gosplan and the Soviet administration more broadly over the 1920s, after which I turn to an analysis of his energetic thinking. Rather than a comprehensive theory, *energetika* appears as a loose concept around which Krzhizhanovskii's thought evolved during his time of practical planning work at Gosplan. It combined an understanding that there is a common material structure of nature and society expressed in energetic principles, with concrete principles of efficiency to apply in engineering and planning, and a theory of history involving an energy-technological interpretation of the productive forces and societal advancement.

## 2 A Revolutionary Engineer

Krzhizhanovskii studied at the Saint Petersburg State Institute of Technology ('Tekhnolozhka'), one of the few elite schools that had been set up in the early nineteenth century to train Russia's technical staff. There he joined a group of leftist students, who, according to Krzhizhanovskii's own account, followed a thread of literature ranging from local revolutionaries to Georgi Plekhanov's

12 Krzhizhanovskii's *Sochineniia* (1933a, 1934a, 1936a) appeared in the 1930s; following his death in 1959 there followed a couple of bibliographies and another (smaller) set of collected works.

13 Melentev 1987, pp. 33, 83. All translations from the Russian and German are by the author.

14 I focus here on Krzhizhanovskii's written or republished works. Even though other GOELRO engineers shared aspects of his ideas, Krzhizhanovskii went furthest in linking electro-technical engineering, Marxism, and economic planning. After the 1930s, something like an 'energetic school' began to develop.

works and Marx's *Capital*.[15] When Lenin joined this circle in 1893, it gradually transformed from a Marxist study group into a group of revolutionary activists: Lenin visited Plekhanov and other first-generation social democrats abroad, smuggled a mimeograph back home, and, upon his return to Russia in 1895, founded the 'League of struggle for the emancipation of the working class' (*Soiuz borby za osvobozhdenie rabochego klassa*) together with Krzhizhanovskii, Julius Martov, and others. Under their central committee headed by Lenin, the League united twenty different leftist literature circles and channelled a 'steady stream of popular leaflets' to *Piter*'s workers.[16]

The Russian social democrats differed from earlier socialist movements in their view on the development of capitalism in Russia. After the failure of the revolutionary movements in Europe in 1848, Russian socialists such as Aleksandr Herzen, Mikhail Bakunin, and Nikolai Chernyshevskii envisioned a distinctly Russian path towards the self-emancipation of working people: They built their ideas around the Slavic village commune (*obshchina*), a community of equals in which land was redistributed periodically and tools were shared. While Marx rejected the utopian element in Herzen and the anti-statist element in Bakunin, he was himself puzzled by Russia's economic development. In his cooperation with Nikolai Danielson regarding the circulation of capital in Russia, he came to share the perspective that Russia's capitalist development differed from Europe's in that it was mainly externally driven by the state, railroads, and banks. Marx even agreed that the village commune with its handicraft industry could indeed become the seed of Russian socialism.[17]

The sharp distinction between 'narodnik' and 'social democratic' views is largely an artefact of Plekhanov's and then Lenin's writings over the 1880s and 1890s.[18] In the 1880s, Georgi Plekhanov turned towards European social democracy, focusing on the working people in capitalism – the industrial proletariat – instead of peasants.[19] The circle around the 'Tekhnolozhka' and the League leaned towards Plekhanov and focussed their agitation and education efforts mainly upon the industrial proletariat. One reason may have been that

15 Krzhizhanovskii 1924, p. 50. This group can be seen as one of the roots of the Social-Democratic Labour Party. Other notable members of that group were Mikhail Brunsev, Leonid and German Krasin, Stepan Radchenko, Zinaida Nevzorova (Krzhizhanovskii's later wife), and Natalia Krupskaia (Lenin's later wife). See Krupskaia 1928, p. 137; Kartsev 1980, p. 46.

16 Frankel 1969, p. 21.

17 Malia 1965, p. 392; White 2019a, pp. 5, 11.

18 White 2019b, pp. 86–92. Plekhanov's 'Our Differences' (1884) and Lenin's 'What the "Friends of the People" Are and How they Fight against the Social Democrats' (1894) made arguments against the 'narodniki'.

19 White 2019b, pp. 68–70.

industrial society was closer to the lives of engineers, who dominated that circle.[20] While Krzhizhanovskii knew and followed these debates, he saw himself less as a theorist than as a revolutionary, an engineer, and a poet (he was a gifted author of agitation material and translated the Warszawianka into Russian).

After his graduation in 1895, Krzhizhanovskii worked for Nikolai Annenskii, a statistician and narodnik, at the Nizhegorodskii Governorate. According to a Soviet biographer, Krzhizhanovskii took the job to help Lenin dispel the narodniki's belief in the revolutionary potential of the small peasant industries: He collected statistics on handicraft associations (*kiustarnie arteli*) to show that such organisations did not flourish so much as dissolve under the conditions of early capitalism.[21] In Lenin's view, which Krzhizhanovskii readily accepted, all countries would have to pass through the stages of capitalism to reach socialism – from small private producers to large-scale industrial production. Krzhizhanovskii and Lenin (and other members of the League) were arrested for 'revolutionary agitation' in 1896. During his exile in Krasnoyarsk, Lenin tried to disprove empirically the viability of the peasant economy more rigorously in *The Development of Capitalism in Russia*.[22]

The Russian Social-Democratic Labour Party was founded in 1898, at a time in which many established revolutionaries had been exiled. When rumours on a change in direction towards a mass party reached Lenin, he drafted a protest letter against it, which was signed by the exiled members of the League, including Krzhizhanovskii.[23] In the following years, Krzhizhanovskii acted as one of the main organisers of the Social-Democratic Labour Party in Russia. Upon his return from exile, he moved to his birth place, Samara, where he continued working as a railway engineer and, together with his wife, set up the central office for the Russian organisation of the newly-established party organ 'Iskra'.[24] Lenin envisaged the role of the journal as one of a 'collective organiser' which would hold together the non-reformist strand of the party.[25] The Krzhizhanovskiis established contact between different local social democrats, distributed literature, and raised funds. At the Second Party Congress in 1903 the on-going conflict over the direction of the party led it to split into rival factions, the *Mensheviks* and *Bolsheviks*. As a person whom both sides could support, Krzhizhanovskii was voted onto the Central Committee of the party

20 Natalia Krupskaia mentioned in her memoirs that the School of Forestry's student circle, in contrast, was largely 'narodnik'; Krupskaia 1928, p. 137.

21 Kartsev 1980, pp. 60–2.

22 Krzhizhanovskii 1936b, p. 58; Flakserman 1964, pp. 20–1, 32; Frankel 1969.

23 White 2001, p. 53; Frankel 1969, pp. 41–2.

24 Mullin 2015, p. 286; Flakserman 1964, p. 36.

25 Frankel 1969, p. 50.

and served there until 1905. Even though he feared that Lenin's radical stance risked party unity, Krzhizhanovskii nevertheless remained one of Lenin's most loyal contacts within the party's Central Committee.[26]

Krzhizhanovskii's legal work as an engineer often served to provide cover for his illegal activities, but regular work became harder to find after the revolution of 1905. After a couple of years underground, in 1907 he was employed by the 1886 Company for Electric Lightning (*Obshchestvo elektricheskogo osveshchenia 1886g.*) on the recommendation of Leonid Krasin, a fellow social democrat who had worked in the electric power industry abroad. The *Obshchestvo 1886g.* was a Siemens-Halske foreign investment, the largest company supplying St Petersburg with electric lighting, and a refuge for other revolutionary engineers.[27] Having been trained in engineering more generally, Krzhizhanovksii now began to pursue a career in electrical engineering. In 1912, he became manager of *Elektroperedacha*, a peat-fired regional power station financed by German and Swiss banks, which he had helped to design.[28] Through this work, Krzhizhanovskii became familiar with the latest foreign literature on regional power stations.[29]

With World War I interrupting supply chains and transport routes, resource planning and research on local supplementary resources – as practised by some electricity and resource boards before the war – became more important. Many of his revolutionary comrades from the *Obshchestvo 1896g*. assumed important positions in raw-materials administration both during and after the war.[30] Krzhizhanovskii continued to work as the managing director of *Elektroperedacha*. In a pattern adopted by many regional power-station operators during the war, he integrated industrial power stations into the regional grid and converted them to peat to save what little petroleum made it from Baku to Moscow.[31] Echoing voices that had called for the exploitation of peat resources for decades, Krzhizhanovskii called for a larger role for peat-fired stations in Russia's central industrial region in 1915.[32] His later *Pravda* article 'Peat

26 Mullin mentions that Krzhizhanovskii acted as a negotiator in the conflict between Martov and Lenin; see Mullin 2015, p. 377.

27 Flakserman 1964, pp. 64–5.

28 Eduard Klasson, who had graduated from the Saint Petersburg State Institute of Technology a couple of years before Krzhizhanovskii, was the main engineer. Like Krasin, Klasson had worked in the German power industry and had participated in the construction of the first long-distance transmission line between Lauffen and Frankfurt.

29 Krzhizhanovskii translated Georg Klingenberg's three-volume *Bau großer Elektrizitätskraftwerke* into Russian; Flakserman 1964, p. 65.

30 Coopersmith 1992, p. 144.

31 Coopersmith 2004; Flakserman 1964, pp. 66, 72.

32 Bruisch 2018.

and the Fuel Crisis' (1920) was meant to garner public support for GOELRO and drew on his earlier argument that high-voltage transmission would allow the exploitation of an otherwise disrespected fuel.[33] After the revolution in November 1917, Krzhizhanovskii quickly became part of the state administration. During the period of War Communism, economic authority was centralised in a couple of different committees and organisations controlling a certain economic sector or local area.[34] By 1919, Krzhizhanovskii headed the central administration of the power industry (*Glavelektro*) in the Supreme Council for the Economy (*Vysshii Sovet Narodnogo Khoziaistva*, VSNKh), which controlled the nationalised industries.[35]

## 3 Technocratic Planning in GOELRO and Gosplan

While most studies of early Soviet economic planning mention Krzhizhanovskii, they usually do not pay much attention to his work outside of GOELRO. Even though he was Gosplan chairman and a member of the Party's Central Committee, he was not at the front line of the vital planning conflicts of the 1920s – the conflict around NEP, the 'scissor crisis', and the method of planning. His marginalisation may also have occurred as he was often described as 'soft-spoken' and mild, though a well-respected and competent engineer.[36] His falling out with Stalin was not as dramatic as Trotsky's and his opposition to Molotov's plans was primarily about the significance of energy planning.[37] His vision of an energy-based, long-term regional planning did not fit easily within the major lines of conflict and had no powerful allies within Gosplan or the Central Committee. For that reason, a historical account of economic planning can ignore most of Krzhizhanovskii's energetic ideas – but a history of Soviet energetics cannot disregard his experiences in planning.

The war gave the idea of rational management of production a new urgency. In the interwar years, the increase of industrial productivity through scientific management and technology became a cherished goal across the political spectrum,[38] and the planning experiences during the war condensed into vari-

33 Flakserman 1964, p. 69.
34 Carr 1979, p. 30.
35 Cummins 1988, pp. 56–7; Zaleski 1971, pp. 26–7. A proposal to reorganise the People's Commissariats and set up a Commissariat for Energy was unsuccessful; see Coopersmith 1992, p. 195.
36 Kotkin 2015, p. 485; Davies 1960.
37 Flakserman 1964, Chapter 6.
38 Maier 1970, p. 28.

ous conceptualisations of a planned national economy.[39] Technologies such as electrification figured prominently in these texts, and were often conceptualised as means to transcend the political conflicts of society.[40] While not all Bolsheviks were prone to this kind of technocratic thinking, Lenin believed in the necessity of the newest technologies for realising socialism. 'The war taught us much,' he noted in 1918, '… but especially the fact that those who have the best technology, organisation, discipline and the best machines emerge on top; it is this the war has taught us, and it is a good thing it has taught us. It is essential to learn that without machines, without discipline, it is impossible to live in modern society. It is necessary to master the highest technology or be crushed.'[41] If Lenin had been sceptical of Taylorism before the war, he strongly embraced it afterwards.[42]

As much as Lenin disliked the merely contemplative intelligentsia, he was disposed towards scientific-technical experts, those 'who sought knowledge as a guide to action'.[43] Enthusiastic about Krzhizhanovskii's draft plan for GOELRO, he replied: 'We don't have enough experts [*spetsy*] of a certain calibre and vision [*s zagadom*].'[44] In the early years of the Soviet Union, he repeatedly saved non-Bolshevik technical experts from persecution by the Cheka. Among them was the liberal Vladimir I. Vernadskii, who had set up a Commission for the Study of Natural Productive Forces (*Kommissiia po izucheniiu estestvennykh proizvoditelnykh sil Rossii*, KEPS) in the Academy of Sciences in 1915 – an institution that would become Krzhizhanovskii's home after 1930.[45] In the same spirit, he supported Alexei Gastev's Central Labour Institute, which sought to apply the principles of scientific management to Soviet production, and a Central Statistical Administration, which would provide Soviet planning with an empirical basis.[46] Lenin's policy towards the technical intelligentsia

39 In the eyes of some Bolsheviks, Germany had transitioned to state capitalism over the course of the war, i.e. centralisation, planning, and dissolution of private companies – an experience that had been anticipated in Carl Ballod's *Der Zukunftsstaat* (1898, republished in 1919), and described in Walther Rathenau's *Die neue Wirtschaft* (1918).

40 Krzhizhanovskii was particularly enthusiastic about Bukhgejm's *On the Economic Liberation of Russia by Electrification of its Territory* (1915); see Krzhizhanovskii 1936c, p. 94.

41 Cited and translated in Bailes 1978, p. 49.

42 Bailes 1977, p. 376.

43 Bailes 1978, p. 47.

44 More precisely 'the ability to guess the future' – more an ability to decipher than to see. Krzhizhanovskii 1936b, p. 97.

45 Bailes 1978, p. 102; see also Graham 1967, p. 22. See Blok 1920 for an overview and a bibliography of the first five years of KEPS' work.

46 Bailes 1977; Blum and Mespoulet 2003.

was contentious among Bolsheviks, but he defended it as necessary to increase the forces of production in a situation of international class warfare.[47]

Before the revolution, Lenin had discussed electrification primarily in the context of the concentration of the productive forces Marx had predicted: the large, globally-acting power companies such as General Electric or AEG were proof of this development. Electrification assumed a more concrete role in Lenin's conception of the technological construction of the Soviet economy only in 1918–19.[48] The story of how Krzhizhanovskii reported to Lenin about the fuel crisis has often been told. Krzhizhanovskii explained how electrification would be a way to overcome the fuel crisis by allowing for the utilisation of low-grade fuel such as peat, which was abundant in central Russia.[49] Lenin encouraged him to put his ideas into a series of newspaper articles, where he should focus not so much on the technical details, but on electrification as 'a political or state plan'.[50] In these articles, Krzhizhanovskii reflected for the first time not only on the technical advantages of electrification, but on the specific role it could play in the construction of a socialist economy. Both Krzhizhanovskii and Lenin framed Russia's electrification as a solution to the fuel crisis and a leap towards socialist construction.

At the same time, however, GOELRO would strengthen Lenin's centralised and technocratic approach to planning.[51] Discussions of a unified plan that would overcome VSNKh's industry-by-industry planning had been going on for some time, and electrification was seen as a project that would affect all other plans.[52] Even though there were opponents to most parts of the plan, who emphasised that the fuel crisis could be solved more cheaply by conventional means and that planning should rest in the hands of workers or party officials, rather than technical experts, the State Committee for the Electrification of Russia was established under the VSNKh in 1919. The plan was worked out between 1919 and 1920 and approved by the Eighth All-Russia Congress of Soviets in 1920. The electrification plan comprised a survey of resources, an

47 Bailes 1978, pp. 50–1.

48 Lenin mentions electrification and some features of the electrification plan already in his instructions – an 'Outline of Scientific and Technical Work' – to Vernadskii's KEPS at the Academy of Science in 1918 (see below).

49 Cummins 1988, pp. 66–8.

50 Krzhizhanovskii 1936c, p. 97.

51 Cummins 1988, p. 2. Krzhizhanovskii mentioned that Lenin was not only interested in centralising planning, but also in the centralisation of production that electrification would enable; see Krzhizhanovskii 1931, p. 22.

52 The eighth and ninth party congress discussed a unified economic plan. See Zaleski 1971, p. 35; Haumann 1974, Chapter VI.

assessment of the type and location of regional power plants, and estimates of the rise in the productivity and output of agriculture, industry and transport.[53]

Right after the approval of GOELRO, VSNKh urged Glavelektro to recommend the organisational restructuring needed to realise the electrification plan. Glavelektro favoured a single commissariat of energy above the VSNKh, which would combine Glavelektro (supervising GOELRO), Elektrostroi, and the Main Fuel Administration into a single energy-planning unit. However, such a centralisation was impossible to achieve at a time when more and more industries and local municipalities called out against the coercive measures of the war economy. The NEP policies were, amongst other things, an attempt to soothe precisely such local unrest. Economic management via the control of energy was seen as a return to the command economy: a centralised means of control over the production and operation of every single power station. Instead, Glavelektro lost all its direct control over local power stations and remained responsible only for the industrial centres of Moscow, Petrograd and Baku.[54]

GOELRO provided the first integrated long-term plan for Soviet economic development, preceding the institutionalisation of a central planning commission by a year: In fact, Lenin understood Gosplan as an organ that would realise GOELRO and continue economic planning along the same lines. When it was established, Krzhizhanovskii became director of both commissions and 13 out of 27 of its members also held positions in GOELRO.[55] Krzhizhanovskii served as head of Gosplan between 1921 and 1923, and again from 1925 to 1930. During this time, its staff grew from a few dozen to a couple of hundred; half of its leading staff were engineers, some with a Menshevik or bourgeois background.[56] From the party's perspective, this ideologically 'dubious' group was, by government directive, responsible for preparing long-term and operational plans for the current year.[57] Gosplan was one of the institutions that integrated non-Bolshevik technical experts into the new Bolshevik state, a Leninist policy which Krzhizhanovskii strongly supported and that Stalin was deeply sceptical of.

Krzhizhanovskii has been described as a technocrat, but he lacked the political flexibility and indifference associated with such a label.[58] He was

53 Zaleski 1971, p. 37.

54 Coopersmith 1992, p. 195.

55 Bailes 1978, pp. 62–3; Haumann 1974, pp. 108, 180; Cummins 1988, p. 27; Coopersmith 1992, p. 157.

56 Pollock 1929, p. 278.

57 Zaleski 1971, p. 41; Cummins 1988, p. 57; Baykov 1947, p. 46.

58 As Davies has described him (Davies 1960); Coopersmith is closer to my understanding (Coopersmith 1992, p. 251). The most detailed discussion of Krzhizhanovskii's thinking to date can be found in Haumann 1974.

not interested in just any technology – hence his refusal of Molotov's focus on machine-building – but he went to great lengths to explain the historical necessity of electrification. During his Gosplan years, he reformulated electrification as the 'technical-economic basis' of socialism, linking it to other fields and problems. But he was certainly fascinated by technology, enthusiastic about the latest developments in electrotechnical engineering, and convinced that it was vital to constructing socialism. When he described electrification as a means to overcome social contradictions, he could be accused of believing in a technological fix. In his materialist view, however, the technical and the social were not two distinct spheres – technology was a result of historical developments and a precondition for those in the future.[59]

Krzhizhanovskii emphasised that electrification was a general technological development pursued by many countries.[60] Gosplan dedicated fifty pages of its bulletin to discussing the first World Power Conference, in order to compare GOELRO against other countries' electrification schemes.[61] The report concluded that GOELRO was in line with the two basic principles of modern electrical-development projects: concentration and interconnection.[62] In fact, the GOELRO system of large regional stations followed the most widespread model of electrical development at that time, brushing aside more radical approaches.[63] According to the Gosplan reporter, capitalist countries had become aware that competition in electrical systems was detrimental because of multiple investments in a parallel infrastructure.[64] A centralised infrastructure was more efficient in material and monetary terms. They interpreted

59 In *Energetika i Socialisticheskaia Rekonstrukciia* (1929) – probably already in defence against Stalin's attacks on technical experts – he spoke out against a 'narrow technicism, which separates the history of technology from the history of living human beings – the bearer of technology'; see Krzhizhanovskii 1933b, p. 363.

60 He followed the work of other electrification commissions in Britain, France, and Bulgaria; Krzhizhanovskii 1924, p. 3.

61 Kukel 1925, pp. 123–76.

62 Kukel 1925, p. 131.

63 By the turn of the century, electro-technical engineers everywhere began to hold a common view on how central stations should be constructed and managed: The larger the machinery, and the greater the diversity of load, the greater the operating efficiency and profitability. The talks, articles, and textbooks of Samuell Insull, Charles Merz, and Georg Klingenberg were particularly important for the 'codification' and circulation of that blueprint of electrical development (cf. Hughes 1993, p. 228). Coopersmith mentions that Krzhizhanovskii was particularly influenced by Klingenberg's *Bau großer Elektrizitätskraftwerke* (Coopersmith 1992, p. 139). The GOELRO followed this blueprint and did not explore other paths of electrical development (Coopersmith 1992, p. 151; Coopersmith 1993).

64 Kukel 1925, p. 133.

this centralisation imperative as capitalist countries having unconsciously followed a path of technological development which would eventually usher them into socialism.[65] In the words of Gosplan's US correspondent, electrification would be capitalism's last technological achievement.[66]

This view on technology and electrification also explains Krzhizhanovskii's position in the conflict over economic planning methods in Gosplan. In the mid-1920s, the debate on the 'price scissors' (i.e. the diverging prices of agricultural and industrial products during NEP) provoked a conflict between economists and engineers over the best method of planning. Vladimir Bazarov, Nikolai Kondratiev and Vladimir Groman understood the economy as a system of autonomous processes, whose states, conditions, and historical tendencies could be studied, but not overcome. 'Genetic' (*geneticheskoe*) planning studied the Russian economy in transition, hoping to derive from this dynamism the scope of planning possibilities. Based on the idea of a dynamic equilibrium between the development of the productive forces, Groman determined a ratio in which agricultural and industrial products should relate to each other. Stanislav Strumilin, a Bolshevik engineer, accepted only physical and technological limits to economic development.[67] He saw Groman's ratio as cementing a temporary empirical relation into a law-governed regularity.[68] If planning was to be based on existing relations, no qualitative change was possible. Genetic planning would merely *reproduce* the economy; teleological or goal-oriented planning could go beyond what is.[69] Krzhizhanovskii shared Strumilin's understanding of planning, because it could account for qualitative changes such as electrification. This was precisely what his concept of technical-economic *basis* was concerned with: a change in the relation of nature and society that was so fundamental that it would render the previous 'laws' of economic reproduction nonexistent.

The conflict between genetic and teleological planning played out as a conflict over the pace of development, and was ultimately decided in the high targets set for the first Five-Year Plan (*piatiletka*). The Menshevik economists who had been arguing for 'balanced growth' were put on trial for conspiratorial activities in the early 1930s. This trial was only one in a series of purges against the older technical intelligentsia between 1928 and 1931. Stalin had

65 Krzhizhanovskii 1924, p. 3.
66 Z. [anonymous author] 1925, p. 217.
67 Collier 2011, p. 56.
68 Barnett 2004, p. 75.
69 Davies 1960, p. 291.

been critical of Lenin's alliance with the *spetsy* from the beginning and, as Kendall Bailes suggests, was supported in his actions against them by a general anti-intellectualism among the rank-and-file, who themselves might have been denied access to higher education under the Tsarist regime.[70] Beyond disagreements on the plan that will be explored below, Krzhizhanovskii's resignation from public office in 1930 has to be seen in the context of Stalin's uneasiness with the old technical intelligentsia in general, and Gosplan technocrats in particular.[71]

Krzhizhanovskii was an active part of the second generation of Russian Marxists, but he did not contribute to their self-understanding in the way Lenin or Trotsky, or even such less-famous figures as Bogdanov, did. While not as intellectually 'soft' as he has sometimes been described, it is clear from his own writings that Krzhizhanovskii considered Lenin to be his intellectual guide. This relationship began to change when Lenin, after the war, became more interested in technology and began to appreciate Krzhizhanovskii for his insight into technical issues. 'He saw in me primarily technology [*tekhnika*]', noted Krzhizhanovskii in 1925.[72] Lenin encouraged Krzhizhanovskii's first programmatic statements (the articles on peat and GOELRO) and pushed him to undergird his technical programme with a broader Marxist outlook.

Over the 1920s and 1930s, Krzhizhanovskii's energetic thinking took on the form of what is best understood as a Marxist productivist ecology, which went far beyond Lenin's ideas.[73]

## 4 Realising Nature's Efficiency

Krzhizhanovskii saw the energy economy as embedded in nature. The Russian word 'energetika' denotes both nature's energy relations (it was used in that sense by Soviet biologists and ecologists) and the energy economy built by society. In an early formulation which passed Lenin's review, Krzhizhanovskii noted that 'it is necessary to realise [*voplotit*] the energetics of nature in those forms of transformations of energy and matter that are needed by the working

70 Bailes 1978, p. 73.

71 Bailes 1978; Fitzpatrick 1979.

72 Krzhizhanovskii 1936c, p. 87.

73 That Krzhizhanovskii really developed into an independent thinker can be seen from how he drew heavily on an 'energetic' language abhorred by Lenin and associated with Bogdanov. However, Krzhizhanovskii never cited Bogdanov directly and had a more materialist view of energy; see Haumann 1974, pp. 115–16.

people for their reproduction of life.'[74] The insight that human productive activity remains a part of the human metabolism with nature was widely accepted in Soviet thinking of the time.[75] It is therefore misleading to speak of a lack of metabolic thinking and a rise of productivism. Productivism rests on that very metabolism: Only insofar as human beings are a part of nature, only insofar as they partake in its metabolism, can they use the productiveness of nature for the species-life of humanity. Productivism is itself an ecological idea in that sense.[76]

At the time, the ecological insight into a nature–society metabolism did not so much pose limits to production than suggest its rationalisation, understood as planned human production on the basis of the latest natural sciences. The Soviets did not fail to heed Marx's remarks on capitalism's undermining of its own material conditions, but there was no reason to assume a rift in the human metabolism with nature that could not be overcome by the more rational form of production socialism would bring about. According to Krzhizhanovskii, *energetika* – the study of energy relations and their interaction with matter – was the science by which that metabolism could be governed in a more rational and efficient way.

The productive, efficient, and rational coincide in Krzhizhanovskii's thinking in a way that can only be understood in the context of the principles of the early twentieth-century power industry. In the years of fuel insecurity due to strikes, dwindling resources, and war, electrification was widely seen as a means of fuel conservation and security.[77] Not only were turbines more fuel-efficient than steam engines, but electrification was also seen as increasing labour productivity through mechanisation and automation.[78] Cheap electricity could power electrolysis to yield fertilisers and thus enhance agricultural productivity. What is more, capitalist countries' power-infrastructure development seemed to prove Lenin's (and Marx's) assertion that capitalist firms would themselves morph into more concentrated, cooperative forms.

74 Krzhizhanovskii 1933c, p. 82.

75 Bukharin's social energetics (published a year later in 1921) has received particular attention among today's eco-marxists, see Foster 2000, p. 227.

76 As Anson Rabinbach puts it, productivism held that 'human society and nature are linked by the primacy and identity of all productive activity, whether of laborers, of machines, or of natural forces.' (Rabinbach 1990, p. 3.) Ecological and productivist thinking have common roots in thinkers like Friedrich Schelling, who conceptualised the unity of nature and society under the notion of productivity; see Heuser 1986.

77 Hays 1999, p. 123; Turnbull 2017.

78 The goal of GOELRO was to achieve the highest possible increase in productivity by the lowest possible means; Gosudarstvennaia Komissiia po Elektrifikacii Rossii 1920, p. 11.

These large trusts could realise production at unseen levels of productivity.[79] Material, business and economic efficiency seemingly coincided in large-scale electrification. For that reason, electrification could stand like a *pars pro toto* for the rational organisation of production.

Krzhizhanovskii's notion of energetics was not limited to electrification. In a discussion on wages in Gosplan, a delegate asked why an increase in productivity preceded an increase in wages (as Strumilin had claimed) and how that time lag could be explained. This knowledge, he added, would surely be of the greatest importance for the self-consciousness (i.e. the acceptance of low wages) of the masses. Krzhizhanovskii replied that 'the formula that gives the true perspective of economic development [*razvertyvanie*] and the right approach to its higher forms – is energetic.'[80] While this must have been a disappointing answer for a delegate hoping to soothe workers back home, Krzhizhanovskii's explanations are worth quoting at length:

> ... the problem of the energetic reconstruction of the economy cannot simply be expressed by an analysis of the state of labour, or the principle applied in the scientific organisation of labour. It would be equally one-sided to conceive of the reproduction of the economy in terms of the mechanisation of labour, i.e. from the perspective of the *content* of the electrification plan. Rather, from the perspective of the technical basis, we find the most correct expression and the most comprehensive approach in the *method* of electrification. Here we have the solution to a perpetual problem in its truest form – the search for an energetic optimum.[81]

The energetic approach was not limited to certain industrial policies, such as increasing labour productivity or mechanisation; rather, it was a method – 'the search for an energetic optimum' – that could yield different solutions. Krzhizhanovskii's cautious, almost searching, formulation is no accident. He understood his work in these early years of planning as 'guessing ahead' (*zagadyvat*), a form of informed speculation. He pointed out more than once that the precise way in which the future socialist economy would reproduce was unknown.[82] What *was* known, however, was the method to achieve it – a more efficient regulation of the metabolism of nature and society.

79 This view was widely shared among progressive electrical engineers; see, for instance, Steinmetz 1916.

80 Planovoe Khoziaistvo 1923, pp. 46–7.

81 Ibid.; emphasis by the author.

82 Ibid.

The first application of this efficiency-centred method beyond the narrower field of energy policy involved the determination of distinct economic regions. From the beginning, internal differentiation was seen as a question of governability and control, but also as affording the possibility to reconstruct economic-administrative entities in a more rational way.[83] Already in 1918, Lenin instructed the Academy of Science's Commission for the Study of the Natural Productive Forces (KEPS) to explore the 'rational distribution of industry in Russia from the point of view of the proximity of resources and the minimisation of a loss of labour' at all stages of the production process. In addition, the commission should propose ways to rationalise production through merging and concentration of production in a few large enterprises and to make the RSFSR self-sufficient in all of the major types of resources and industry. In all of its works it should pay 'particular attention to electrification of industry and transport'.[84] While the KEPS had published a series of works during and after the war, the fulfilment of Lenin's instructions seems to have been interrupted by the civil war.[85] This surveying work was continued by GOELRO to decide on the most appropriate place for regional power stations.

In 1920, the All-Russian central executive committee (VZIK) formed an administrative committee to prepare a method of *raionirovanie* (the construction of economic regions) and determine, roughly, the border of regions. As part of this work, a sub-commission within Gosplan was formed, headed by Ivan G. Aleksandrov, a GOELRO engineer and economist, and Krzhizhanovskii. Aleksandrov and Krzhizhanovskii conceived of economic regions as 'combined production complexes', formed according to 'energetic principles' – self-sufficient, but open, economies.[86] They proposed forming 21 economic regions, which would be as autarkic as possible in terms of energy and would otherwise industrially specialise according to locally available resources and climatic conditions. Narrowed down to six principles of *raionirovanie*, the work of the commission was adopted by VZIK in 1922 but, after months of fierce discussion, the plan was refused at the Party Congress in 1923.[87] Even though the economic regions suggested by Gosplan were never realised, recent

83 The construction of economic regions has a longer history that reaches back into the nineteenth century; see Mieczkowski 1966, p. 89.

84 Lenin 1969, pp. 228–30.

85 Blok 1920; Malle 1985, pp. 300–1.

86 Karelin 2010, p. 15.

87 The theses are republished in Krzhizhanovskii 1957, pp. 102–8; Mieczkowski 1966, p. 112.

scholarship suggests such principles of regionalisation circulated widely and had some impact upon economic planning.[88]

Regions were not just lines on a map, but 'living' economic entities. *Raionirovanie* was therefore not to be a one-time decision, but part of an ongoing process of economic planning.[89] Aleksandrov devised a method to determine from how far a certain site of production should obtain its raw materials. The formula could even account for different resource qualities, as long as they were expressed in one dimension: fuels, for example, were weighed according to their calorific values.[90] On the basis of such calculations, Krzhizhanovskii would later come to revise his view on the advantages of peat.[91] While not excluding the vital role of energy centres – particularly the Donbass and Baku regions – in supplying the entire union, this principle of regional autarky sought explicitly to avoid the uneven development and resource imperialism of capitalist countries. The emphasis on the development of local resources remained a mainstay of Soviet energy policy over subsequent decades.[92]

The idea of regional autarky did not necessarily imply a strengthening of the countryside. In both theory and practice, electrification and industrialisation remained policies overwhelmingly focused on the most promising sites for the development of productive forces.[93] While the 'scissor crisis' has to be seen in the larger context of international currency relations,[94] it also showed that the countryside bore most of the weight of industrialisation without itself becoming more productive. The possibility of an alliance between workers and peasants (*smychka*) guided a variety of policies in the mid-1920s and revived Lenin's idea of the electrification of the countryside. Mieka Erley notes that the debate on the *smychka* stands in a long tradition of Russian thinking about the rural–urban divide in Liebigian terms: as a metabolism in which matter and energy are exchanged, and which can be disrupted.[95]

In his second term as director of Gosplan, Krzhizhanovskii began to link electrification more closely to this internal conflict.[96] When a new collection of hitherto-unpublished letters of Friedrich Engels appeared in Russian in

88 Mieczkowski (1966) saw only a minimal impact of the commission, Hirsch (2014) and Rindlisbacher (forthcoming) suggest otherwise.

89 Aleksandrov 1928a, p. 53.

90 Aleksandrov 1928a, 1928b. Haumann notes that this method of 'material indexing' goes back to Nikolai F. Charnovskii (Haumann 1974, p. 103).

91 Flakserman 1964, Chapter 5.

92 Frey 2019, pp. 7–14.

93 Coopersmith 1993.

94 Sanchez-Sibony 2019.

95 Erley 2018, p. 144.

96 Krzhizhanovskii 1925a, pp. 14–15.

1923, Krzhizhanovskii was excited to find Engels's speculation on the possibilities of electrification.[97]

> The steam engine taught us to transform heat into mechanical motion, but the exploitation of electricity has opened up the way to transforming all forms of energy – heat, mechanical motion, electricity, magnetism, light – one into the other and back again, and to their industrial exploitation. The circle is complete. And Deprez's latest discovery, namely that electric currents of very high voltage can, with a comparatively small loss of energy, be conveyed by simple telegraph wire over hitherto undreamed of distances and be harnessed at the place of destination – the thing is still in embryo – this discovery frees industry for good from virtually all local limitations, makes possible the harnessing of even the most remote hydraulic power and, though it may benefit the towns at the outset, will in the end inevitably prove the most powerful of levers in eliminating [*Aufhebung*] the antagonism between city and countryside. Again, it is obvious that the productive forces will thereby acquire a range such that they will, with increasing rapidity, outstrip the control of the bourgeoisie.[98]

Here Engels seemed to have in mind primarily the spatial redistribution of industry – if water power chained early industry to the countryside and steam power allowed modern industry to move to the city, then electricity would free industry 'from virtually all local limitations'. In that sense, the 'elimination of the antagonism' can be related to the construction of economic regions mentioned above. To Soviet economists and engineers, it meant more than that: Electrification of the countryside would raise the productivity of agrarian labour (through direct application of electric power), win over the peasants for the Soviet cause, and create a common socialist life-world for both urban and rural populations.[99]

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97 He was not the only one: Trotsky was enthusiastic about that passage as well (Trotsky 1994, p. 312).

98 Letter from Engels to Bernstein, 27 February 1883; emphasis and German original by me. Wolfgang König traces Engels's remarks back to a series of articles on the 'electrotechnical revolution' in Louis Viereck's Bavarian newspaper *Sueddeutsche Post* in 1882 (König 1989). Iring Fetscher mentions that Marx had become enthusiastic about electricity earlier and had pointed Engels to Deprez's work in 1882. Wilhelm Liebknecht recalled a conversation with Marx in 1850, in which Marx predicted that 'King Steam's reign was finished' and 'a new, more powerful revolutionary would appear – the electrical spark.' (Fetscher 1981, pp. 190–1.)

99 Golcman and Gorev 1925.

But there was also a more direct link to the metabolic rift: Krzhizhanovskii pointed out that Engels had realised the significance of electricity as a last 'link' in the productive metabolism with nature, which would entail entirely different relations of production.[100] Part of the electrification plan had always been to use large-scale electrification for the industrial production of fertiliser through electrolysis – a means to return the nutrients taken from the soil by agriculture and erosion.[101] In his later writings, Krzhizhanovskii referred explicitly to Marx's passage on the degradation of both soil and worker in capitalism and suggested *energetika* as a more harmonious relation to nature: 'Having risen in a long and harsh struggle with nature, which has shaped human collectives into the most diverse forms, yet each time creating an internally antagonistic, contradictory whole, man finally senses [*nashchupyvat*][102] the ways in which the powerful creation of his hands can be included in nature merely as an element that ennobles it.'[103] Krzhizhanovskii saw the socialist organisation of the economy based on electricity and electrochemistry as a rational way to balance the metabolism between city and countryside and to restore both soil and workers.

Krzhizhanovskii introduced the last volume of his Collected Works (*Sochineniia*) (1936) with Marx's words on the realm of freedom. In this paragraph, Marx distinguished between a realm of necessity, 'the sphere of material production proper', and a realm of freedom, 'the development of human power as an end in itself'. The realm of necessity cannot be entirely overcome, as 'under all possible modes of production' human beings will 'wrestle with nature to satisfy [their] needs'. However, the expansion of the forces of production and the collective and rational governance of 'the human metabolism with nature' can diminish the energy spent (*Kraftaufwand* in the German original) in this realm of necessity.[104] Krzhizhanovskii read this as a timeline for the construction of a Soviet economy: The Soviet people still live in the realm of necessity, but the plans, geared towards the collective appropriation of nature, would lead them into the realm of freedom. In the first instance, this meant to gain general control over the human metabolism with nature and to determine the measures that would enable a collective governance of the 'entire mechanism of production and reproduction of material values'.[105]

100 Krzhizhanovskii 1933c, p. 362.
101 Gosudarstvennaia komissiia po elektrifikacii Rossii 1920, pp. 123–4; Krzhizhanovskii 1936d, p. 467.
102 To find out something by touch.
103 Krzhizhanovskii 1936e, p. 347.
104 Marx 1981, pp. 958–9.
105 Krzhizhanovskii 1936f, pp. 6–8.

That Krzhizhanovskii omitted Marx's last sentence – to wit, the reduction of the working day is the 'basic prerequisite' for the realm of freedom – provides a demonstration of his priorities.

At the root of his conviction was a knowledge of the progressing productive forces, and more precisely, an insight into the significance of the energy basis they rested on. As can be seen from Engels's statement cited above, the rise of electricity was accompanied by *ad hoc* theories of what would now be termed 'energy transitions'; Krzhizhanovskii was no pioneer here, but drew on the works of Wilhelm Ostwald, Frederick Soddy and others. He liked to cite one of his professors who had called the age of steam 'the age of the third estate' and the age of electricity the age of the proletariat.[106] A young statistician and later collaborator, Veniamin Veic, worked out a more detailed energetic history of the productive forces in his *Potential and Kinetic Productive Forces in the World Economy* (1927), part of which he presented at the second World Power Conference in Berlin.[107] Drawing on Krzhizhanovskii's work and language, Veic justified the 'leading role of the energy basis' by its influence on the speed of development and the location of the productive forces, as well as on the major contradictions between the productive forces and society.[108] In the view of the Soviet *energetiki*, this contradiction determined the current situation: Capitalism had brought about an energy basis that favoured cooperative forms of economic organisation (e.g. trusts, interconnected grids), which capitalist countries themselves were unable to fully realise.

When Stalin announced the building of Socialism in One Country in 1925,[109] the comparisons with capitalist countries took on a less-emancipatory and a more competitive form. Krzhizhanovskii thought that it would be possible for a socialist country to catch up and even surpass capitalist countries. Only socialist countries could combine central planning with national ownership of

106 Davies 1960, p. 297; see, for instance, Krzhizhanovskii 1933b, p. 354. Haumann notes that this counterposition of steam and electricity goes back to the narodnik economist Aleksandr S. Posnikov (Haumann 1974, p. 102). In a variation, Krzhizhanovskii later identified 'the age of communism' with 'the age of the atom'.

107 Veic 1927, 1930. Veic wrote his earlier work in the Communist Academy of Sciences' institute for methodology, a rival to the Russian Academy of Sciences founded in 1918, focusing on economics, the technical and social sciences (the Academies merged in 1936). Apart from Veic, there was at least one other research project centring around Krzhizhanovskii's energetic ideas in the Communist Academy: Maria Falkner-Smit's research on the 'energification of industry', i.e. the productivity gains through electrification; see Falkner-Smit 1930. Both Veic and Falkner-Smit joined the Academy of Sciences during Krzhizhanovskii's vice-presidency; Veic began to work at the Institute of Energetics.

108 Veic 1930, p. 73.

109 See, for the prehistory of this shift over the 1920s, Zakunov 1994, Chapter 7.

power utilities and industries, such that the interests of producers and consumers were aligned and electrification would be able to function as a rationalising and socialising force.[110] In preparation for the first *piatiletka*, Krzhizhanovskii developed the concept of 'energy-equipment of living labour [*energovooruzhenost zhivogo truda*]', a measure of the energy produced per person or worker and an indicator of the Soviet Union's backwardness. However, even if the energy economy of capitalist countries was still many times more powerful, their forces acted chaotically against each other, in a 'complex polygon'.[111] When the metabolism of nature and society was rationally regulated, Krzhizhanovskii argued, the 'forces of nature' and human labour – which he once called 'our red coal'[112] – would come to work in parallel, as a single, rectified force. The emancipation from the elements of nature was universal, and the Soviet Union should be judged in terms of the amount of natural power it was able to subdue.[113]

Energetic ideas are evident in the language and the prominence that is assigned to the energy balance in the first Five-Year Plan.[114] But the conflict over the pace of industrialisation between VSNKh and Gosplan had already begun by that time, and Krzhizhanovskii's influence was waning. While he had always been a proponent of fast and decisive industrialisation, he spoke out against VSNKh's upwards revision of the plan's production targets in 1928.[115] The deeper disagreement between Stalin and Molotov's industrialisation policy focusing on heavy industry and Krzhizhanovskii's industrialisation based on a new 'technical-economic basis' has rarely been noted. After all, Molotov did not plan to drop electrification. But the point Krzhizhanovskii tried to make again and again was that an energetically-optimised economy was not realised by any single measure, that not *all* electrification optimised the productive metabolism. Optimisation required accounting on the level of the material-energetic efficiency of the *entire economic organism*. It required an institutional venue, the 'commanding heights' from which the economy could be constantly evaluated and planned-for. In Krzhizhanovskii's view, there should be a general plan referring to the reconstruction of the technical-economic basis of the economy over a longer period of time – a plan based on energetics like that of GOELRO – which embedded shorter operational

110 Krzhizhanovskii 1928, p. 35.
111 Ibid.
112 Krzhizhanovskii 1925b, pp. 11–12.
113 Krzhizhanovskii 1928, p. 18.
114 Gosplan 1930, pp. 24–6.
115 Davies 1998, p. 61.

plans.[116] But Stalin and Molotov preferred five-year horizons, possibly because they (correctly) feared long-term planning *à la* Krzhizhanovskii would require an army of non-party energy engineers, just as GOELRO had.[117]

Krzhizhanovskii argued against Stalin and Molotov's path of modernisation on the grounds of the historical development of productive forces and their current 'energetic stage'. Heavy industry was important, but it had to be put on the new technical basis of electrification. To make his point, he cited a letter from Engels to Nikolai Danielson from 1892, in which Engels invoked a fixed path of capitalist development (railways, heavy industry, electrification) and insisted on the need for Russia to develop a modern industry.[118] By doing so, Krzhizanovskii subtly implied that the focus on machine-building was as outdated in 1930 as the narodniki's hope in small-village industry had been in the 1890s. Industrialisation on the current highest technological level was necessary and the Bolshevik Revolution made it possible not to follow after the previous developmental steps, but to leapfrog to the most advanced level. Drawing on Engels and Lenin's argument on economic concentration, Krzhizhanovskii suggested the construction of regional 'energy-industrial complexes', which would combine heat, power and electrochemical production, and rationalise transport, industry and agriculture on the basis of electricity's centralising and efficiency-driven imperatives.[119] For all his campaigning, the model of development shifted from a focus on electrification to machine-building, and the energy engineers lost their impact on planning. Krzhizhanovskii's contribution to the energy part of the second Five-Year Plan, formulated as head of Glavelektro rather than Gosplan, ended up being quietly ignored by Stalin and Molotov.[120]

116 Krzhizhanovskii 1930a, 1930b.

117 Flakserman 1964, pp. 144–5. A similar suspicion was directed at Gosplan technocrats, among whom were only few party members.

118 Letter from Friedrich Engels to Nikolai Danielson, 22 September 1892, Institut Marksa-Engel'sa-Lenina 1951, p. 165. As mentioned above, White points out that this was not Marx's view (White 2019a, b).

119 Krzhizhanovskii 1933b, p. 361.

120 Bailes 1978, p. 185. David Shearer argues that Stalin's industrialisation policy was primarily driven by the attempt to consolidate a powerful state. Krzhizhanovskii's energetic planning can be seen as one of the experiments 'cut short by the Stalinist reorganization' of the industrial economy; Shearer 1996, pp. 12–13. Flakserman argued that this turn away from energetic planning led to a slower and less-efficient electrification of the country (Flakserman 1964, pp. 145–52).

## 5 Conclusion

After he left Gosplan, Krzhizhanovskii became vice president of the Academy of Sciences and head of its Institute of Energetics. Ironically, he became part of Stalin's plan to 'bolshevise' the Academy. In his new position, he worked on a new curriculum for engineers, reorganised the Academy, and devised an all-Russia energy plan.[121] Krzhizhanovskii remained convinced of his analysis of the historical state of the world economy and the role of the energy economy. He co-edited a five-volume history of science and technology with an emphasis on energy, which became a standard textbook in engineering education, and continued to try to influence planning from outside Gosplan through newspaper articles. 'We were born too early', commented Krzhizhanovskii on his removal from Gosplan to a fellow engineer.[122] There was indeed a revival of energetic thinking within Soviet economic planning in the 1950s and 1960s, which was by then influenced more by cybernetics than by Marxism.

Productivist and ecological thinking are deeply entangled. Though clearly a programme of industrial expansion, Krzhizhanovskii's *energetika* did not eschew the concept of metabolism as presented by Marx. In fact, it even built on it. There is no contradiction between productivist and metabolic thinking *in principle*; they have turned out contradictions *in practice*. That human production is a conscious manifestation of the general life-process is a perspective that was not peculiar to Krzhizhanovskii. For all their insights into the complexity of nature, neither Vernadskii nor Bukharin spoke out against industrialisation as such.[123] Rather, they believed that the right form of industrialisation could avoid the metabolic rifts generated by capitalist production. In Krzhizhanovskii's view, energetic optimisation was the conscious and rational governance of the metabolic relation that exists between nature and society.

This imagined, productive unity of nature and society rests, to borrow from Walter Benjamin, on a 'corrupted' concept of labour.[124] Hannah Arendt saw a link between metabolic thinking and the primacy of labour over other forms of human activities: 'Within a completely "socialized mankind," whose sole

121 Ibid.; Fitzpatrick 1979, p. 219; Flakserman 1964, pp. 189–231.

122 Flakserman 1964, p. 245.

123 As mentioned above, Vernadskii, who coined the term biosphere, set up a commission for the study of the natural productive forces. And despite his focus on industrial expansion, Krzhizhanovskii declared that 'a proper role for conservation is essential for the healthy development of our country' and recommended the creation of a strong central organ for conservation (Weiner 2000, p. 270).

124 Benjamin 1968, p. 258.

purpose would be the entertaining of the life process', noted Arendt in her critique of Marx's concept of labour, 'all work would have become labour because all things would be understood [...] as results of living labour power and functions of the life process.'[125] A productivist society subdues all transformative activities, natural or social, to the purpose of reproducing life. In turn, whatever reproduces life comes to be seen as progressive: This is most apparent in Krzhizhanovskii's concept of 'energy-equipment of labour', which relates natural forces and human labour in a way that couples the emancipation of the latter to the exploitation of the former.

Benjamin was one of the few contemporaries who criticised this 'social-democratic' relation to nature. He did so not for its lack of ecological thinking, but its flawed concept of history. While Krzhizhanovskii spoke out against Eduard Bernstein's evolutionary understanding of history when he signed Lenin's letter of protest, his own concept was not so different. Whereas Bernstein offered 'empirical' historical progress to lull revolutionary action, Krzhizhanovskii invoked the energetic progress of the productive forces – whose basic assumptions were widely shared among natural scientists of the time – to legitimise industrial expansion. Both emphasised their 'scientific' historical method and regarded, in Benjamin's words, 'technological development as the fall of the stream' with which they thought they were moving.[126] Krzhizhanovskii was convinced that the opportunities for realising socialism were increasing as a result of electrification; socialists only had to seize the moment. From there, as Benjamin observed, it was only a small step to believing that the work of miners and engineers furthering technological progress already constituted a political achievement. Krzhizhanovskii, too, recognised more the progress in the mastery of nature than the retrogression of the society the Bolsheviks were creating.[127]

As critical as we should be of the socialist exploitation of nature, *energetika* was not only a productivist ideology. It can also be read as a critical materialism in Alfred Schmidt's sense.[128] Its truth lies not in its positive theory – the productive unity of nature and society, and the energetic stages of the productive forces – but in the material critique it waged against the early twentieth-century capitalist energy-economy: the massive waste, spatial inequalities, and contradictions produced by the oil, coal, and power industries. By taking seriously the material conditions of production, *energetika* did lead to an

125 Arendt 1958, pp. 88–9; see also Heller 1981.
126 Benjamin 1968, p. 258.
127 Benjamin 1968, p. 259.
128 Schmidt 2017, p. 22.

energy system that was progressive in certain regards.[129] However, the history of *energetika* shows that any attempt to recover the concept of metabolism has to come to terms with its productivist and technocratic prehistory. Metabolic thinking alone is hardly progressive in a warming world: A society can be regressive *and* geared towards survival just as it was towards production.

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129 The Institute of Energetics conducted research on regionalisation, district heating and the cogeneration of power and heat. In subsequent years, the Soviet Union became a forerunner in cogeneration technology, which was only rediscovered in most Western countries after the 1970s oil-crises. Rüdig 1986, p. 127; Werner 2017, p. 219.

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