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India's new coal geography: Coastal transformations, imported fuel and state-business collaboration in the transition to more fossil fuel energy

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ABSTRACT

The advance of renewable energy around the world has kindled hopes that coal-based energy is on the way out. Recent data, however, make it clear that growing coal consumption in India coupled with its continued use in China keeps coal-based energy at 40 percent of the world's heat and power generation. To address the consolidation of coal-based power in India, this article analyses an energy transition *to*, rather than *away from*, carbon-intensive energy over the past two decades. We term this transition *India's new coal geography*; the new coal geography comprises new ports and thermal power plants run by private-sector actors along the coastline and fuelled by imported coal. This geography runs parallel to, yet is distinct from, India's 'old' coal geography, which was based on domestic public-sector coal mining and thermal power generation. We understand the development of coastal thermal power as an outcome of long-term electrical energy shortages and significant public controversy within the old coal geography. By analysing the making of the new coal geography at a national level, and scrutinizing its localised manifestation and impact through a case study of Goa state, we outline the significant infrastructural investment and policy work of a dispersed network of public- and private-sector actors that slowly enabled this new coal energy avatar. We argue that the enormous effort to establish India's new coal geography further entrenches the country's reliance on coal. The result is that for India, energy security is a choice between domestic and imported coal.

1. Introduction

While Europe and North America are transitioning away from coal, its reign over power generation is not over yet. Among the main countries that consume coal, India remains a key player: not only is domestic coal extraction and use still expanding – the country is also emerging as a key agent in the global coal trade as the second biggest importer [1,2]. India's increasing use of coal, coupled with China's unrelenting coal consumption, means that coal contributes 40 percent of the world's total power and heat generation: a share in global energy production which has remained the same for the past 40 years in spite of growing attempts at decarbonisation [2]. The catastrophic implications of burning coal for power generation at this rate are well documented and can on its own destabilise the climate change target of staying below the two-degree centigrade rise in temperature [3,4].

India is expected to become the main international coal importer in the future as Chinese reliance on imported coal reduces [2,3], with Indonesia and Australia being the main coal exporting countries [5]. India has long imported higher purity coking coal for steel-making, primarily from Australia. The import of thermal coal for power production is, however, entirely new. Before 2002, thermal coal did not even exist as a category in official trade statistics.[1] In the fiscal year 2007–2008, India imported 10 million tons of thermal coal. This rose to 45 million tons in 2011–2012 [6].[2] The latest available figure from 2018 to 2019 shows imports of 150 million tons [7],[3] and for the fiscal year 2019–2020, the projection is 200 million tons [9]. Using 2007–2008 as a

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[1] See the Export-Import database of GoI's Ministry of Commerce, https://commerce-app.gov.in/eidb/.
[2] Available statistics use financial rather than calendar year.
[3] Domestic coal mining meanwhile recorded an output of 730 million tons for 2018–2019 [8].

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baseline, this amounts to an increase in recorded imports of 1,400 percent in just over a decade.

In response to India's dramatically increasing coal imports, we analyse the production of what we term India's new coal geography: an entirely new landscape of thermal power infrastructure based on international supplies of coal, which has so far not been mapped and analysed systematically. The new coal geography is predominantly coastal and controlled by private actors who operate ports and power plants that rely on imported coal. And it runs parallel to the domestic public-sector mining and power generation of the 'old' coal geography. To map and analyse this new coal geography, we ask: What are the political-economic and technical-infrastructural realignments that have enabled coal-based power generation in this new coal geography? How is this geography configured at the national level and how do subnational regions change infrastructurally, politically and environmentally when they are integrated into the new coal geography? By addressing these questions that incorporate both the making of the new coal geography at a national level and its localised manifestations and impact in specific contexts, we argue that India's rise as a global player in coal trade, coupled with the emergence of a new coal geography at home, represents an energy transition to (more) coal-based energy. This energy transition will add to India's already substantial reliance on coal energy for years to come, with significant negative consequences for global climate change. This finding is in line with recent research on energy transitions that show the remarkable endurance of fossil fuels like coal, in spite of available, lower cost renewable options both globally [10–12] and in India [13,14].

The article is structured as follows. We start our analysis of the making of India's new coal geography by providing theoretical entry points into energy transitions and the making of resource geographies. This is followed by a discussion of our methods. We then proceed to map and analyse the new *national* coal geography, followed by its *localised* manifestations and impact through a case study of the Indian state of Goa, which is rapidly emerging as a new coal hub. In the next analytical section, we bring our findings from the national and the state level together. Finally, in the conclusion, we reflect on how the enormous scale of financial and political investments that has enabled India's new coal geography is likely to block the country's transition away from coal.

2. An energy transition to (more) coal-based energy

The sizeable literature on energy transitions has, to date, mainly focused on how to design, implement, govern and operate new low-carbon power production facilities, based on the assumption that older forms of energy will disappear once renewable options become available [10,15]. One cause for great optimism has been the increasing availability of cost-competitive forms of renewable energy around the world giving impetus to the massive decarbonisation efforts that are urgently needed. One factor that underpins the optimism in much of the energy-transitions literature is the understanding of energy transitions as the process of a new fuel acquiring a large or dominant *share* of overall use [16]. Following this definition, historical examples of energy transitions include transitions from wood to coal and from coal to oil. However, if we focus not on the *share*, but rather on the total *amount* of energy used, a quite different picture emerges wherein no actual energy transition has ever taken place in modern times [10] as the amount of coal, wood and oil that are currently used globally are all at historic highs. New energy forms, including more recent renewable ones, are, from this perspective, what Bell and York [11] term additions rather than transitions. This is the case because older forms of energy may reduce their overall share of energy use but remain important, or even continue to increase, in terms of amount. From an energy addition perspective, the global energy system remains locked into high coal-energy use for the foreseeable future undermining reports of 'a terminal decline' [12,17]. An energy addition perspective in this manner focuses our attention on how 'the teleological model [of energy transition research] asserting the "death of coal" needs to be fundamentally re-examined' ([10]: 208).

As some parts of the world reduce their use of coal, primarily Europe and North America, it becomes pertinent to understand how and why India is not only expanding domestic coal production and use but also adding an entirely new energy geography based on imported coal [2,18]. Understanding the specific national and international networks that continue to support high carbon energy is vitally important in order to seek actual energy transitions away from the use of fossil fuels rather than merely adding renewable energy on top of existing fuels, as has been the case at a global level to date. To understand the emergence of new coal energy, we draw inspiration from recent work on resource geographies within Human Geography, and specifically assemblage thinking, which enables us to see the interlinking of different networks of humans and materials [19-21]. Putting in place a complex resource geography like coal energy is, from this perspective, always 'a process of making, of continuous transformation, and of becoming, rather than as something final or static' ([22]: 240). Resource geographies rely on a set of interlinked logics of economy, territory and subject formation [23,24] that bring together a rich 'energyscape' [5] of new relations, as different sites become connected in the production, transportation, generation and transmission of energy. Such relations not only shape energy and socio-environmental outcomes; they also crucially produce economies and forms of politics whose impact may span generations [25]. If we understand resources and energy 'as interconnected networks tying together sites and scales' ([26]: 434], we see how the shaping of a new (coal) resource geography depends on much more than merely infrastructural solutions. By looking across 'material infrastructures, socio-cultural artefacts and political structures' ([26]: 437), energy appears as 'fragmented, contested and converted at particular sites' ([26]: 446). New resource geographies – in our case, India's new coal geography – thus emerge as one spatial aspect of 'a global assemblage of finance, infrastructure, and expertise that together constitutes the political economy of coal' ([27]: 153–154). Rather than seeing energy production as a singular and fully functional system with a controlled and centralised design, this conceptualisation draws our attention to distributed experimentation by many different actors in pursuit of partial and compartmentalised energy solutions.

In this article, we analyse one crucial aspect of the present energyscape of coal, namely, how the assemblage of the network of relations across Indian national and state government together with domestic and international private sector entities in power generation, logistics, and transmission produce India's new coal geography. Coal is perhaps the resource that more than any other material commodity has shaped India as a nation, including its political economy and ecology [28]. Coal transforms landscapes and rearranges social relations around the coalfields, along transport routes and in India's megacities where much of the electrical energy is consumed. Coal is also fundamental to India's national and global relations by influencing industrial growth, the balance of trade and national energy-security concerns. Crucially, the availability of coal in large quantities close to the surface across central-eastern India, the long history of extraction with significant technical and infrastructural provisions and the many-faceted and multi-tentacled bureaucratic superstructure that surrounds it combine to give unprecedented preferential status to this fossil fuel – in spite of the many factors that support a transition to low-carbon energy. The creation over the past two decades of a new coal geography in India marks a significant departure from the well-established trajectory of domestic energy security rooted in coal-based resource nationalism, what Chatterjee [29] calls India's model of fossil developmentalism.

A prerequisite for understanding how this new coal geography has been assembled is to disentangle the existing system of domestic coal economies in India. Lahiri-Dutt [30] uses the concept of 'coal worlds' to show that that the Indian coal industry is neither singular nor homogenous. She identifies four separate coal economies, which she terms national, neoliberal, statecraft and subsistence coal. With multiple and complex labour arrangements, these coal economies are defined by

different coal worlds that have distinct production logics and labour and supply arrangements. The first two coal economies (national and neoliberal) constitute the official economies that contribute to large-scale power production in the public sector, for electrical energy, and in the private sector, to generate power for industries like cement and steel. The two other worlds constitute the informal sector, with varying degrees of legality involved; and they present different community uses of coal in small-scale operations that might even defy straightforward distinctions between legal and illegal (hence termed non-legal by Lahiri-Dutt). Against this backdrop, the new coastal coal geography has emerged as a fifth coal world in India since about the year 2005. This new coal world operates within the formal large-scale system of coal energy, yet with distinct production logics and supply arrangements vis-à-vis the other two formal coal worlds, in addition to the specific spatial dynamic of coastal infrastructure.[4]

The backbone of Indian energy security was always Lahiri-Dutt's [30] national coal: domestically produced coal that relied on a set of interlinked public sector enterprises. In this 'old' (and still-expanding) coal geography, the state-owned enterprise Coal India Limited extracts coal in the central and eastern parts of the country. This coal is then transported by the Indian Railways via heavy-duty links to the main cities of the north, west and south, with the National Thermal Power Corporation – or one of the many state electricity boards around the country – as final customers. All this is done for electricity generation primarily for the "urban-industrial nexus" [28].[5] India's coal energy sector has, in stages since India's Independence, managed to put in place a relatively robust model for coal extraction and transport and for electricity generation and transmission. The sector has been able to produce and transport ever larger amounts of coal, particularly from the 1980s onward, to new and expanding metropolitan power plants, even as it has faced stiff resistance and pressure from a vast number of groups and actors around the country [28,31]. Yet in spite of its vast scale and substantial policy support, neither coal production nor thermal power generation have ever kept pace with electricity demand [31,32]. India's old coal geography has continued to struggle to serve all consumers, to remain financially viable and to adhere to environmental and social legislation [31]. Reforms to increase coal-based power generation have included opening up to private sector coal mining and power generation for use in cases such as, for example, steel and cement production in 1993 [28]. Significant weaknesses have, however, remained, and these culminated in the early 2000s, when the already distressed old coal geography entered into a prolonged state of crisis as the large gap between demand and supply escalated dramatically. As other forms of electricity production failed to contribute, India's inability to supply electricity in line with developmental targets, and with the aspirations of key pressure groups [31,32], became evident. A discourse of 'a national energy crisis' subsequently took hold and set in motion policies and programs seeking to expand energy production outside of the traditional central-eastern coal heartland.

Another aspect of the 'energy crisis' is the profile of Indian coal and thermal power companies as among the lowest cost producers in the world [33]. A large part of this low-cost profile – the ability to produce cheap coal-based electricity – is the sector's inability or unwillingness to deal appropriately with a range of social and environmental consequences, including compensation and resettlement of project affected populations, environmental mitigation, and proper mining closure and post-mining rehabilitation when operations stop [28,34,35]. The reorientation of coal-based energy production to new territories, that is, the coastal regions, promises improved stability against some of the challenges that plagued the old geography, such as 'disruptive' public protests and litigation related to mines and thermal power plants [28,36]. In addition, the coastal states along India's western and south-eastern coastline generally display a more predictable pro-business orientation, are better governed, and are less prone to political instability and unpredictable populist policies that have often characterised the central and eastern coal belt. The move away from the forests and agricultural fields into new territories has generated new political conflicts due to new forms of land expropriation and dispossession [37,38]. Operating along the coastline comes with new challenges, including administrative approvals to use often ecologically sensitive stretches of land [39] as well as environmental and other clearances and permissions [28,29]. While coastal land might be seen as 'available' – since ownership, as is the case in the coal-bearing inland, is vested with the state as common property [38] – or is seen as 'unproductively used land' [40], much coastal land is in fact occupied by informal land users, generating new conflicts and resistance movements.[6] Coastal coal infrastructure, like elsewhere in the country, thus requires high-level political support to secure land and administrative approvals for developers.

India's new coal geography signifies dramatic rearrangements of coastal land use, the rise of new private players in the sector, significant infrastructural transformations, realigned domestic energy-security concerns and modified international relations – even as it extends and solidifies the use of coal energy at a time when renewable alternatives are not only needed but are also increasingly affordable. Understanding the making and manifestation of this new coal geography thus offers important insights into the future of coal, not just in India, but globally. Before we turn to a more detailed mapping and analysis of the making and manifestation of India's new coal geography, we introduce our research methods.

3. Research design and methods

In this exploratory case study we outline and explain the emergence of a new, national coal-based energy geography that is separate from the dominant geography of thermal power production in India. Following Bridge and Gailing we understand energy transitions as 'the production of novel combinations of energy systems and social relations across space' ([44]: 1038). Further, we define India's new coal geography as coal energy infrastructure established in coastal India with mainly private sector involvement, predominantly using imported coal,[7] and supported by the Government of India (GoI) in the fields of energy policy, infrastructure and land governance. Such coastal energy infrastructure was absent across India before the year 2005, barring in a few megacities such as Mumbai or Chennai.

Our political economy understanding of energy transitions enables us to look beyond socio-technical solutions in infrastructure to embrace political challenges, which shape outcomes [44,45]. Significant controversy has followed the development of India's new coal geography with differences of opinion within the national government and widespread resistance to specific projects among various civil society actors and groups. The picture that emerges from our analysis by necessity plays out unevenly across the nation [45]. To analytically integrate the 'big picture' of the new coal geography in its entirety, with the 'smaller picture' of its manifestation in, and impact on, particular localities and environments in Goa state, we apply a multi-level perspective. This allows us to outline national energy development while providing deeper insights into one specific local context. This is particularly relevant in India's federally organised governance system wherein the state

[4] Since our analysis focuses on the spatial and political-economic aspects, we prefer the use of coal geography to Lahiri-Dutt's coal world.

[5] We here outline only the main characteristics of the old geography for comparative purposes (see [28] for further details).

[6] Such processes are well known in the global and Indian land-grabbing literature where so-called vacant lands have been identified for new investments [41–43].

[7] Available environmental approval documents show that many coastal power projects propose to use a mix of domestic and imported coal in spite of their different chemical compositions.

governments exercise authority over several domains that impact directly on energy transitions, including land governance.

We use the Goa case study as an 'exploratory' rather than a typical case [46] to analyse emerging sub-national rearrangements of existing and new energy infrastructures that enable the new coal geography to materialise. By moving the analysis to a lower level, we draw attention to (1) the extensive and oftentimes environmentally destructive transformations in infrastructure, land use and biophysical environments that occur as particular regions are integrated into India's new coal geography; and (2) the uneven and regionally varied nature of the national geography. In using Goa as our case study, we acknowledge that it is not a representative case – indeed, it is India's smallest state, and one of its wealthiest. At the same time, the integration of Goa into the new coal geography, as it currently unfolds, is characterised by two transitions that render Goa useful as an exploratory case: the transition of the region from marginal to central in the coal trade as existing iron ore export infrastructure was repurposed for coal imports; and the slow but steady transition in coal imports from coking to thermal coal.

For the big picture, we combine publicly available government documents and news reports with satellite images. We analyse the thermal power projects that were approved up to 18 November 2019 in all the coastal districts of India, according to information available on the website of the Ministry of Environment, Forest and Climate Change. We found 84 cases in total that we classified as coastal, and we examined their environmental clearance approvals along with other administrative documents to identify their stages of operation (under construction, delayed, operating or cancelled), the composition and percentage of coal in supplies (domestic/imported) and the project promoters (private/public). We also used the largest inventory of global environmental justice movements, the Atlas of Environmental Justice (www.ejatlas.org) [99], in combination with local news reports to analyse active protests against these coastal power plants.

To examine actual implementation on the ground and create the map in Fig. 1 below, we visually inspected satellite images. This does not require advanced GIS analysis. As Oskarsson, Lahiri-Dutt and Wennström ([34]: 9) point out, 'anyone with an internet connection can browse Google Earth images to see the "black holes" at the heart of India's energy security' since mining, transport and electricity-generation activities based on coal colour the infrastructure and its immediate surroundings pitch black. Unfortunately, a lack of data prevents us from fully untangling the international coal supply network to see the 'global picture' that feeds into India's new coal geography. We know, however, that supplies come from Indian-owned mines in, for example, Australia, Indonesia and Mozambique [47,48], while other supplies are purchased on the global market from independent producers, or even occasionally on the domestic market if coal is available at a lower rate.

Our analysis of the Goa case is based on a combination of qualitative field research in the ethnographic tradition, coupled with a desk study of relevant documents. The second author has worked on environmental challenges in Goa over several years, while the fourth author conducted month-long fieldwork in 2017 focusing explicitly on coal protests. The fourth author conducted 11 semi-structured interviews with social and environmental activists, journalists, fishing communities and concerned citizens affected by coal projects. The fourth author also observed community meetings that passed resolutions against coal. We have also analysed key policy documents pertaining to coal-related infrastructure projects in Goa, and have closely monitored the news coverage of coal-related developments in the state over the past four years. We have also analysed reports and other public statements produced by civil society and activist groups.

4. The emergence of India's new coal geography

The preconditions for India's new coal geography lie in the liberalisation of the economy from the 1980s onward, which slowly opened the coal energy sector to private sector actors [28]. An early key reform in the sector happened in the year 2000, when the private sector was allowed to mine coal for its own industrial production purposes in, for example, cement and steel-making units. And since 2018 the entire sector has been opened up for private companies, including international ones [49]. Other significant policy reforms that have paved the way for the new coal geography include the possibility of importing the coal and power generation technologies required to expand energy production. In combination, these reforms and rearrangements represent dramatic change for an industry long stuck in old ways of producing energy [28,31].

As shown above, it was in response to an intensifying energy crisis that extensive policy experimentation in the domain of energy began around 1995. This process would unfold over several decades and involved frequent adjustments between various branches of the GoI, led by its Ministry of Power. The focus was initially on domestic coal-based power expansion (as well as hydro), but widened over the years to include private sector thermal power from 2006 [39,40]. Key to the development of India's new coal geography was the Ultra Mega Power Production (UMPP) policy, introduced in 2005, to support large power plants of at least 4000 MW using high efficiency Super Critical Technology. By establishing a set of very large power plants, the GoI hoped to generate a further 100,000 MW by the year 2012. Nine projects were originally proposed, with four located next to coal mines and five in coastal locations. One key reason for selecting coastal locations – other than the use of imported coal – was the possibility of using seawater for cooling, thus solving the problem of scarcity of freshwater that hampered plants on the fringes of Indian cities [50].

While most coal projects proposed since the early 2000s were based on the use of domestic coal, UMPP projects encouraged the use of imported coal of a higher quality than what is available in India, particularly in terms of sulphur content [51,52]. Over the years, more proposals were made. Fifteen received approval, with approximately half of these intending to use imported coal [50]. However, to date only two UMPPs have become operational: the coastal Mundra power plant in Gujarat and the Sasan power plant next to a coal mine in the central Indian state Madhya Pradesh [52]. Reasons for the failure of UMPP projects to start operations are similar to those that have affected other large power plants across the country: public protests over land acquisition, delayed or denied environmental approvals and a lack of affordable coal supplies [51]. In spite of its limited appeal, the UMPP policy did manage to open up a new approach to producing power in coastal locations, something that had not been attempted before. One key Ministry of Coal planning document noted already in the early years of coastal power developments that 'importing power grade coal for consumption in power plants at certain coastal locations … is considered necessary for enhancing fuel diversification and energy security ([53]: 4)'.

While overcoming the energy crisis has been a top, long-term national goal, significant resistance to foreign energy dependency remains within key government ministries. The import of oil and natural gas weighs heavily on India's balance of trade, and branches of the GoI have therefore not looked favourably at adding coal to the list of imported fuels. Successive high-level ministers have continued to reiterate their intention to end all import of coal, and recently the Minister of Coal stated that all coal imports would end in the fiscal year 2023–2024 [54]. Yet in spite of such statements, the amount of imported coal continues to rise. This is in no small part due to *other* branches of the GoI offering support for coal imports, including reduced taxes.[8] But exactly where all this coal is used is unclear as data remains incomplete. The Central

[8] While analysing why different Indian ministries entertain widely different attitudes towards coal is beyond the scope of this article, we note that such 'internal contradictions within the state', to use Poulantzas' [55] wording, are not uncommon in India. See Sampat [56] for a comparable and highly illustrative example of such internal contradictions in the domain of land use and governance.

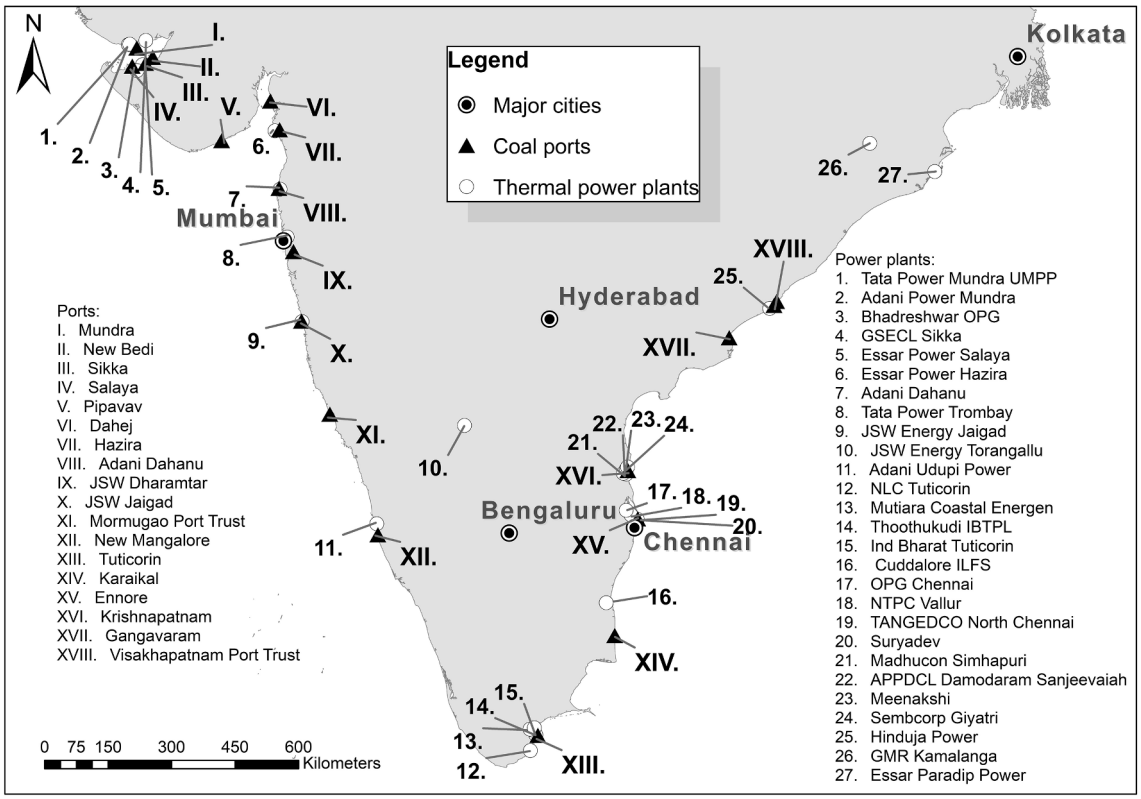

Fig. 1. Coastal power plants and coal ports.

Electricity Authority [57] of the Ministry of Power states that for the fiscal year 2018–2019, 61 million of a total of 150 million tons of imported coal was used in power production. Of this, 40 million tons was used for coastal coal producers designed to use imported coal, while a further 21 million tons was imported for power plants intended to use domestic coal. The imported coal in the latter category is termed 'blended coal' and is used to augment uncertain and more polluting supplies from domestic sources.[9] All in all, many coastal as well as interior power plants continue to struggle with the quantity, quality and price of coal.

In GoI environmental approval documents, thermal power-plant proponents are typically only required to broadly indicate the source of the coal they plan to use, even though the composition of the coal has a direct bearing on pollution-control measures as well as financial viability. For example, the approval for Adani Power Ltd.'s Mundra thermal power plant merely states that international coal will be used [59]. At times requirements are included to specify the country of origin, such as Indonesian coal for the Ennore Creek thermal power plant [60]. Coastal power plants may also indicate a range from 100 percent imported coal to as little as 30 percent. Adding to the regulatory uncertainty is the flexibility that producers have to use more domestic coal when this becomes available, as the GoI has allowed already operating power plants to shift part of the coal to lower cost Indian coal [57]. Available statistics indicate, however, that the opposite also occurs as power plants designed to run on domestic coal use imported coal [57]. Given this flexibility to switch between sources of supply, we may expect further coal supply changes as operators align with domestic and international coal market fluctuations, changing regulatory norms and the overall trajectory of the Indian power sector.

Indonesia is the world's largest exporter of thermal power coal and has been the main source for India's coastal power plants. One source places the country's share at 61 percent in 2018 [61]. Domestic and international coal market purchases make up the remainder of imported coal to India, although details about the quantities and qualities remain scarce. Direct ownership of coal assets abroad by Indian firms include Indonesian mines, where Tata Power has been the co-owner of the PT Kaltim Prima Coal mine since 2007 [48], while GMR has been a co-owner of PT Golden Energy Mines since 2011 [62]. A number of Indian companies have attempted to establish Australian coal mines. The largest and most controversial among these is the Adani Group's proposed Carmichael mine and GVK's Alpha Project [63,64]. The cost of transporting coal is always a major concern for low-cost operations like those in India [65], but transportation costs become even more important for imported coal since transport across oceans is often two to three times as high as the cost of transporting domestic coal. Data from the Indian Ports Association [66] show that 58 million tons of coal was handled across public sector ports during the six months from April to November 2019. However, these statistics do not disaggregate handling, and some of the coal that is moved along the Indian coastline is domestic coal. The Adani Group, which owns a number of thermal power plants, also handles about a third of all Indian coal imports via its ports [9]. The company operates five ports around India with the flexibility to switch to domestic coal if this becomes preferable to international coal. In a newspaper interview, one Adani executive stated: '[…] that's the advantage we have. Having ports on both sides of the peninsula, you can catch coal for instance at Dhamra and ship it to Goa, Vizag [Visakhapatnam], Mundhra or Dahej' [67]. The power plants of India's new coal geography will depend on shipments of coal for decades to come, and an operator such as the Adani Group is well positioned to ensure a flexible supply of it via its ports, from a variety of international and domestic sources. Flexibility in coal supply and port infrastructure are, in this manner, two additional key enablers of the new coal geography.

[9] Among the 54 public and private thermal power plants listed in 2020 as using blended coal, many are located far from the coast in northern states like Punjab or Chandigarh [58]. These power plants have, in many cases, been forced to import low ash coal to comply with air quality regulations.

Table 1
Coastal thermal power plants in India.

Total proposed	84
Cancelled or delayed	54
Operating	27
Under construction	3

Source: [69] and own analysis.

GoI data shows that 77 coastal power plants with widely variable power-generation sizes were approved from 2005 to 2014, mainly by private sector proponents, but also by public sector ones. The projects were environmentally approved, which means that specific sites had been identified and that detailed Environmental Impact Assessment reports had been finalised and extensively vetted in both public hearings and by environmental experts [68]. In contrast, after 2014 only seven projects have been approved, possibly because imported coal has become more expensive. Had all 84 environmentally approved coastal power plants been operational, they would have added significantly to India's current 281 operational thermal power plants [69]. However, as of early 2020, 'only' 27 of these 84 power plants (with an installed capacity of 36,600 MW) are operational while a further three are under construction. This indicates the difficult and contested path from formal approval to actual operations (see Table 1). In addition, the operational power plants often have less installed capacity than in the approval document, but the range is very wide, from a mere 60 MW to 4620 MW.

Some of the new energy producers are among India's largest business groups, including Adani, Reliance and Tata. The Adani Group has, in addition to building ports, been active in thermal power by building its own coastal power plants and buying already existing ones [70]. At the same time, the company has invested in a new power plant away from the coast, running on domestic coal [71]. Other power producers include companies with generic names like Coastal Energen Pvt Ltd and Thermal Powertech Ltd.[10] Little is known about these companies and their operational and financial strengths. Data also shows five public sector power plants using imported coal, though only as a supplement to the main supply of domestic coal.

As seen in Fig. 1 below, we find thermal power clusters across a few states: in Gujarat (seven power plants), Andhra Pradesh (six) and Tamil Nadu (seven). These are industrialised or higher income states and have higher energy demand. Within the states with coastal power, most of the power plants form coal clusters in the immediate vicinity of a coal port. A few larger companies have also been able to build dedicated ports to import coal to meet their own needs. Moving the coal a short distance overland from ports to power plants appears the preferred choice for operators, rather than locating the power plant on cheaper land further away from the port. But the picture is somewhat muddled as we also witness the opposite phenomenon where power plants that are located in or close to the main coal mining regions import coal, while power plants located further away from Indian coalfields still use domestic coal. The possibility to secure domestic coal supply contracts in many cases appears to trump the logistical considerations of coal transport.

In sum, India's new coal geography consists of coastal power plants spread across the country and driven by many different investors, from well-known Indian business groups to state power producers and relatively unknown private entities. The fact that these plants have great operational flexibility indicates the considerable political support they enjoy: where public authorities could have strictly enforced approval conditions pertaining to plant size, fuel use or environmental regulations, they have, in practice, preferred that power plants are established and become and remain operational.[11] It is, however, also apparent that many power producers persistently struggle to operate profitably with widespread low plant load factors, frequent attempts to renegotiate power purchasing rates and attempts to secure lower cost coal supplies (see e.g. [61,72,73]). While we thus note that overall the private sector appears to be preferred, when establishing new port and power plant infrastructure, the new coal geography, along with India's wider coal sector, struggles in actual operations, characterised by dramatic declines in private shareholder value and recurring government bailouts of public power plants [33,72].

While this section has mapped and analysed the big picture of India's new coal geography, we now turn to the analysis of how this geography is established in specific sub-national locations.

5. Goa: Reassembling infrastructure for India's new coal geography

Although Goa is now emerging as a new coal hub, it was iron ore mining that had long played an important role in the state's economy, and much of the state's infrastructure was configured to cater to mining. Mines in their own right claim much land, but the mining infrastructure additionally incorporated road transport networks [76] and riverine spaces, since much of the ore was transported by barge from the mining areas to the Mormugao port for export. The public sector Mormugao Port Trust (MPT), which operates the port, derived most of its revenue from iron ore exports. If capital is indeed value in motion, as Marx would argue [77], the mining ban that was imposed in Goa in 2012 severely undermined the ability of Goa's mining infrastructure to serve the needs of capital. When mining activities stopped, the associated infrastructure no longer underpinned the movement of raw materials, goods and services, and thus no longer played a role in the generation of capitalist value. Mining sites turned unproductive, barges and trucks sat idle, roads and rivers saw less traffic and activities and revenue for MPT fell dramatically. The ban on mining was thus a central component in a conjuncture in which multiple factors coalesced to create enabling conditions for the emergence of a new coal geography: the loss of jobs and income caused by the collapse of mining; a dormant infrastructure; a revenue crisis at MPT; a new national Indian government with grand visions for new infrastructure projects; and private industrial actors requiring coal. From this conjuncture emerged attempts to rework the state's existing infrastructure to a new coal geography.

At Mormugao port, central actors (both public and private) moved relatively quickly to reposition it as a multi-commodity port with an important coal component. In 2015, the port had two dedicated coal terminals, both run by private operators: one by a subsidiary of the private sector group Jindal South West (JSW), JSW Port Ltd.; the other by the private sector conglomerate Adani Group's Adani Mormugao Port Terminal Private Ltd. While coal had started arriving in minor quantities already in the 1990s [78], total coal imports stood at only 2.7 million tons in 2001. In 2011–2012, this amount had risen to nearly 7 million tons and in 2015–2016 to nearly 12 million tons per year – an increase of more than 70 percent in four years. In contrast to the new national coal geography, for which thermal coal is crucial, coking coal still dominates at Mormugao port. Coking coal comprised 82 percent of total coal imports in 2011–2012 and 67 percent in 2015–2016. But a transition is

[10] M/S. Coastal Energen Pvt Ltd. runs a 1050 MW power plant in Thoothukudi District, Tamil Nadu, M/S. Thermal Powertech Corporation India Limited has a 1980 MW unit in Nellore District, Andhra Pradesh. M/S. Ind-Barath Power (Madras) Ltd. operates a 660 MW power plant in Thoothukudi District, Tamil Nadu. M/S. Torrent Energy Ltd operates a 950 MW unit in Bharuch District in Gujarat.

[11] Since economic liberalisation, the structural power of Indian business in general has expanded dramatically, if unevenly [74]; but beyond such general assertions, little is known about how energy investors connect to policy makers, the strategies they deploy, etc. Gautam Adani, the chairman of the Adani Group, India's largest private coal mining company, largest coal port operator and largest coal importer, is known to have been close to Prime Minister Modi for many years, and allegations of crony capitalism (also in the coal sector) are often raised [75]. But details remain scarce.

clearly under way as the growth of thermal coal imports has outpaced coking coal during this period: thermal coal imports more than tripled while coking coal imports grew by 37 percent.

The integration of Goa into India's new coal geography aligns with the big national infrastructure programs of the GoI, namely Bharatmala and Sagarmala. The former is a road and highways project, while the latter seeks to 'unlock' the potential of India's waterways and coastline to promote 'port-led prosperity'. Under Sagarmala, a new master plan for Mormugao port was finalised in 2016 in which coal imports played a key role. To turn the port into a coal hub, the plan envisioned several new infrastructure projects at the port. One was the capacity expansion of the existing coal berths run by private actors to double imports [79]. The second was the expansion of the approach channel to enable much larger vessels carrying more cargo to dock. The third was the development of three additional berths to be used for coal import by Vedanta Limited, one of the largest extractive industry companies in the world [80]. The ambitious master plan operates with an 'optimistic scenario' in which up to 50 million tons of coal would arrive per year by 2035. To reach this target the master plan identifies 17 coal-backed power plants and more than 20 steel plants 'in the pipeline in the hinterland' ([81]: 291) as potential clients and envisions a much greater role for imported thermal coal in the future.

The coal geography that MPT's 'hub' connects to is truly global. As described by *The Indian Express* [82], a coal shipment for a steel factory in Karnataka began its journey in South Africa's Richards Bay – one of the largest coal export facilities in the world – where it was loaded onto a vessel sailing under a Bahamas flag, by the Singapore based importer Adani Global Private. After it arrived in Goás Mormugao port, it was transported by road to its final destination in Koppal, Karnataka state. Currently, the destination for most of the imported coal is the expanding, coking coal dependent steel factories in Karnataka, across the state border [79]. The Karnataka steel industry includes key actors at the MPT such as JSW Steel, another subsidiary of JSW. Its Bellary unit is the largest steel plant in the region, requiring more than 15 million tons of coking coal per year [78]. While this demand is largely met by ports located on India's East coast, JSW's terminal at MPT supplies one third of the coking coal [78,79]. The closer proximity to Mormugao port cuts down costs for JSW and is the main driver of the company's desire to expand its import via Goa. The Adani Group, another key actor involved in the reconfiguration of Mormugao port, mainly imports coal for its clients in the steel industry in Karnataka. But Adani is also India's largest private thermal power producer with an installed capacity of 12,450 MW, most of which is coal based. This includes a 1200 MW capacity thermal power plant in Udupi, in coastal Karnataka, which uses 100 percent imported coal as fuel and is proposed for a significant expansion to 2800 MW.

While the first part of Goa's infrastructural rearrangement thus centred on the expansion of an existing public port to enable private operators to import more coal, the second part centred on enabling the movement of imported coal from Mormugao port to destinations in Karnataka state. This involved widening and/or linking existing roads, doubling existing railway capacity and setting up power transmission lines to provide power generated outside the state to flow into Goa. Existing road, rail *and* riverine infrastructure is thus being reassembled to suit the needs of coal, with new infrastructure being added as well. These ambitious plans for a new road-river-rail corridor between Goa and Karnataka all entailed construction in the ecologically sensitive Western Ghats mountain range, one of the world's 'hottest biodiversity hotspots' and home to two wildlife sanctuaries. In addition to widening existing roads to enable more trucks to pass, an entirely new highway on viaducts running through pristine parts of one wildlife sanctuary is planned [78,80]. The new power transmissions lines similarly run through the wildlife sanctuary for several kilometres, while the laying of a second railway track through the Western Ghats takes place on the steepest gradient anywhere on the Indian Railway System [83]. According to official figures, more than 34,000 tonnes of coal is transported by this rail route every day, most of it by JSW [84,85]. Existing riverine infrastructure is also being integrated into the new coal geography. Six rivers have been nationalised under the National Waterways Act, 2016, in order to facilitate their rapid 'development' with, among other things, new jetties [86] that are ostensibly designed to stagger coal silos from MPT towards the east [82]. In combination, the road and rail projects will mean that 80,000 trees need to be cut and more than 200 ha of protected and reserve forests in the Western Ghats diverted [83]. The integration of Goa into the new coal geography will in these ways affect a large number of Goan villages [87,88].

Many of these deeply interrelated coal projects only make economic and infrastructural sense when seen as a singular intervention. Officially, they have, however, been split into small, isolated projects. This obscures the bigger infrastructural transformation underfoot, artificially minimises the 'official' environmental impact of the new coal geography and makes it difficult for those affected by localised coal-related developments to organise politically across sites and scales (for similar experiences see [34,89]). Yet from an environmental justice perspective, the negative impacts have been evident in Goa, and resistance has been considerable. Goan activists and civil society groups have documented how repeated violations of coal handling at Mormugao port, for example uncovered coal storage areas, causing coal dust to travel for miles [90], 'blackening lungs, pushing up incidents of respiratory disorder … threatening fragile forests, paddy fields, countless streams and rivers' [84]. Cases of bronchitis, sinusitis and pulmonary disorders have reportedly increased manifold, and the layers of coal dust that settle on fields and plants may damage photosynthesis, affecting crop yields and biodiversity [82]. Inadequately covered rail wagons spill coal along their journey through the state and release fugitive dust emissions [90]. The increased movement of trains and trucks with heavy loads also threaten old heritage buildings [84], and the channel dredging and capacity expansion at MPT coupled with riverine coal transport threaten to destroy the livelihoods of local fishing communities [80]. Coal has also been documented washing up on beaches, both in large chunks and as fine dust.

The vibrancy of Goan civil society [91] has ensured considerable popular opposition to the integration of Goa into India's new coal geography. Close to one third of Goa's villages have passed resolutions opposing the movement of coal through their areas [83], and different social movements have organised to stop coal-related infrastructural developments. This includes the Old Cross Fishing Canoe Owners Co-op Society, which is connected to the National Fishworkers Forum, as well as Goa Against Coal and Our River, Our Rights. The environmental appeals court – the National Green Tribunal – has been petitioned and cases have been filed in state-level courts; and the popular protests against coal led to the mandatory public hearing on environmental impacts for the Mormugao port expansion and road construction being extended to a full eight days, making it probably the longest ever public hearing in India. And, in the summer of 2020, protests against laying double tracks for railway transportation of coal erupted in many villages. Various state institutions have also interfered in the process. The Goa State Pollution Control Board has ordered reduced coal handling at Mormugao port, or has temporarily withdrawn its consent to operate, following breaches in pollution levels or excess coal handling. The Goa Coastal Zone Management Authority has expressed concerns about the consequences of dredging the approach channel to the port; and the High Court has admitted Public Interest Litigation against coal, even if it has refused interim stays on coal handling [92]. The integration of Goa into India's new coal geography has thus been highly controversial and the negative environmental and social consequences evident. But the import and transport of coal continues with strong political support.

The emergence of Goa as a coal hub within India's new coal geography is illustrative of the uneven and varied manifestation of this geography and of the ways in which it appropriates, reassembles and adds to existing infrastructure to suit the needs of imported coal, often with environmentally destructive effects. For instance, rather than using a

newly established port on 'easy to acquire' coastal lands, existing public sector ports were used in Goa. Both in Goa and in several other states, private companies operating within public sector ports are in fact the key movers of coal. In this regard, Mormugao port resembles Visakhapatnam port in Andhra Pradesh, Chennai port in Tamil Nadu and New Mangalore port in Karnataka, where official ownership is with the public sector, but where privately operated 'berths' within these ports do the actual heavy lifting. The infrastructure put in place by the national Indian government over many decades is thus put to use in the new coal geography by private sector investors who are able to swiftly adjust to new opportunities for importing coal or for moving domestic coal from one coast to the other. While the overall extent of this form of 'hidden privatisation' – where formal ownership remains public while operations are carried out by private companies – is not known, it is striking that parts of India's old coal geography have similarly been stealthily privatised, with many of Coal India's officially public sector mines in central India now outsourced to private operators [30].

Our Goa case is also illustrative of some of the contingencies and conjunctural specificities (e.g. the collapse of mining and the revenue crisis of MPT) that enable and shape the uneven integration of a region into India's new coal geography. In this sense, more regionally focused empirical research is needed to understand the specificities for other regions and states. Unlike, for example, Goa, Andhra Pradesh and Tamil Nadu, the state of Gujarat follows a very different pattern insofar as its coastal coal infrastructure does not consist of a focused geographical agglomeration next to a major port. Instead, many power plants in Gujarat simply have their own ports. In contrast, although Goa has a major public port by national standards, its State Electricity Department does not have its own power generating facilities, but depends entirely on allocations made by the central government, with roughly 80 percent of the contribution coming from coal-based power plants outside the state. Specific state-level political economies are thus important in shaping how a region is integrated into (or is left out of) the national coal geography.

Lastly, the Goa case has illustrated the considerable political support for India's new coal geography. The arrival of coal in Goa has been very unpopular among a broad section of citizens, and opposition has been significant. Goa arguably has India's most vibrant, most active and most resourceful civil society. Class and rural-urban differences are less pronounced in Goa than elsewhere in India, and there is a long history of social movements from below centred on the preservation of land, forests and livelihoods, all of which continue to inspire environmental activism in the present [91]. Yet, while the anti-coal campaigns in Goa might have succeeded in slowing down the transitions underfoot, they have not been able to stop coal in its tracks.[12] This does not bode well for other states where the political support for coastal coal is equally robust, but civil society is weaker.

As we argued earlier, Goa may not be a 'typical' case of how sub-national regions are integrated into India's new coal geography. While further research may indicate differently, there may in fact *not be* a typical sub-national case. Other states with significant coastal power – primarily Gujarat, Andhra Pradesh and Tamil Nadu – all present different combinations of features that have enabled the new coal geography. In contrast, states with coastal locations and industrialised economies like Maharashtra, Karnataka and West Bengal, which could have been integrated into the new coal geography, have not extensively supported coastal coal power plants. Untangling the drivers of the uneven manifestation of India's new coal geography is thus a complicated affair that requires in-depth studies at the intermediate and local levels.

6. Conclusion: A new Indian coal geography reinforces fossil fuel dependence

The development of a hitherto unmapped new Indian coal geography, located along the Indian coastline, dependent on imported coal and reliant primarily on the private sector, presents the emergence of a new resource landscape. This new energyscape is disconnected from the 'old' coal geography that was centred on extraction in the coal-bearing central-eastern heartlands, heavy duty railway transport and power production on the *peri*-urban fringes of mega cities. India's new coal geography reinforces fossil fuel dependence, and, as such, represents a transition to additional coal-based energy in spite of the rise of lower cost renewable energy solutions.

While the prolonged Indian energy crisis from the 1990s onward paved the way for the establishment of the new coal geography, there was no clearly articulated government master plan driving its emergence and no coherent centralised policy approach that made it happen. What we have seen is, rather, a prolonged period of gradual and distributed experimentation and flexible adjustment by private and public sector companies, but also across national and state governments, at a conjuncture of energy crisis that created enabling conditions for the emergence of a new coal geography operating alongside the old one. The new coal geography is thus not simply the outcome of unleashed market forces as much as private sector investors who were taking the lead: private coal depended on state divestment and reduced government control over energy and coal, but it also crucially piggybacked on India's political and bureaucratic structures for support, clearances and permits. Indeed, existing public infrastructure and extensive government support were (and continue to be) essential for making the new coal geography financially, politically and logistically possible. India's new coal geography, thus, relies on deregulation, even as it looks for support from the same political and bureaucratic structures during initial establishment and continued coal operations. The private sector investors of the new coal geography, in this manner and in the words of Bear ([95]: 19), sought to 'accumulate capital and power from the long-term history of colonial public works and their reconstitution in the present'.

While coal, thus, continues to be India's favourite fuel for electrical energy, the reasons for this are not simply straight-forward path-dependence. The flexible and responsive public–private collaboration in the domain of coal energy that we have analysed in this article has managed to put in place coal transport and thermal power generation capacity (via old and new coal geographies) on such a scale that it has largely succeeded in overcoming India's persistent electrical energy supply crisis.[13] Coal energy, thus, continues to enjoy policy support, in spite of occasional statements to the contrary [96]. And very large public investments have already been sunk into the material and infrastructural systems that sustain the new coal geography, suggesting that it will not be easily abandoned.[14] At the same time, it is very clear that a large part of India's thermal power sector is far from profitable. Operations are characterised by low plant-load factors, renegotiated price-purchasing agreements, changes to lower cost coal supplies, reduced

[12] This ability to ignore or fend off anti-coal protests in Goa is derived from the intimate nature of its dominant state-business alliance wherein the distinction between political and economic elites is blurred. Many political and bureaucratic careers in Goa are built on successful business ventures – in the real estate sector or in more or less direct involvement in the mining industry. It is well documented that some of Goa's most important political families function as focal points for large networks that span across the government, the bureaucracy and industry, whose shared interests they both articulate and respond to [93,94].

[13] Other persistent problems such as the equitable distribution of electricity to all citizens, including the poorest, and the inability to deal with the negative environmental and social consequences of energy production remain largely unaddressed at a national level [21,22].

[14] Further research would do well to connect India's new coal geography to its various international supply chains to understand rearrangements in coal-producing territories around the world and the political economy of coal trade.

environmental control and hollowed out shareholder prices on the stock market. The state-business collaboration that is able to build and operate coastal coal energy infrastructure is, in these respects, a highly uneven one without clear winners. And yet the infrastructure continues to find enough support to remain operational while coal imports rise steadily.[15]

And as we move to the state-level, we are able to note how, in addition to the prolonged work of experimentation and adjustment between many actors, the consolidation of coal also depended on considerable on-the-ground work to retrofit existing, and adding new, infrastructure. In other words, even as India continues to rely on coal, which is the most conventional form of energy known in the country, it has taken an enormous amount of effort to establish the new coal geography. These efforts include large monetary investments by private- and public-sector actors in infrastructure capable of handling millions of tons of coal and generating vast amounts of thermal power. But they also include the proactive support of political and bureaucratic structures across consecutive national governments and the different sub-national legislative bodies which are part of India's system of federal governance. In our Goa case study, support from public authorities was apparent, with a few notable exceptions, as various civil society groups and actors objected to aspects of the new coal operations from the expansion of port facilities, to storage and transport solutions. With the spectre of energy crisis still in recent memory, it appears that Indian policy makers prefer to continue supporting the new coal geography, even when renewable energy is available at a lower cost.

At a moment in history when climate change is evident and India's domestic renewable energy sector is fast expanding, the well-entrenched and expanding infrastructure and policy support, which underpins the new coal geography – and hence coal energy in India more generally – raises particularly complicated and uncomfortable questions about the country's possibilities to transition to low carbon energy in the future: Is India's new coal geography sufficiently robust to fend off the twin challenges of climate change and cheap renewables in the short to medium term? Based on the analysis in this article, the answer would seem to be a tentative yes. In relation to the increasing use of imported coal, it is noteworthy that India's first domestic commercial coal mine auction took place on 18 June 2020 under the slogan Unleashing Coal. With this auction, the government aimed to attract new private investors to 41 domestic coal mines – many of them in biodiversity rich forest areas – and make the country self-reliant in coal [97]. Tellingly, the prime minister had spoken of turning coal to diamonds through the auction process [98]. Rather than a transition away from coal, the main energy-policy question in India today, thus, concerns the relative share of domestic to imported coal within the dominant coal-based energyscape.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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