From Growth to Entwicklung

An Outline of Political Economy for Ecological Civilization

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Abstract

Modern political economy has largely taken economic growth as its organizing horizon. Rooted especially in the English and Scottish Enlightenment, this tradition understands progress through the expansion of production, trade, productivity, property, accumulation, and wealth. Yet an alternative conceptual lineage can be reconstructed from the German traditions of Bildung, Entwicklung, historical formation, and institutional mediation. This article argues that ecological civilization requires a shift from growth as quantitative expansion to Entwicklung as the qualitative development of life-conditions. However, such a shift also requires a new problem of measurement. It is not sufficient to impose ecological constraints on growth; development itself must become measurable in terms of capability formation, complexity, ecological directionality, metabolic admissibility, reproductive capacity, democratic governability, systemic resilience, and the social organization of time. The article therefore introduces the concept of Ecological Development Complexity, building on economic complexity analysis while extending it beyond export sophistication toward ecologically directed and socially reproductive capabilities. Drawing also on Diane Coyle's recent critique of the national accounting framework, the article argues that the crisis of growth measurement is not only an external ecological criticism of economics but an internal crisis of contemporary economic statistics. Coyle's emphasis on comprehensive wealth and time-use accounting is interpreted as an important bridge from GDP-centered growth accounting toward ecological development accounting. The ecological crisis reveals that growth-oriented political economy has externalized the material, metabolic, social, and temporal conditions of its own possibility. By contrast, an ecological reinterpretation of Entwicklung allows the economy to be understood as the institutional mediation of inner and outer nature: human capacities, work, care, time, and social reproduction on the one hand; energy flows, material cycles, ecosystems, and planetary boundaries on the other. The article develops this argument through a comparative reading of English, French, and German Enlightenment traditions, before proposing a political economy of ecological civilization grounded in commoning reproduction, custodial property, ecological development complexity, and multi-ledger accountability.

Keywords: growth, Entwicklung, ecological civilization, ecological realism, political economy, economic complexity, green complexity, Diane Coyle, national accounting, time-use accounting, Bildung, commoning reproduction, custodial property, planetary boundaries

1. Introduction: The Problem of Growth

Modern political economy has been organized around a powerful assumption: the economy is healthy when it grows. Growth has become not merely an empirical indicator, but a civilizational norm. Rising output, productivity, trade, income, capital accumulation, and consumption are

treated as signs of progress. The central question of economic governance has therefore been how to secure, accelerate, stabilize, or redistribute growth.

This orientation has deep roots in the English and Scottish Enlightenment and in classical political economy. From Locke's theory of property and improvement to Smith's analysis of division of labour and commercial society, the modern economy is framed as a dynamic order of productive expansion, exchange, accumulation, and wealth creation (Locke 1988; Smith 1981; Hume 1985). In this tradition, growth is not an accidental outcome. It is closely tied to the very meaning of modern civilization.

Yet ecological crisis has made this assumption increasingly unstable. Climate change, biodiversity loss, material overuse, soil degradation, freshwater stress, and the breach of planetary boundaries demonstrate that economic expansion cannot be assessed only in monetary or output terms (Rockstrom et al. 2009; Steffen et al. 2015; Richardson et al. 2023). The 2023 planetary boundaries update concluded that six of nine boundaries had been transgressed, underlining the inadequacy of treating economic expansion as a self-legitimating measure of progress. Growth may increase measured wealth while undermining the biophysical conditions of life. A society may become economically richer while becoming ecologically poorer.

The measurement problem is not merely an external criticism of economics from ecological theory. It is increasingly recognized within debates on economic statistics themselves. Diane Coyle argues that the framework of national accounting developed in the mid-twentieth century no longer corresponds to the structure of contemporary economies. It was designed for an era in which physical capital, industrial output, and demand management were central, whereas today's economies are shaped by digital services, intangible assets, data, environmental constraints, unpaid work, and the changing organization of time (Coyle 2025). The problem, therefore, is not only that GDP is an insufficient measure of welfare. It is that the statistical infrastructure of growth no longer adequately describes the economy whose progress it claims to measure.

This article argues that ecological civilization requires a conceptual shift from growth to Entwicklung. The German term Entwicklung carries meanings that exceed the English word development. It suggests unfolding, formation, maturation, mediation, and qualitative transformation. Whereas growth refers primarily to quantitative increase, Entwicklung concerns the emergence and transformation of forms of life, capacities, institutions, and relations.

The central thesis is this: ecological civilization requires replacing growth as the organizing telos of the economy with Entwicklung: the qualitative, democratic, measurable, and ecologically bounded development of the conditions of life.

However, this shift immediately raises a further question. If growth is no longer the primary measure of progress, then how should development be measured? It is not enough to set ecological limits from the outside. A political economy of ecological civilization must also be able to describe whether an economy is genuinely developing: whether its capabilities, institutions, technologies, labour forms, time structures, and social relations are becoming more capable of reproducing life within planetary boundaries.

This is where economic complexity analysis becomes relevant. Economic complexity research has attempted to measure not merely how much an economy produces, but what kinds of productive knowledge and capabilities it contains. Hidalgo and Hausmann's work on economic complexity interprets diversified and less ubiquitous export structures as indicators of more complex productive capabilities, while product-space research shows how economies diversify into nearby products based on existing capability structures (Hidalgo et al. 2007; Hidalgo and Hausmann 2009). This does not yet provide a sufficient measure of ecological development, but it offers an important starting point: development can be understood as the structured formation of capabilities, not merely the expansion of output.

The article proceeds in five steps. First, it reconstructs three Enlightenment horizons of political economy: English growth, French political universality, and German Entwicklung. Second, it contrasts growth and Entwicklung as two different logics of economic thought. Third, it reinterprets Entwicklung ecologically as the mediation of inner and outer nature. Fourth, it introduces Ecological Development Complexity as a possible metric framework for measuring Entwicklung, now strengthened by Coyle's argument for comprehensive wealth and time-use accounting. Fifth, it outlines the institutional implications of this shift: commoning reproduction, custodial property, and multi-ledger accountability.

2. Three Enlightenment Horizons of Political Economy

The modern idea of economy did not emerge from a single intellectual tradition. It was shaped by several competing and overlapping Enlightenment trajectories. For the purposes of this article, three are especially important: the English and Scottish horizon of commerce and growth, the French horizon of political universality and general will, and the German horizon of formation, mediation, and development.

These are not closed national traditions. Each contains internal tensions, and each interacted with the others. Nevertheless, the distinction helps clarify three different ways in which modernity has understood the relation between economy, society, reason, and nature.

3. The English and Scottish Horizon: Growth, Commerce, and Expansion

The English and Scottish Enlightenment gave modern political economy its most influential vocabulary. Locke's account of property linked labour, appropriation, and improvement; Hume explored commerce, manners, and political economy; Smith articulated the division of labour, market coordination, and the growth of opulence (Locke 1988; Hume 1985; Smith 1981, 1982).

In this horizon, the economy appears as a sphere of productive and commercial dynamism. Goods, labour, money, capital, land, prices, and interests circulate through increasingly complex networks of exchange. The division of labour increases productivity. Markets coordinate dispersed knowledge and interests. Commerce extends interdependence beyond local communities. Wealth grows through specialization, investment, and exchange.

The basic civilizational formula may be expressed as follows: more production, more exchange, more wealth, more power, more civilization.

This formula should not be dismissed too quickly. The English and Scottish tradition grasped a real historical transformation: the emergence of commercial society as a dynamic order capable of mobilizing labour, capital, knowledge, technology, and exchange at unprecedented scale. It also recognized that cooperation among strangers could be mediated through institutions, prices, contracts, and markets.

Yet from the standpoint of ecological realism, this horizon contains a structural danger. It tends to treat outer nature as an external field of appropriation, improvement, extraction, transport, and exchange. Land becomes property; forests become timber; rivers become transport routes or energy sources; soils become agricultural productivity; minerals become inputs; colonies become supply zones; fossil fuels become industrial power.

The economy thus becomes exo-expansive. It moves outward toward new lands, resources, labour reserves, markets, technologies, and frontiers of accumulation. Its strength is dynamism. Its danger is boundlessness.

This dynamic has been central to the history of industrial capitalism. Wrigley has shown how the English Industrial Revolution depended on the transition from organic energy constraints to fossil energy, especially coal (Wrigley 2010). Malm has argued that fossil capital was not simply a technological necessity but a historically specific organization of power, labour, and energy (Malm 2016). Ecological economists have similarly emphasized that modern growth rests on material and energetic throughput that cannot be reduced to monetary circulation (Georgescu-Roegen 1971; Daly 1996).

The English growth horizon therefore remains indispensable for understanding modern economic dynamism, but inadequate as a foundation for ecological civilization. A system designed for expansion cannot by itself define the conditions of life on a finite planet.

4. The French Horizon: Universality, State, and Political Legitimacy

The French Enlightenment introduces a different problem. Its central question is not only how wealth grows, but how society can be rationally and politically constituted. Rousseau's account of the general will, Condorcet's faith in progress, Diderot's encyclopedic project, and the revolutionary tradition all place economy within a broader horizon of citizenship, law, sovereignty, and universal reason (Rousseau 1997; Condorcet 2012; Diderot 1992).

In this tradition, economy cannot be left to the spontaneous order of exchange. It belongs to the constitution of the political community. The decisive questions are: Who is the people? What is the general interest? What is legitimate property? What must the state secure? What rights and duties belong to citizens? How can society be made rational and just?

The French horizon therefore corrects the English one by refusing to let the market define society as a whole. It brings economic relations under the judgement of political legitimacy. It insists that property, exchange, taxation, welfare, and inequality are not merely technical issues but public questions.

This remains crucial for ecological civilization. The ecological transition cannot be left to market adjustment alone. It requires law, democratic legitimacy, public investment, planning, regulation,

rights, duties, and collective decision-making. Markets may coordinate some activities, but they cannot decide the ultimate ends of civilization.

However, the French universalist horizon also has a limitation. Its universalism can become abstract. It may imagine reason as legislating from above while nature remains an object of administration. The political community is constituted through law and citizenship, but its ecological embeddedness remains insufficiently theorized. The French tradition can say: the economy must serve the general will. Ecological realism must add: the general will itself must be formed within the material conditions of the Earth.

This requires a reinterpretation of universality. The universal is no longer an abstract human standpoint above nature. It must become planetary commonality: the recognition that humanity shares life-conditions with the more-than-human world. The political question is therefore not only how to constitute a people, but how to constitute democratic agency within planetary boundaries.

5. The German Horizon: Bildung, Mediation, and Entwicklung

The German tradition opens a third horizon. Its central terms are not only property, commerce, sovereignty, or law, but Bildung, Entfaltung, Vermittlung, Sittlichkeit, and Entwicklung: formation, unfolding, mediation, ethical life, and development.

In Kant, the human being is not merely a creature of needs, interests, and appetites, but a being capable of autonomy and moral self-legislation (Kant 1996). In Herder and Humboldt, human development is linked to language, culture, education, and the unfolding of capacities (Herder 2002; Humboldt 2000). In Hegel, freedom is not merely formal independence but becomes actual only through institutions: family, civil society, law, the state, and ethical life (Hegel 1991). In Marx, the economy becomes the central field of historical development, but also of alienation: labour transforms nature and society, yet under capitalist relations it does so in a form that estranges human beings from their own activity, from one another, and from nature (Marx 1976, 1992).

The significance of this horizon lies in its developmental and mediational structure. Human beings are not simply individuals pursuing interests within given institutions. They are formed through institutions, labour, language, culture, and social relations. The economy is therefore not merely a mechanism for resource allocation or output expansion. It is part of the historical formation of human capacities and forms of life.

Here the distinction between growth and Entwicklung becomes decisive. Growth means quantitative increase. Entwicklung means qualitative formation. Growth asks: how much more? Entwicklung asks: what kind of form is emerging? Growth measures expansion. Entwicklung examines mediation, contradiction, maturation, and transformation.

This distinction is central for ecological civilization because an economy can grow while degrading the very capacities and life-conditions upon which development depends. It can expand output while fragmenting communities, exhausting bodies, deskilling work, destroying ecosystems, and destabilizing climate systems. From the perspective of Entwicklung, such growth is not genuine development but distorted formation.

The German horizon therefore allows political economy to ask a deeper question: not simply whether the economy expands, but whether it develops a freer, richer, more adequate relation between human beings, institutions, work, and nature.

6. Growth and Entwicklung: A Conceptual Contrast

The difference between growth and Entwicklung may be summarized as follows:

Growth	Entwicklung
Quantitative expansion	Qualitative formation
More output	Better life-conditions
Accumulation of capital	Development of capacities
Expansion of markets	Transformation of institutions
Externalization of nature	Mediation of inner and outer nature
GDP as central measure	Multi-dimensional reproduction of life
Nature as resource	Nature as condition, co-world, and limit
Labour as input	Labour as formative activity
Progress as increase	Progress as maturation
Efficiency within given ends	Reflection on ends themselves

The point is not that growth and Entwicklung are always mutually exclusive. Material expansion may be necessary where basic needs remain unmet. But growth is not self-legitimating. It becomes meaningful only when subordinated to development understood as the qualitative improvement of life-conditions.

This distinction also clarifies debates around degrowth, post-growth, and steady-state economics. The strongest ecological critique of growth does not simply demand less in an abstract sense. It asks what kinds of economic activity should expand, contract, transform, or disappear in light of social needs and ecological limits (Daly 1996; Jackson 2017; Kallis 2018; Hickel 2020). A hospital, a coal mine, a public library, a care cooperative, an arms factory, and a wetland restoration project cannot be judged by one aggregate growth measure alone. They must be evaluated according to their contribution to the reproduction of life.

This is where Entwicklung provides a more adequate normative grammar. It allows us to distinguish between expansion and development, between accumulation and maturation, between throughput and flourishing.

7. Ecological Realism: The New Condition of Development

The ecological crisis changes the meaning of political economy. It reveals that the economy is not an autonomous domain governed only by markets, preferences, technologies, and institutions. It is embedded in planetary metabolism: energy flows, material cycles, ecosystems, soils, waters, climate systems, and living processes.

This insight has been developed in ecological economics, social metabolism studies, Marxian ecology, and world-ecology approaches (Georgescu-Roegen 1971; Daly 1996; Foster 2000; Haberl et al. 2016; Moore 2015). While these traditions differ in important respects, they share a rejection of the idea that the economy can be adequately understood as a circular monetary flow detached from biophysical reality.

From the standpoint of ecological realism, the economy is a historically specific mode of organizing human metabolism with nature. It mediates between what may be called inner nature and outer nature (Volanen 2026a).

Inner nature refers to the human side: bodies, needs, senses, capacities, care, attention, imagination, vulnerability, labour, time, and the ability to participate in meaningful common life.

Outer nature refers to ecosystems, materials, energy gradients, climate stability, biodiversity, soils, waters, atmosphere, and the more-than-human world that sustains life.

These are not separate domains. They are mediated through labour, technology, institutions, culture, property, money, law, and political decision-making. The economy is one of the central mediations through which inner and outer nature are reproduced - or damaged.

Ecological Entwicklung can therefore be defined as: the qualitative development of the institutional, technical, cultural, temporal, and democratic capacities through which societies reproduce inner and outer nature within planetary limits.

This definition transforms the meaning of development. Development can no longer mean the expansion of human mastery over nature. Nor can it mean merely national industrialization, rising GDP, or technological modernization. It must mean the formation of a way of life capable of sustaining and enriching the conditions of life.

8. From Production to Commoning Reproduction

A growth economy understands itself primarily through production. It asks how goods and services can be produced, exchanged, consumed, and monetized. Even when welfare is considered, it is usually assumed to depend on expanded production and consumption.

Ecological civilization requires a different starting point: reproduction. More precisely, it requires commoning reproduction - the collective, democratic, and ecologically bounded reproduction of the conditions of life.

This concept draws on several traditions. Feminist political economy has shown that capitalist production depends on unpaid and underpaid reproductive labour, care, and social maintenance (Federici 2012; Fraser 2022). Commons theory has shown that communities can govern shared resources through institutional arrangements that are neither purely private nor purely state-based (Ostrom 1990, 2005). Marxian ecology has shown that capitalism produces metabolic rifts between society and nature (Foster 2000; Foster, Clark, and York 2010). Degrowth and post-growth thought have argued that the economy must be reorganized around sufficiency, care, ecological limits, and democratic provisioning rather than aggregate expansion (Kallis 2018; Hickel 2020; Jackson 2017).

Commoning reproduction brings these strands together. It means that production is only one moment within the broader reproduction of life. Economic activity must reproduce material conditions of life, ecological conditions of life, social conditions of cooperation, bodily and psychological conditions of flourishing, institutional conditions of democracy, cultural conditions of meaning, and intergenerational conditions of continuity.

From this perspective, the central question is not whether production grows, but whether the shared conditions of life are maintained, repaired, and enriched.

This also changes the meaning of work. Labour is not merely a production factor, a cost, or a commodity. It is the practical mediation through which human beings transform outer nature and, in doing so, transform themselves. Work is where truth, goodness, beauty, and fairness may either be separated and alienated - or reintegrated in meaningful activity.

A civilizing economy must therefore ask: Is work truthful in relation to ecological reality? Is it good in relation to common purposes? Is it beautiful in the sense of skilled, fitting, and meaningful form-giving? Is it fair in the distribution of burdens, benefits, risks, and surplus? This is where Entwicklung becomes Bildung: the formation of human beings through meaningful, ecologically responsible, socially recognized activity.

9. From Dominium to Custodium

The growth economy has historically been tied to a strong concept of ownership: dominium, the right to possess, use, profit from, transfer, and dispose of property. In its most expansive form, ownership includes abusus: the right to consume, exhaust, or destroy what one owns.

Modern property theory is, of course, more complex than this simplified picture. Ownership is often understood as a bundle of rights, obligations, permissions, and restrictions (Honore 1961; Singer 2000). Yet the ideology of absolute ownership has nevertheless played a central role in capitalist development, especially when land, labour, forests, minerals, water, and infrastructures are treated as assets subject to private control.

Ecological Entwicklung requires another principle: custodium. Custodium means stewardship, curatorship, trusteeship, or guardianship of a bounded field of action. Ownership is no longer absolute domination over an object but responsibility within a web of life-conditions.

Land, waters, forests, infrastructures, firms, and technologies are not merely assets. They are nodes in the metabolism between society and nature. Their use must therefore be judged by their effects on the reproduction of shared life-conditions.

The contrast may be stated as follows: Dominium asks: What may I do with what I own? Custodium asks: What am I responsible for within the conditions that make life possible?

This shift does not abolish use, initiative, enterprise, or innovation. It redefines them under ecological realism. The right to use becomes inseparable from the duty not to destroy the conditions of common life.

Such a transformation resonates with legal and commons-based approaches that seek to move beyond possessive individualism toward relational, ecological, and community-oriented conceptions of property (Mattei 2011; Mattei and Capra 2015; Ostrom 1990; Nedelsky 1990). It also provides an institutional bridge between ecological limits and economic agency.

10. Measuring Entwicklung: From Economic Complexity to Ecological Development Complexity

If Entwicklung is to replace growth as the guiding concept of political economy, it cannot remain only a philosophical or normative category. It must also become measurable. Otherwise the argument risks remaining negative: growth is criticized, ecological constraints are imposed, but no positive account is offered of how development itself can be observed, compared, guided, or institutionally governed.

The problem is therefore not only to limit growth, but to measure development differently.

Economic complexity analysis provides a promising starting point. Its basic insight is that the development of an economy cannot be understood only by measuring the aggregate quantity of output. One must also examine the structure of what the economy is capable of producing.

Hidalgo and Hausmann define economic complexity in terms of the productive knowledge embedded in an economy, inferred through the diversity of products it exports and the ubiquity of those products across countries (Hidalgo and Hausmann 2009). A diversified economy that exports products few other countries can produce is interpreted as possessing a richer and more complex capability structure. The Product Space approach similarly maps the relatedness of products and shows that countries tend to diversify into products that are close to their existing capabilities (Hidalgo et al. 2007). These frameworks shift attention from output volume to capability structure: from how much? to what can this economy do?

This is close to the logic of Entwicklung. Development is not merely the enlargement of economic mass. It is the formation of structured capabilities, the differentiation of functions, the accumulation of practical and technical knowledge, and the capacity to move into more sophisticated forms of production and coordination. Economic complexity therefore offers a partial metric for development understood as qualitative formation.

However, economic complexity is not yet ecological Entwicklung. A highly complex economy may produce environmentally destructive goods, military technologies, fossil infrastructures, surveillance systems, speculative financial instruments, or high-throughput consumption patterns. Complexity as such measures capability, but not purpose. It measures sophistication, but not ecological direction. It can describe a more structured economy without asking whether that structure reproduces or destroys the conditions of life.

This limitation has already led to attempts to connect complexity analysis with the green economy. Mealy and Teytelboym develop a Green Complexity Index and Green Complexity Potential to measure countries' existing capabilities in green products and their opportunities for green diversification. Their work explicitly extends economic complexity analysis toward green industrial policy by mapping which countries are likely to possess the capabilities needed to compete in environmentally beneficial products (Mealy and Teytelboym 2022). This is a significant step because it introduces directionality into complexity analysis: not simply whether a country is complex, but whether its complexity can be mobilized toward ecological transition.

Yet even green complexity remains insufficient if it is restricted to export competitiveness in green products. Ecological civilization requires more than the capacity to sell wind-turbine

components, batteries, heat pumps, water technologies, or recycling equipment on world markets. It requires the reorganization of the economy as a system of commoning reproduction. The relevant question is not only whether a country can export green goods, but whether its capability structure contributes to the maintenance, repair, and enrichment of the shared conditions of life.

For this reason, this article proposes the concept of Ecological Development Complexity. Ecological Development Complexity may be defined as the degree to which an economy's capabilities, institutions, technologies, labour forms, time structures, and infrastructures are organized toward the democratic and ecologically bounded reproduction of life-conditions.

10.1 Capability Complexity

The first dimension concerns the diversity, sophistication, and density of productive, scientific, technical, and organizational capabilities. This includes conventional economic complexity indicators such as the Economic Complexity Index and Product Complexity Index, but it should not be restricted to export baskets. Contemporary complexity methods are increasingly applied to trade, technology, research, and other economic activities, allowing a broader view of capability formation beyond goods exports alone.

Relevant indicators may include diversity and sophistication of production; technological complexity of patent portfolios; research complexity across scientific domains; occupational and skill diversity; institutional capacity for coordination and learning; and capacity to maintain, repair, and adapt infrastructures. This dimension asks: what can the economy do?

10.2 Green Directionality

The second dimension concerns whether existing and emerging capabilities are directed toward ecological transition. Green complexity indicators are useful here because they identify the extent to which countries possess capabilities in environmentally beneficial products and how close they are to further green diversification (Mealy and Teytelboym 2022).

Relevant indicators may include the Green Complexity Index; Green Complexity Potential; share of green products in exports and production; green patent intensity; proximity to green product spaces; capacity for renewable energy, energy efficiency, circular economy, ecological restoration, low-carbon infrastructure, and repair economies. This dimension asks: toward what ends are capabilities developing?

10.3 Metabolic Admissibility

The third dimension concerns the biophysical conditions of economic activity. A complex and green-directed economy may still exceed ecological limits if it relies on excessive material throughput, land use, energy use, extraction, or waste. Therefore complexity must be assessed against metabolic admissibility.

Relevant indicators may include material footprint per unit of capability or well-being; energy use and exergy use per unit of socially useful output; carbon emissions, including consumption-based emissions; circular material use rate; land, water, and biodiversity impacts; dependence on fossil energy or critical material bottlenecks; and alignment with planetary boundaries. This dimension asks: does the economy remain within the conditions of life?

10.4 Reproductive Capacity

The fourth dimension concerns the reproduction of inner nature: human bodies, capacities, care, time, education, health, attention, meaning, and social cooperation. Conventional complexity analysis tends to focus on productive capabilities, but ecological Entwicklung requires asking whether the economy reproduces the human and social conditions upon which all production depends.

Relevant indicators may include access to healthcare, education, housing, food, and basic services; care capacity and care quality; work autonomy and meaningful work; time sovereignty and reduction of destructive overwork; skill formation and lifelong learning; social trust and cooperative institutions; and capacity for local maintenance, repair, and provisioning. This dimension asks: does the economy reproduce the people and communities through which it exists?

10.5 Democratic Governability and Systemic Resilience

The fifth dimension concerns the capacity of a society to govern its development democratically under conditions of uncertainty, ecological pressure, and systemic risk. A highly complex economy can be fragile if it depends on opaque supply chains, centralized technical systems, geopolitical vulnerabilities, or institutions that citizens cannot understand or influence.

Relevant indicators may include democratic participation in investment, land use, energy, and infrastructure decisions; transparency of ecological and material accounts; resilience of critical supply chains; regional redundancy and repair capacity; public or commons-based control over strategic infrastructures; crisis preparedness and adaptive governance; and institutional capacity for learning and correction. This dimension asks: can development be collectively understood, governed, repaired, and redirected?

Systemic resilience may also be treated as a distinct sixth dimension. It measures whether an economy is robust, repairable, adaptive, and capable of maintaining life-supporting functions under stress. This prevents ecological development from becoming a fragile high-complexity system dependent on opaque supply chains, critical bottlenecks, or unrepairable infrastructures.

10.6 From National Accounting to Ecological Development Accounting

Coyle's proposal for a new measurement framework is especially relevant here. She does not simply argue for replacing GDP with a single alternative index. Rather, she points toward a broader reconfiguration of economic measurement around comprehensive wealth and time-use accounting (Coyle 2025). Comprehensive wealth shifts attention from annual output flows to the stocks of produced, natural, human, social, organizational, and intangible capital on which future well-being depends. Time-use accounting, in turn, starts from the fact that every person has only twenty-four hours per day and that economic arrangements shape how this time is divided between paid work, unpaid work, care, consumption, leisure, learning, and civic participation.

This is an important bridge from growth accounting toward Entwicklung accounting. Growth accounting asks how much output is produced over a given period. Comprehensive wealth accounting asks what happens to the assets and capacities that make future well-being possible.

Time-use accounting asks how the limited time of human lives is organized and distributed. Both moves open the door to a more adequate account of development.

Yet from the standpoint of ecological Entwicklung, Coyle's proposal must be radicalized. Comprehensive wealth accounting remains insufficient if it treats natural, human, and social capital as substitutable assets within a generalized balance sheet. Time-use accounting remains insufficient if it measures the allocation of time without asking whether social time is organized according to ecological necessity, democratic agency, and the reproduction of life-conditions. Ecological Development Complexity therefore extends Coyle's measurement problem: it asks not only what stocks and time-use patterns exist, but whether capabilities, material flows, institutions, and social time are organized toward the admissible reproduction of inner and outer nature.

Coyle's contribution is thus best understood as an internal critique of the inherited statistical infrastructure of growth. Ecological Entwicklung turns that critique into a normative and institutional framework. The question is not only how to count what really matters, but how to determine what must be reproduced, what may be transformed, and what must not be destroyed.

Taken together, these dimensions form an Ecological Entwicklung Dashboard:

Dimension	Core question	Indicative measures
Capability Complexity	What can the economy do?	ECI, PCI, technological complexity, research complexity, skill diversity
Green Directionality	Toward what ends are capabilities developing?	GCI, green diversification potential, green patents, ecological transition sectors
Metabolic Admissibility	Does the economy remain within life-conditions?	material footprint, energy use, emissions, biodiversity impact, planetary boundary alignment
Reproductive Capacity	Does the economy reproduce people and communities?	care, health, education, housing, meaningful work, time sovereignty, local provisioning
Democratic Governability	Can development be understood and steered?	participation, transparency, ecological accounting, public/commons control, adaptive capacity
Systemic Resilience	Can the system endure, adapt, and be repaired?	supply-chain resilience, energy security, repair capacity, redundancy, crisis preparedness

The resulting principle can be stated as follows: development is not complexity as such, but ecologically directed and socially reproductive complexity.

Or more formally: Ecological Entwicklung = capability complexity + green directionality + metabolic admissibility + reproductive capacity + democratic governability + systemic resilience, with time-use accounting as a cross-cutting test of reproductive reality.

This formulation does not reduce development to a single index. Indeed, at the present stage a dashboard may be superior to a composite indicator, because it preserves the multidimensional structure of ecological development. A single number risks reproducing the problem of GDP: it compresses qualitatively different processes into one aggregate and may conceal trade-offs. A dashboard can show whether an economy is becoming more capable, more ecological, more

reproductive, more resilient, and more democratic - or whether gains in one dimension are being purchased through losses in another.

Ecological Development Complexity therefore serves as a bridge between the philosophical concept of Entwicklung and the institutional requirements of ecological civilization. It shows how development might be measured without returning to growth as the dominant measure of progress. It also clarifies why ecological realism is not merely a theory of limits. It is a theory of directed capability formation under the conditions of life.

11. Multi-Ledger Accountability

The measurement of ecological Entwicklung requires a transformation in economic accounting. A growth economy can operate with one dominant ledger: money. If monetary value increases, the economy appears successful. Ecological harms, social depletion, care deficits, time exhaustion, and intergenerational costs are often treated as externalities.

Ecological Entwicklung requires at least a triple ledger. First, a financial ledger must account for income, investment, debt, prices, wages, fiscal capacity, and monetary flows. Second, an energy-material ledger must account for energy use, exergy, material throughput, extraction, conversion, infrastructure, waste, and circularity. Third, an ecological ledger must account for climate stability, biodiversity, soil health, water systems, carbon sinks, ecosystem resilience, and the integrity of life-support systems.

Growth may appear positive in the first ledger while being negative in the second and catastrophic in the third. Such growth cannot be considered development. It is a form of displacement: apparent monetary success purchased by material depletion and ecological degradation.

Coyle's emphasis on time-use accounting suggests that this triple ledger should be supplemented by an explicit reproductive time account. Financial, energy-material, and ecological accounts show whether economic activity is monetarily viable, materially possible, and ecologically admissible. But they do not yet show how social time is organized: who performs paid work, unpaid work, care, learning, maintenance, civic participation, and recovery; how time burdens are distributed; and whether the temporal structure of society supports or undermines the reproduction of inner nature.

Ecological Entwicklung therefore requires either a triple ledger with time-use accounting as a cross-cutting dimension or, more explicitly, a fourfold accountability structure: financial accountability; energy-material accountability; ecological accountability; and reproductive time accountability.

This time dimension is not merely a welfare supplement. It becomes decisive when ecological transition is understood as a bounded historical task. If a society commits to carbon neutrality by a specific year, that target defines not only an emissions budget but also a social time budget. Present activity is then no longer legitimately scheduled only by capital's expected return, investment cycles, or short-term productivity gains. It is scheduled by a collectively recognized ecological necessity.

This is why ecological civilization requires institutional mechanisms of admissibility. Economic activity must be assessed across its full chain: intake, conversion, outflow, allocation, and

temporal burden. It must remain within ecological thresholds and contribute to the regeneration of life-conditions.

The multi-ledger perspective is consistent with ecological economics and planetary boundary research but pushes the question further into institutional design. It asks not only what should be measured, but how measurement becomes binding in property regimes, investment criteria, public budgeting, industrial policy, procurement, taxation, accounting, and democratic planning.

In this sense, ecological Entwicklung is not only a philosophical category. It must become a constitutional, legal, accounting, and institutional principle.

12. Reinterpreting the Enlightenment for Ecological Civilization

The three Enlightenment horizons can now be reinterpreted from the standpoint of ecological civilization.

The English tradition offers an account of commercial dynamism, markets, practical coordination, innovation, and distributed knowledge. Ecological civilization cannot simply discard these insights. But market dynamism must be subordinated to ecological admissibility. Markets may coordinate means; they cannot define civilizational ends.

The French tradition offers an account of political universality, citizenship, law, public purpose, and democratic legitimacy. Ecological civilization needs this strongly. But political universalism must be re-grounded in planetary conditions. The general will must become ecologically literate.

The German tradition offers an account of development, mediation, Bildung, institutional freedom, and historical transformation. Ecological civilization can draw deeply from this horizon. But it must also correct the anthropocentric residues of older developmental narratives. Entwicklung must no longer mean the development of human freedom over against nature. It must mean the co-development of human freedom with the conditions of life.

The synthesis may be stated as follows: from England, economic coordination and practical dynamism; from France, democratic legitimacy and public universality; from Germany, qualitative development, mediation, and formation; beyond all three, ecological realism as the planetary condition of civilization.

This is not a rejection of the Enlightenment, but its ecological transformation. The task is not to abandon reason, freedom, universality, or development, but to reinterpret them within the material conditions of a finite, living planet.

13. Economy as Planetary Oikonomia

The word economy derives from oikonomia: the ordering or management of the household. Modern capitalism transformed this household logic into a growth machine. Ecological civilization requires recovering the deeper meaning of economy - not by returning to the ancient household, but by expanding the concept to the scale of the Earth.

The economy is the ordering of our common home. This is not a metaphor of sentimental harmony. It is a hard institutional claim. Energy, materials, labour, technology, property, law,

money, care, infrastructure, time, and democratic decision-making must be organized so that the conditions of planetary life are not consumed as external inputs.

The central question is therefore no longer: How can the economy grow? It becomes: How can the planetary household develop? Or more precisely: How can the economy become the conscious, democratic, technically competent, measurable, and ecologically bounded organization of commoning reproduction?

This is the real content of ecological Entwicklung.

14. Conclusion: From Growth to Entwicklung

The modern growth paradigm emerged from a historically powerful configuration: commercial expansion, property, colonial extraction, fossil energy, industrial production, technological innovation, and market coordination. It produced enormous increases in output and wealth, but also deep forms of alienation, ecological degradation, social inequality, and planetary destabilization.

The ecological crisis now forces political economy to reconsider its foundational category. Growth can no longer function as the organizing telos of civilization. It must be subordinated to a richer and more demanding concept: Entwicklung.

Ecological Entwicklung means the qualitative, democratic, measurable, and ecologically bounded development of the conditions of life. It requires the mediation of inner and outer nature: human bodies, capacities, work, care, time, and institutions on the one hand; ecosystems, energy flows, material cycles, and planetary boundaries on the other.

This shift also requires a new approach to measurement. Economic complexity analysis provides an important starting point because it measures capability structures rather than mere output volume. Green complexity adds ecological directionality. Coyle's critique of the national accounting framework strengthens the argument by showing that the GDP/SNA apparatus itself no longer adequately describes contemporary economic reality, especially under conditions of digitalization, intangible assets, environmental constraint, and changing time-use. But ecological civilization requires a broader framework than either GDP, comprehensive wealth, or time-use accounting alone: Ecological Development Complexity, in which capability complexity is integrated with green directionality, metabolic admissibility, reproductive capacity, democratic governability, systemic resilience, and reproductive time accountability.

This has institutional implications. Production must be reframed within commoning reproduction. Property must move from dominium toward custodium. Economic accounting must move from a single financial ledger toward multi-ledger accountability. Democracy must extend into the material and temporal organization of life: production, reproduction, infrastructure, energy, land use, technology, time, and investment.

The task is therefore not merely to green growth, nor simply to reduce growth. It is to transform the economy from a system of accumulation into a system of civilizational development.

The central thesis may be restated in its strongest form: ecological civilization requires replacing growth as the organizing telos of the economy with Entwicklung - the qualitative, democratic, measurable, and ecologically bounded development of the shared conditions of life.

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Appendix: A Preliminary Framework for Measuring Ecological Development Complexity

A.1. Rationale

If Entwicklung is to replace growth as the guiding category of political economy, it must also become measurable. Otherwise, the argument remains primarily negative: growth is criticized, ecological limits are imposed, but no positive account is given of how development itself may be observed, compared, guided, or institutionally governed.

Economic complexity analysis offers a useful starting point because it shifts attention from the quantity of output to the structure of productive capabilities. Conventional economic complexity asks what an economy is capable of producing and how rare or sophisticated those capabilities are. Ecological Development Complexity extends this question: it asks whether those capabilities are ecologically directed, metabolically admissible, socially reproductive, democratically governable, temporally sustainable, and systemically resilient.

Thus, Ecological Development Complexity does not measure complexity as such. It measures the quality of complexity under the conditions of ecological realism.

A.2. Definition

Ecological Development Complexity may be defined as the degree to which an economy's capabilities, institutions, technologies, labour forms, time structures, and infrastructures are organized toward the democratic and ecologically bounded reproduction of life-conditions.

In condensed form: Ecological Development Complexity measures ecologically directed, socially reproductive, democratically governable, and temporally sustainable complexity.

This distinguishes it from conventional economic complexity. A highly complex fossil-industrial economy may possess sophisticated capabilities, but if these capabilities depend on ecological overshoot, social exhaustion, time colonization, or systemic fragility, they do not represent ecological Entwicklung. Likewise, an economy may produce green technologies while remaining socially extractive, democratically opaque, materially unsustainable, or temporally destructive.

A.3. Basic Structure

Ecological Development Complexity can be represented as a function of seven dimensions:

EDC = f(CC, GD, MA, RC, DG, SR, TA)

Symbol	Dimension	Core Question
CC	Capability Complexity	What can the economy do?
GD	Green Directionality	Toward what ends are capabilities developing?

Symbol	Dimension	Core Question
MA	Metabolic Admissibility	Does economic activity remain within life-conditions?
RC	Reproductive Capacity	Does the economy reproduce people, communities, and inner nature?
DG	Democratic Governability	Can development be collectively understood and steered?
SR	Systemic Resilience	Can the system endure, adapt, and be repaired?
TA	Temporal Accountability	How is social time organized, distributed, and bounded?

These seven dimensions should initially be treated as a dashboard rather than as a single index. A dashboard preserves the multidimensional character of ecological development and avoids the danger of reducing qualitatively different processes to one aggregate number.

A.4. The Seven Dimensions

1. Capability Complexity

Capability Complexity measures the diversity, sophistication, and density of productive, technical, scientific, and organizational capabilities.

Possible indicators include: Economic Complexity Index; Product Complexity Index; technological complexity of patent portfolios; diversity of skills and occupations; research and innovation capacity; capacity to maintain, repair, and adapt infrastructures; institutional capacity for learning and coordination.

2. Green Directionality

Green Directionality measures whether an economy's capabilities are oriented toward ecological transition and restoration.

Possible indicators include: Green Complexity Index; Green Complexity Potential; share of green products in exports and production; green patent intensity; renewable energy capabilities; circular economy capabilities; repair, reuse, maintenance, and restoration sectors; ecological transition investment.

3. Metabolic Admissibility

Metabolic Admissibility measures whether economic activity remains within the biophysical conditions of life.

Possible indicators include: Material footprint; energy use; fossil energy dependence; consumption-based carbon emissions; water use; land use; biodiversity impacts; circular material use rate; alignment with planetary boundaries.

4. Reproductive Capacity

Reproductive Capacity measures whether an economy renews the human, social, and institutional conditions on which it depends.

Possible indicators include: Health and functional capacity; education and lifelong learning; care capacity and care quality; housing security; food security; meaningful work; work autonomy; social trust; local provisioning and maintenance capacity.

5. Democratic Governability

Democratic Governability measures whether the direction of development can be publicly understood, contested, and steered.

Possible indicators include: Participatory budgeting; citizens assemblies; worker participation in firm governance; cooperative and commons-based ownership; public ecological accounting; open data on energy, material, and ecological impacts; regional and local decision-making capacity; democratic control over strategic infrastructures.

6. Systemic Resilience

Systemic Resilience measures whether an economy is robust, repairable, adaptive, and capable of maintaining life-supporting functions under stress.

Possible indicators include: Energy security and energy diversity; dependence on critical materials; supply-chain vulnerability; food system resilience; repairability of infrastructures; domestic or regional maintenance capacity; redundancy in critical systems; crisis preparedness; adaptive governance capacity.

7. Temporal Accountability

Temporal Accountability measures how social time is organized, distributed, and bounded. It extends Coyle's time-use accounting into ecological Entwicklung by asking whether the temporal organization of society supports the reproduction of inner and outer nature.

Possible indicators include: Time-use accounts; distribution of paid and unpaid work; care time; civic time; learning time; recovery time; time poverty; working-time autonomy; temporal alignment with ecological transition targets; social time budgets for decarbonization and restoration.

A.5. Dashboard and Composite Options

At the first stage, Ecological Development Complexity should be constructed as a dashboard. Each dimension may be normalized on a scale from 0 to 1. This allows comparison without prematurely collapsing the whole framework into a single number.

If a composite index is later desired, three possible aggregation methods may be considered. An additive form is simple and useful for descriptive comparison, but it allows compensation: high performance in one dimension may conceal severe weakness in another. A geometric form is more suitable for ecological-realist assessment because it penalizes imbalance. A constrained form, defined by the weakest necessary condition, is the strongest version of the no-exception principle: severe ecological overshoot, social exhaustion, democratic exclusion, temporal destruction, or systemic fragility cannot be fully offset by high technological sophistication.

A.6. Interpretation

Type	Description
Simple sustainability	Low complexity, relatively low ecological pressure, but limited transformative capacity
Destructive complexity	High capability complexity combined with ecological overshoot, social depletion, or time colonization
Green technocracy	Strong green directionality but weak democratic governability, reproductive capacity, or temporal accountability
Ecological Entwicklung	High capability complexity, green directionality, metabolic admissibility, reproductive capacity, democratic governability, systemic resilience, and temporal accountability

The purpose is not to maximize complexity in itself. The purpose is to cultivate the kind of complexity that strengthens the shared conditions of life.

A.7. Summary Proposition

The framework can be summarized in one proposition: Ecological Development Complexity transforms economic complexity from a measure of productive sophistication into a measure of civilizational viability.

In this sense, EDC provides a possible measurement architecture for ecological Entwicklung. It does not replace ecological limits with another growth metric. Rather, it asks whether an economy's capabilities are becoming more capable of sustaining, repairing, and enriching the conditions of life within planetary boundaries - and whether the time of human lives is organized in ways that make this reproduction possible.